Technical University of Denmark

The feasibility of domestic CO2 emissions trading in Poland

Missfeldt, Fanny; Hauff, J.

Publication date:
2000

Document Version
Publisher's PDF, also known as Version of record

Risø-R-1203(EN)

The Feasibility of Domestic CO_2 Emissions Trading in Poland

By Jochen Hauff

Edited by Fanny Missfeldt

The study was supported by the UNEP Collaborating Centre on Energy and Environment, Risø, the Danish Energy Agency, and the World Bank Regional Office in Warsaw, Poland.

Risø National Laboratory, Roskilde
September 2000

Abstract In early 2000, neither a comprehensive upstream system nor an all-encompassing downstream approach to CO_2 emissions permit trading seems feasible in Poland. However, a pilot emissions trading system in the power and Combined Heat and Power (CHP) sector is thought to be a realistic option in the near future.

A comprehensive upstream approach would require permits for the carbon contained in fossil fuels produced or imported in Poland. It is ruled out due to the perceived difficulties of the inclusion of the coal sector in such a system. While inclusion of the gas sector, and especially of the oil sector, seems possible within a relatively short time, relying on an upstream approach without the coal sector is not advisable. Once the restructuring of the coal sector as well as the privatization of the gas and oil sector is advanced, an upstream approach might become an option again.

A comprehensive downstream approach would regulate CO_2 emissions at their source, that is mostly at point of combustion of fossil fuels. A system which includes industry, households and transport can be assumed to be infeasible. Instead, a "core program" was examined, which would focus on power and heat generation as well as energy intensive industries. Such an approach was found feasible in principle. Currently, however, only the largest emitters could be easily integrated in a reliable system. Drawing the line between those included and those excluded from such a partial system requires careful analysis. Including all enterprises in the relevant sectors would require significant improvements in monitoring and reporting reliability.

For both the upstream and downstream approach, the issue of electricity imports from the liberalizing European power markets poses a serious challenge. A national permit system might discriminate against domestic power producers and the environmental goal might be undermined by imports from foreign producers, if these are not subject to carbon regulation in their home country. Unless internationally agreed solutions are found to solve this problem, trading systems are unlikely to become a binding policy tool with significant environmental effects.

A pilot emissions permit trading system could be introduced in the professional power and heat sector. Here, awareness concerning the instrument was found to be high and the system could be based on monitoring requirements already required by law. Gradual inclusion of more relevant sectors and eventual combination with an upstream component to include oil refineries, and with them the growing CO_2 emissions from transport, seem possible.

Such a pilot program would allow firms and the policy maker to gather relevant experiences for the possible future introduction of a comprehensive system and for the emerging international emissions trading system. To determine whether a pilot system is desirable, however, an extensive and comparative analysis of different climate protection policy options is still needed for Poland. It should include a close look at the implications of EU climate protection policies and the effects of the liberalization of international electricity markets on domestic policy options.

ISBN 87 – 550 – 2740 – 7
ISBN 87 – 550 – 2729 – 3 (Internet)
ISSN 0106 - 2840

Information Service Department, Risø, 2000

Preface

> "Many thought that environmental damage would be ended precisely by the abolition of the greed and the selfishness of private property. But it did not happen. The bureaucracy of a classical socialist system [.] is even more short-sighted in this respect than the decision makers of other systems"(Kornai 1992, p.178)

When the Communist regimes collapsed in the early nineties of the last century, environmental policies in the region had hardly emerged in practice. As Kornai describes, central planning had lead to some of the highest levels of pollution, including some of the worst environmental disaster zones. Examples are Chernobyl, the Black triangle, and Chelyabinsk. On the other hand, the region remained host to distinctly higher levels of biodiversity than in Western Europe.

Following transition, many countries wholeheartedly replaced central planning as the means of resource allocation. Ideas emerged to also use the market in the area of environmental policy, for example through emissions trading. Earlier than many Western European countries, experts from Poland have been interested in using emissions trading as an instrument of environmental policy. Among the first trading experiments in Europe were those in Chorzów and Opole in Poland.

However, efforts did not go beyond these early attempts. After all, economic transition brought along major challenges of reform, as reflected in a decline of GDP of 17.8% at its worst (Fischer et al. 1996, p.52). Policy reforms in Poland have mostly been focusing on accession to the European Union. Even if Poland had endorsed emissions trading at that point, it would have conflicted with the European Union, who until the endorsement of the Kyoto Protocol to the Climate Convention in 1997 mainly focused on a carbon and/or energy tax.

Following Kyoto, however, legislation for domestic trading was introduced in Denmark in 1999, and has been discussed in the United Kingdom, Sweden, and France among others. In early 2000, the European Commission published a 'Green Paper' on the possibility of introducing EU-wide trading (EC 2000).

Against this background, the relevance of an analysis of emissions trading in Poland appears more pertinent. Questions in this context are: whether greenhouse gas emissions trading is a useful tool for Poland, and in which part of the economy an emissions trading regime could most suitably be implemented. The report presented here attempts to find answers to the second question.

This report presents the main findings of Jochen Hauff's Master thesis, which he wrote in the summer of 1999 in Warsaw. His work was able to benefit from a large number of interviews with Polish experts, and from a survey he conducted among Polish industry. It was funded through the UNEP Collaborating Centre with the financial support of the Danish Energy Agency. The Warsaw office of the World Bank and the Energy Market Agency (ARE) provided logistical support.

Fanny Missfeldt, Roskilde September 2000

Acknowledgements

This paper is based on the empirical part of my Masters thesis in environmental economics, prepared under the auspices of Prof. Dieter Cansier, University of Tübingen, Germany. It contains the results of empirical research which I conducted in Warsaw, Poland during June 16 to September 17, 1999.

The research was made possible by the financial support I received from the United Nations Environmental Programme Collaborating Centre on Energy and Environment, at Risø National Laboratories, Roskilde, Denmark. Dr. Fanny Missfeldt coordinated and reviewed the study and its present edition on behalf of the Centre. I thank her very much for all her valuable comments and support. Equally important was the logistical support provided by the World Bank Regional Office in Warsaw. Using their facilities and being able to profit from the discussions with World Bank staff laid a very good basis to my work. In particular, I wish to thank Mr. Christian Duvigneau, Mr. Johannes Heister and Mr. Basil Kavalsky for allowing me to work under such ideal conditions.

The research itself proved highly rewarding. Practically all people contacted in Polish environmental policy making and in the energy sector were highly interested in the topic and were willing to share information. This resulted not only in a good response rate in the empirical survey conducted, but was expressed also in numerous conversations I enjoyed during my stay. I am very thankful to all my conversation partners in Poland[1], who bore with my Polish and made their knowledge available. Crucial for the success of the empirical survey was the support I received from Mr. Marek Kumanowski, Mr. Ryszard Giliecki, Mr. Bogusław Dębski and Ms. Johanna Kacprowska and their friendly colleagues at the Energy Market Agency (ARE), Warsaw. Also, the help I received from various international experts[2], who commented on drafts of my questionnaire is gratefully acknowledged.

Finally, I thank for the support of my partner, Beth Coffey, who accompanied the work on the original thesis and this report with much patience and native-speaker's criticism.

Despite the already extensive coverage presented in this thesis, there remains a considerable amount of information unused. This refers to data raised in the empirical survey which went beyond the focus on CO_2. Other relevant topics such as the influence of Poland's envisaged membership to the EU or the technological options for CO_2 reduction had to be largely ignored due to time constraints. I do hope that this paper can contribute to a discussion on a domestic greenhouse gas system in Poland.

Jochen Hauff

Budapest, May 10, 2000

Permanent email contact: jochen@hauff.net

1 A list, too long to mention here, is included in the back of the paper.
2 I am thankful for comments from Stefan Bayer, Bogusław Dębski, Henryk Gaj, Ned Helme, Cathleen Kelly, Jürgen Lefevere, Fanny Missfeldt, Maciej Sadowski and Peer Stiansen.

Table of contents

List of tables

List of figures

List of abbreviations and acronyms

AIJ	Activities Implemented Jointly
ARE	Agencja Rynku Energii [Energy Market Agency], Warsaw.
CAC	Command and Control
CDM	Clean Development Mechanism
CFC	Chlorofluorocarbon
CHP	Combined Heat and Power
CH_4	Methane
CO_2	Carbon dioxide
CO	Carbon monoxide
GDP	Gross Domestic Product
Gg	Gigagramm (one Gg = one thousand metric tons)
GHG	Greenhouse Gase(s)
GUS	Głowny Urząd Statystyczny [Central Statistical Office], Warsaw.
GWP	Global Warming Potential of greenhouse gases
HFCs	Hydrofluorocarbons
HMG	High Methane Gas
JI	Joint Implementation
LMG	Low Methane Gas
LNG	Liquified Natural Gas
LPG	Liquid Petroleum Gas
NO_x	Nitrogen oxides
N_2O	Nitrous oxide
PARG	Polish Coal Sector Restructuring Agency
PFCs	Perfluorocarbons
PKN	Polski Koncern Naftowy [Polish oil company]
PLN	Polish Złoty
POGC	Polish Oil and Gas Company
PSE	Polskie Sieci Elektroenergetyczny [Polish Power Grid Company]
SF_6	Sulfur hexafluoride
SO_2	Sulfur Dioxide
TJ	Terajoule
TPA	Third Party Access
UNFCCC	United Nations Framework Convention on Climate Change
VAT	Value Added Tax

1 Introduction

The idea to use tradeable emissions permits in environmental policy is not a new idea. It was proposed by Dales (1968) more than 30 years ago, and has received much attention in economic literature to date (Baumol and Oates 1988, Hanley et al. 1997). Attempts of implementing trading regimes followed in practice, and Poland did gather some experimental experience concerning emissions trading in the early 1990s (Żylicz 1998). While several countries have successfully implemented trading systems as part of their environmental protection policy (Mullins 1998), recently also with regards to GHG (Pedersen 1999), Polish air protection policy to date follows the majority of European countries and continues to rely on a mixture of technical emission standards and charges.

Currently, the international discussion around emissions trading has gained new momentum due to its inclusion as a policy tool in efforts to protect the global climate. For Poland, too, its emissions reduction commitment under Kyoto Protocol to the United Nations Framework Convention for Climate Change (UNFCCC) necessitates a discussion on how current and future commitments can be achieved best. The fact that Poland might act as an important seller in a potential emissions quota market (Missfeldt and Villavicenco 2000) or in a future version of the EU burden sharing agreement, provides additional motivation for considering the introduction of a CO_2 emissions trading system in the country.

This paper is taking an empirical viewpoint when examining the feasibility of a tradeable CO_2 emissions permit system in Poland.[3] The presented analysis identifies issues and conditions, which would need to be addressed in the Polish case, and proposes design features of an emissions trading system which might ease its introduction in the country. The paper does not deal with the fundamental question of *if* such a system would be desirable for Poland at all. To answer this most important question, a comparison of a tradeable emissions permit system with other instruments of climate protection policy (such as technical standards or a carbon tax) would be necessary. While the present study could serve as an input to such a comprehensive approach, it can by no means replace it.

The analysis is based on interviews and a survey conducted among those enterprises in Polish industry, which are likely to be players in a potential emission permit market. It was the aim to assess industry awareness of and attitudes toward climate protection in general and emissions trading in particular. Also, information on technical parameters such as monitoring equipment and reporting procedures in place was raised directly from potentially affected enterprises. Supplemental statistical data is provided to judge the significance of certain industry sectors from the point of view of CO_2 emissions and in order to get an idea of the number, size and progress in restructuring of enterprises in relevant sectors. Combined with a description of the framework for environmental policy making in Poland and a review of Polish pilot programs and research, a clearer picture emerges, in how far and when CO_2 emissions trading may be a feasible option for Polish environmental policy.

The paper is structured as follows: Section 2 reviews the framework for environmental and climate protection policy in Poland. This includes a look at the current and projected emission and energy situation of the country, its legislative framework in air pollution control and an overview of research and experiences concerning the introduction of a tradeable pollution permit system in

3 Methane and N_2O represent roughly 23% of Polish GHG emissions expressed in GWP in 1988 (Househam et al. 1998, p. 148). A discussion of a comprehensive system, covering these GHG as well would be desirable, but was beyond the scope of this paper.

Poland. Poland's program under the AIJ pilot phase is also discussed here. Against this background, the empirical approach of the paper is laid out in Section 3, where methodology and summary results of the questionnaire-based survey are presented and where the interview partners are named. Also, a set of criteria defining an ideal point of regulation for CO_2 is presented. The following sections aim at finding this point by examining the technical monitoring requirements and options, enterprise awareness and attitude as well as industry restructuring.

In Section 4 the implementation of a "downstream approach" is discussed for Poland. This design option would affect actual emitters of CO_2, and among them mostly consumers of mineral fuels for energy purposes such as power and heat producing companies and energy intensive industries. A second design option discussed in Section 5 is the so-called "upstream approach," where potential CO_2 emissions in the form of carbon contained in fuel are subject to regulation. Such an approach would affect producers and importers of mineral fuels in Poland, that is the coal, gas and oil industries. In the final Section 6, a pilot system in the Polish power sector is proposed as a feasible first step towards a more comprehensive CO_2 emissions trading system in Poland.

2 The context for climate protection policy in Poland

2.1 Polish commitments and CO_2 emissions

Poland signed the UNFCCC in 1992, ratified it in 1994, and became a full party to the Convention on 26 October 1994 (Secretariat 1999a). As a baseline year for GHG emissions, 1988 was chosen.[4] Under the Convention, Poland committed not to exceed 1988 GHG emissions by the year 2000. Under the Kyoto Protocol, which Poland signed in July 1998, the country committed itself to a 6% reduction of a basket of emissions by the period 2008-2012 (Secretariat 1999b). The total of Poland’s CO_2 emissions in the base year 1988 as given in the Second National Report, amounts to 477,584 Gg (RP 1998c). Poland is, after Russia and the Ukraine, the third largest emitter of GHG emissions in Central and Eastern Europe (Simeonova and Missfeldt 1997).

4 Poland makes use of Article 4.6 of the Convention which allows ‘a certain degree of flexibility’ to countries with economies in transition in fulfilling their commitment (UN 1992). This can been justified by the fact that 1988 represented the last ‘normal’ year before the setting in of strong economic recession in the second half of 1989.

Table 1: Polish CO_2 emissions inventory in 1988 and 1997				
	1988		1997	
	Emissions in Gg	Emissions in % of total	Emissions in Gg	Emissions in % of total
TOTAL DOMESTIC EMISSIONS	477,584	100.0	362,301	100.0
1. All Energy (Fuel Combustion + Fugitive)	463,051	97.0	350,962	96.9
1.A. Fuel Combustion	462,998	96.9	350,876	96.9
1.A.1. Energy and Transformation Industries	260,537	54.6	192,783	53.2
1.A.2. Industry and Construction	60,900	12.8	70,025	19.3
1.A.3. Transport	28,238	5.9	26,663	7.4
1.A.4. Other Sectors	111,229	23.3	60,857	16.8
1.A.5. Other	2,094	0.04	549	0.2
1.B. Fugitive Emissions from Fuels	53	0.01	86	0.02
1.B.1. Solid Fuels	NA	NA	0	0.00
1.B.2. Oil and Natural Gas	53	0.01	86	0.02
2. Industrial Processes	13,574	2.8	10,664	2.9
2.A. Mineral Industry	12,036	2.5	9,872	2.7
2.B. Chemical Industry	29	0.00	136	0.04
2.C. Metal Production	699	0.01	656	0.2
Source: RP (1998c); MEPNRF (1999d)				

As is evident from Table 1, emissions from energy use in energy and transformation industries account for by far the largest share in overall CO_2 emissions, followed by industry and construction. While emissions from transport decreased in absolute terms between 1988 and 1997, their share increased from 5.9 to 7.4% in 1997. Process related industrial emissions reach only 2.9%. In total, CO_2 emissions in 1997 amounted to 362,300 Gg, which represents 76% of their 1988 level. Emissions of Methane and N_2O in 1997 were at 73% and 77% of the 1988 level, respectively. Hence, Poland will with certainty meet its commitment under the UNFCCC to keep emissions in the year 2000 below the base year level. With regard to the 6% reduction by the 2008-2012 commitment period under the Kyoto Protocol, several forecast scenarios exist.

A country study (IEP 1996), undertaken with support of the US government, assessed a range of scenarios with a time horizon until 2030. It concluded that Poland will exceed 1988 CO_2 emissions by 2010 when undergoing base-line economic development of 3-5% annual GDP growth and in the absence of any climate protection policy. If such "base-line" growth was combined with weak or strong climate protection policies, however, Poland would emit less CO_2 in 2010 than in 1988. Other scenarios which assume stagnation (2-3% annual GDP growth) or rapid GDP growth (4-6%) predict CO_2 emissions in 2010 to be below 1988 levels, independent of whether no, weak or strong climate protection policy measures are assumed.

For the decades thereafter, only those scenarios which include the option of utilizing nuclear energy and make the most optimistic assumptions about the ability of the Polish economy to integrate newest, highly energy efficient technologies show a significantly lower value of absolute CO_2 emissions until 2020 and 2030 compared to 1988. The more modestly optimistic assumptions of the base-line scenario with 3-4% annual GDP growth after 2010 project an increase in CO_2 emissions between 1% and 20% during 1988 and 2030, depending on the strength of climate protection policy and the impact of temperature increases. The pessimistic "economic stagnation" scenario assumes only around 2 % annual GDP growth and leads to 10-15% increases in Polish CO_2 emissions when comparing 2030 values to 1988 emissions.

A 1999 preliminary[5] update of the IEP study (FEWE 1999) revised the assumptions concerning macroeconomic development upward. The study considered an "active," a "basic" and a "passive" economic growth scenarios, where 8-6%, 7-5%, or 6-2% annual GDP growth rate would be achieved respectively.[6] Based on these optimistic assumptions and additional assumptions regarding a growing share of the service sector in the economy and of improving energy efficiency, the model indicates CO_2 emission levels of around 15% under the 1988 value by 2010 for all three scenarios. The Kyoto target of 6% reduction by 2008-2012 seems thus likely to be achieved even without an active climate protection policy (FEWE 1999, p. 29).

By 2020, the assumption of no particular climate policy and an "active" economic development leads to CO_2 emissions of 6% below the base year level, a "basic" economic dynamic generates emissions only 3% below base year level, and a "passive" development would lead to emissions of 12% under 1988 level (FEWE 1999, p. 11). Hence, according to these projections, if further international efforts to reduce GHG emissions after the first commitment period are assumed, Poland would need to resort to more active climate policies in order to meet future targets.

The main conclusion from these figures is, however, that Poland is likely to be in the position to achieve emission reductions significantly higher than its commitment even with a relatively modest climate protection policy. FEWE (1999) estimates that abatement measures costing below 20 USD per ton of reduced CO_2 emissions could lead to a 20% reduction of total CO_2 emission by 2010 in relation to the base year level. Hence, implementing *some* GHG abatement instrument in addition to the favorable economic restructuring could make Poland an important seller on an international emissions or quota market.This potentially lucrative activity (compare Missfeldt and Villavicenco 2000) might be a main argument for Polish decision makers to engage in emissions trading.

2.2 The Polish energy sector

As displayed in Table 1, the combustion of fossil fuels is by far the most important source of GHG emissions in Poland. A look at consumption levels and the structure of Polish energy supply is thus crucial to understand possibilities and consequences of regulating carbon emissions in Poland. While fuel specific data will be provided when discussing implementation issues further below, this section is intended to provide a quick overview of the Polish energy situation.

At the beginning of its transition to a market economy, the Polish economy belonged to one of the most energy intensive in the world (Meyers et al. 1994). The emphasis on heavy industries, artificially low prices for energy, and production inefficiencies are among the reasons why in 1992, Polish energy intensity[7] was two and a half times higher than the OECD average (OECD 1995).

---

5 The study is still subject to review by the government so that the numbers included are not official yet.

6 In all scenarios, the rate of growth is declining slowly from the higher to the lower value given until 2020.

7 Expressed as unit of GDP per unit of primary energy consumption.

Table 2: Poland's economic growth and change in energy consumption, 1989-1998										
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
GDP (% change on previous year)	0.2	-11.6	7.0	2.6	3.8	5.2	7.0	6.0	6.8	4.8
Energy consumption (% change on previous year)	-5.0	-17.6	-2.1	-1.1	4.1	-4.9	3.3	8.9	-3.7	-7.4
Source: GDP growth rates 1989-1992: World Bank (1997), 1993-1997: GUS (1999a), 1998: GUS (1999b). Energy consumption: calculated from ARE (1999a). Data for 1998 are preliminary.										

The data presented in Table 2 indicate that a decoupling of economic growth and energy consumption took place in Poland during the past years. While GDP grew steadily since 1992, annual energy consumption fluctuates around a downward trend. Energy consumption is influenced by improving energy efficiency in the economy and climatic circumstances (GUS 1998a). A decoupling can be clearly stated as energy consumption in 1998 was below the 1992 level in absolute terms (ARE 1999a). This development is the main reason for the significant reduction in Polish CO_2 and SO_2 emissions (compare MEPNRF 1997 and Salay 1996).

Based on a comparison with other OECD countries, forecasts by NOBE (1999) expect an absolute growth of energy consumption in the next 20 years. The growth rate, however, is expected to be roughly a third of the growth in GDP, which implies that the efficiency of energy consumption is foreseen to increase significantly (NOBE 1999).

With regard to the structure of Polish energy supply, the dominance of coal is evident in Table 3: almost 70% of energy supply comes from this source, followed by crude oil with roughly 15% and natural gas, accounting for about 9% of supply in 1997. Coal dominates Polish electric power generation: 94% of installed capacity is coal-fired, a third of which is represented by the five big brown coal power plants (GUS 1998a, p.375).

Table 3: Total energy supply in Poland 1997		
	Absolute in TJ	Share in %
Steam Coal	1925159	44.0
Coking Coal	589565	13.5
Brown Coal	543676	12.4
High Methane Natural Gas	325235	7.4
Nitrified (Low Methane) Natural Gas	69054	1.6
Crude Oil	632514	14.5
Peat and Wood	127507	2.9
Hydro and Wind Energy	71772	1.6
Solid Waste Fuels	7476	0.2
Derived Energy Balance	84271	1.9
Total Energy Supply	4376229	100
Source: GUS (1998a), Table 1(4).		

Official forecasts concerning the energy structure go back to the "Energy Policy Guidelines" from 1995 (MoIT 1995), which have been reiterated more recently in Poland's response to the EU questionnaire concerning the energy sector (RP 1996a).[8] These forecasts foresee a relatively slow reduction in coal use. In particular the brown coal plants are expected to continue to play an important role in the future as a commercially cheap source of electricity. The use of gas is expected to increase, mainly due to newly installed peaking power capacity as well as due to replacement of small-scale boilers in municipal heat supply.

A shift to gas can also be expected to be driven by a long-term contract on gas deliveries from Russia. This "take or pay" contract will double the amount of gas delivered to Poland annually by the year 2010 (RP 1996a). Oil and oil-derived products are forecasted to play a growing role due to the increase in road based transportation of persons and freight. Other energy carriers are expected to remain of marginal importance. Recent but not official forecasts envisage a faster decline in coal consumption than the governmental projections. According to NOBE (1999), the share of coal in total primary energy consumption will half until 2020.

2.3 The evolving institutional framework for environmental protection in Poland[9]

While the importance of energy policy for effective climate protection in Poland cannot be underestimated, the elaboration and implementation of an explicit climate protection policy would fall under the responsibility of the environmental protection authorities (Personal communication Sobiecki). A tradeable carbon emission permit system would build on and be coordinated with regulation and procedures that are already a part of the environmental protection policy.

This section gives an overview of environmental protection policies in Poland. After a brief discussion of the ground-laying legal documents, the focus is on the regulation of air emissions in Poland. Issues of monitoring, reporting and verification are included as they are crucial elements of a workable tradeable emission permit system. Institutions and regulation dealing directly with climate protection policy are highlighted in a separate sub-section.

2.3.1 Legal basis and policy documents

The Water Law from 1974 (KS 1999a) and the 1980 Environmental Protection Act (KS 1999b) with their numerous amendments provide the legal basis for environmental protection in Poland. These acts follow a mixture of the "polluter pays" and the "user pays" principles, as they contain legislation addressing actual emissions to the environment as well as the use of natural resources. The legal basis has been updated to explicitly endorse the principle of "sustainable development" in 1994 (RP 1996b, p.7).

Under Part V of the Environmental Protection Act, provisions for the use of "economic instruments" are collated (KS 1999b). These provisions refer to fees (Articles 86-86g) and funds (Articles 87-88j), which, alongside with fines (Articles 106-110c) are discussed in more detail in Section 2.3.2. In the Act, no mention is made with regard to emissions trading. However, the regulations concerning air emission (Articles 25-32) stipulate that new firms, which want to operate in a non-attainment area[10] can invest in mitigation options at existing firms in order to be granted an operation permit. Such a local "bubble" is, however, rarely used in practice as firms rather invest in their own installations or seek locations elsewhere (Personal communication Kamiński, S).

8 In late 1999, new "Energy Policy Guidelines" containing revised forecasts were under preparation by the Ministry of the Economy.
9 Apart from the personal communications cited, the section benefitted from discussions with Barbara Letachowicz, World Bank, Eugieniusz Jędrysik, MEPNRF, Zbigniew Karaczun, MEPNRF, Miroslaw Soboloewski, Chancellory of the Sejm, and Tomasz Żylicz, University of Warsaw.
10 The Polish air protection legislation defines a set of ambient air quality standards (see Section 2.3.2). In areas where these are not attained, the authorities can, in principle, not permit additional pollution.

The legal basis is accompanied by an official "National Environmental Policy" (MEPNRF 1991), which served to define aims and priorities for policy making since its adoption in 1991. A draft of the latest update (MEPNRF 1999b) reaffirms the general aim of environmental policy to warrant "environmental security" (paragraph 12) of Poland's inhabitants and environment, and stresses the importance of meeting the environmental criteria set by the EU as a means to reach this goal.

Two sets of criteria are proposed in the policy draft. The first set prioritizes among environmental problems. According to Paragraph 22, global environmental problems such as GHG mitigation would rank after the elimination of pollution hot spots and the mitigation of foreseeable environmental degradation within the country. With regard to how these measures should be implemented, the criterion of cost-effectiveness ranges first, followed by the economic viability of the supported projects and their demonstration character. With regard to emissions trading, the document calls for an enabling clause to introduce a tradeable permit system (paragraph 24) without going into more detail about this option (MEPNRF 1999b).

These criteria, if adopted, could mean that climate protection policy might have a difficult stance if it competes for official funds with more immanent local environmental needs. On the other hand, making cost-effectiveness an important criteria might help the introduction of the principle of emissions trading.

For several years, a comprehensive "Environmental Act" has been under discussion in Poland (see Jendrośka 1998 for an account). It is meant to replace the collection of legal acts pertaining to partial aspects of environmental protection, which currently serves as a base for environmental policy making. Several drafts have been worked out and re-written since 1991, but none of them has ever found enough support to be submitted to parliament (Żylicz 1999).

The most recent available draft in 1999 relies heavily on the existing system of environmental fees (Draft Act, no year). In an accompanying document, which explains and justifies the choices made in the draft of the legal text, it is stated that the system of fees should continue to play the role of a financing instrument rather than an incentive to reach a certain environmental goal. With regard to emissions trading, the document states that it should be treated as an option which could be introduced in the future.[11] This draft act, which is the latest one publicly available at time of writing, did not find support within the current government. A new draft is currently underway, which was intended to be up for public debate in late 1999. This draft is said to include no provisions which would, at least in principle, allow for the introduction of a national or international permit system in environmental protection (Personal communication Kamiński, S).

2.3.2 Administrative procedures in place

The administration of environmental protection in Poland is relying on a combination of standards and a system of emission fees and penalty fines, which was established already in the 1970s. During socialist times, this system had hardly any impact on the behavior of firms (Śleszyński 1998). Fees and the significantly higher penalties for exceeding the allowed emission standards placed no effective incentive for pollution abatement, because state-owned enterprises were operating under

11 The possibility to introduce a national system of tradeable emission permits is provided for under Art. 91 of the draft. Here, the Minister responsible for environmental protection is allowed to introduce such a system by way of ministerial decree. This decree would define the pollutant addressed as well as the geographical reach of the program. It would determine the way to account for the ambient impact of emissions and provide for monitoring and reporting guidelines. Since CO_2 emissions are not regulated by regional ambient standards, but would have to be addressed in a national approach, Article 91 would be the relevant provision of the draft for our purposes. The draft text of Art. 90 gives all responsibility for design issues to the Minister. Importantly, the fact that it could be introduced by decree would make the introduction of the system a decision of the executive authorities and would not need parliamentary approval.

soft budget constraints.[12] This led to the (legal) practice that firms chose to exceed the standards and to pay the penalty rather than reducing emissions (Żylicz 1994). The fines paid to the state budget were thus financed by the state budget. Żylicz concludes that there was in practice no command and control system in existence, but "a market with unlimited access to the environment, treating it as if its resources were limitless" (Żylicz 1994, p.97).

In 1989 and 1990, significant changes to environmental policy were introduced. While the standard and fee system was maintained in principle, it was made a more effective tool by giving environmental authorities the power to close down (fully or partially) polluters which exceed emission standards and by increasing the fee and fine levels in real terms, that is to a level exceeding a mere adjustment to inflation (Anderson and Fiedor 1997). At the same time, the enterprises faced hardening budget constraints, which made fees and penalties for non-compliance a more important factor in their decision making. Nevertheless, non-compliance and non-payment remain a significant problem in some sectors (Śleszyński 1998).

a) Emissions and ambient standards

Polish environmental policy relies mainly on ambient concentration standards for 172 substances in water, air and soil. These were last updated in 1998 by decree of the Minister of the Environment (Dz. Ust. 55 poz. 355, 6.5.1998). The ambient pollution concentration is monitored by the State Inspectorate for Environmental Protection and its regional subsidiaries.

Regional and local authorities[13] are responsible for issuing operating permits for installations and processes that emit at least one of the 172 pollutants, which are subject to ambient standards[14] (KS 1999b, Article 30). In these operating permits the allowable emission rates for pollutants are defined. In principle, operation permits are issued by the "Starosta," the head to the local administration. Operating permits for installation emitting "particularly dangerous" substances as well as power generation capacity of more than 300 MW are issued by the Voivods (Rz 21.9.1998). Guidelines for granting such a permit were last specified in a decree by the Minister of Environmental Protection (Dz. Ust. 124 poz. 819, 30.9.1998), according to which the regional or local authority has to consider, among others:

- the technical circumstances of installations,
- fuel specific aspects,
- pollutant removal activities,
- monitoring possibilities.

Also, the decision maker has to consider the ambient air quality in the region (KS 1999b, Article 28).

A substantial number of enterprises is thought to be operating without valid operating permits. This is not only the result of attempts of (mostly smaller) enterprises to avoid such a permit, but also due

12 Kornai (1992) describes the concept of a soft budget constraint, where firms in a planned economy are seen to have little if any reason to comply with financial incentives (or fines) as they are focused on meeting physical output targets. Eventual financial losses could be expected to be covered by the state budget or soft credits as bankruptcy provisions did not exist for political reasons.

13 The Polish system of public administration is divided into central, regional and local levels. *Central* authorities comprise national ministries and their associated institutions. On the *regional* level, two administrations coexist. The "Voivode" is the representative of the central government and is appointed by the Prime Minister. The "Marshal of the Voivodship" is head of the executive organ of the regionally elected "Sejmik" (small parliament), and thus represents the "self-administration" of the region. The division of responsibilities between Voivod and the Marshal of the Voivodship are regulated specifically in each law which affects the regions. On a *local* level, the "powiat" (county) comprises several "gminas" (communes). The "Starosta" is head of the county council, while the "Burmistrz" (mayor) presides over the communal or town council (PPWK 1999).

14 Internal combustion engines coal combustion devices under 0.5 MW and gas, coke or biomass fired installations smaller than 1 MW of installed capacity are exempt from the requirement to hold an operating permit (KS 1999b, Article 30). They are nevertheless required to report emissions and pay fees if they are run by a registered business entity (Personal communication Kamiński, S).

to a backlog of permit issuance following changes during administrative reform.[15] As permits have to be renewed at least every ten years, the work-load for permit issuance is permanently high (Personal communication Rachobińska). The regional authorities respond to this problem by prioritizing among the permit applications. Permits for (known) large polluters can be expected to be reviewed first, in order to capture the most important sources (Personal communication Rachobińska).

Apart from the emission limits defined by regional authorities in the operating permits, binding emission standards for SO_x, NO_x, CO and dust from combustion processes are set for the whole of Poland by decree of the Minister of the Environment (Dz. Ust. 121 Poz 793, 22.9.1998).[16] The decree was last updated in late 1998. It distinguishes "existing" from "new" installations, and assigns differing emissions standards to them.[17] For old sources, stricter standards are announced for the period of 2006-2010. The decree stipulates a requirement for continuous monitoring for all sources with an installed thermal capacity of more than 300 MW. Sources of that size which are not yet applying continuous monitoring are required to do so by January 1, 2001 (§ 11). Smaller sources are required to conduct measurements of their actual emissions at least twice a year (§ 12).

The due application enterprises emission standards as well as emission permits in enterprises' operation permits is controlled by the subsidiaries of the State Inspectorate for Environmental Protection at Voivode level. The Inspectorate conducts site visits and takes measurements. In 1997, a third of the more than 36,000 registered polluters nationwide was controlled by the Inspectorate. In a fifth of all controlled cases the controls involved actual measurements taken on site (GUS 1998b).

b) Fees and fines

The fees which enterprises have to pay for their resource use or for emissions are based on self-reported data. Enterprises submit quarterly reports of their emissions and calculate their payment to the regional authorities based on a list of fees set by the Ministry of the Environment. This list is updated annually. Fee levels for air pollutants set in the most recent update are given in Table 4.

Table 4: Fees imposed on the emissions of some major air pollutants

	in Polish Złoty per ton	in US Dollar per ton[18]
SO_2	330	82.7
NO_x, (including N_2O)	330	82.7
CO	90	22.6
Dust	220	55.2
CO_2	0.17	0.04
CH_4	0.17	0.04
CFCs	115500	28956

Source: Dz. U. 1998 Nr 162 poz. 1129

15 The reform of public administration and self government entered into force on January 1, 1999. It reduced the number of Voivodships from 48 to 16, and introduced the administrative setup described in footnote 13.

16 These pollutants are also included in the ambient standards discussed above. This might lead to the situation, that while emission standards are fulfilled, ambient standards for these pollutants are exceeded. In such cases, regional authorities are entitled to require existing sources to meet stricter standards than forseen in the Ministerial decree on emissions standards. However, these standards cannot be stricter than those existing for new sources (Dz. Ust. 124 poz. 819 30.9.1998). This means that the right of the enterprise to operate and emit is overriding the objective to meet ambient standards.

17 "New" are all installations that were put in operation after 28 March 1990. All older installations are referred to as "existing" (Dz. Ust. 121 Poz 793, 22.9.1998) § 1,2.

18 Using the interbank exchange rate of 1 USD = 3.9890 PLN, of September 6, 1999.

Żylicz (1994), Anderson and Fiedor (1997) and Śleszyński (1998) agree that the fees are set below "Pigouvian level." Put differently, while they do provide *some* incentive to abate, fee levels are not high enough to reach efficient levels of abatement. This is also due to the fact that fees are deductible from taxable income, which considerably reduces their impact on firm profits (Śleszyński 1998).

Anderson and Fiedor (1997) point out that while absolute levels do not correspond to actual damage or cost of abatement, the *relation* of the different fee levels might roughly represent the relative harmfulness of the pollutants. This is, however, not true in the case of GHG, where the same amount is charged for CO_2 and methane emissions. This indicates that no account is taken of significantly higher Global Warming Potential (GWP) of methane.[19] Anderson and Fiedor (1997) conclude that "ultimately the rates are set at levels that are politically acceptable and meet revenue requirements" (p.3). Śleszyński (1998) argues that revenue raising instruments could be structured more simply, for example as product fees, thus costing less transaction cost.[20] He commends the wide scope of the fees and the fact that the system is widely accepted by the public.

The collection of fees is the responsibility of the Marshals of the Voivodships.[21] It is based on the self-reported payment requirements of the firms. Control is taking place with regards to whether the reported amount due is actually paid, and whether the reported payment due is credible. For this, the current payment is compared with those of recent years. Only in cases where substantial variations occur, a closer examination might be conducted. While it would be possible to compare the data reported with information (for example output or energy consumption) reported to other governmental agencies, such comparisons would by far exceed the capacity of the administration (Personal communication Rachobińska). Śleszyński (1998) mentions lacking capacity on the side of the regional environmental authorities to be a reason for low enforcement rates. Of the total fees imposed on pollution in 1997, roughly 70% were collected. Looking at air pollution, however, the collection rate is much higher: approximately 94% of all fees imposed were collected (GUS 1998b, p. 465).

Fines for exceeding the emission standards set in the operating permits of emitters amount to up to ten times the fees set on the emissions of the pollutant (§3.1 Decree of the Council of Ministers, Dz. U. 1998 Nr 162 poz. 1138, 22.12.1998). They also differ from fees in as much as they cannot be deducted as cost from the taxable income, but have to be paid out of after-tax profits. This adds significantly to their impact on firms, and makes the standards meaningful targets for environmental investment in firms. The collection of fines, however, reached only 13% of the imposed fines in 1997. In the field of air pollution, the collection rate was better than the average, but with 23% appears rather low (GUS 1998b). Anderson and Fiedor (1997) caution that in many cases non-collection is due to arrangements where firms agree to an emission reduction plan and in return are "forgiven" their payments. Hence the figures on collection do understate the ability of the environmental authorities to react to excessive pollution.

c) Funds

A new element to environmental policy in Poland was the introduction of a system of environmental funds. These local, regional and national environmental funds receive the proceeds from fees and

19 The fact that the fee on N_2O is higher (as is its GWP) seems likely to be a coincidence due to its inclusion as NO_2 rather than a consideration of the effect the gas has on global warming.
20 There seems to exist no assessment or even estimate of the cost of environmental administration in Poland. At least no such work was known to the representatives of environmental institutions who I interviewed.
21 This is *not* the same entity as the environmental agency of the Voivod, responsible for issuing operating permits for large emitters. The Marshallery of the Voivodship is the administrative arm of the elected regional government. Compare footnote 13.

fines imposed on polluters. Also, they collect interest payments on previous credits and profits from other investments.[22] The environmental funds are required to "recycle" their revenues by co-financing environmental investment. This is done by means of direct grants and, to an increasing degree, by soft loans (NFOSiGW 1999). In 1997, roughly 30% of all environmental investment in Poland was financed by the environmental funds (MEPNRF 1999c), slightly down compared to the 40% reported for 1995 (EAPS 1997).

It is an important feature of these funds that investment in environmental protection became independent from the budget situation of the government. As a consequence, spending for environmental investment did not have to be justified against other priorities of government policy. This made it possible already in 1991 that Poland, despite the economic crisis of the country, reached a level of environmental investment as a percentage of GDP comparable to OECD countries and has sustained such levels since then (Anderson and Żylicz 1997). While this indicates a successful operation of the system, the dominant role of the funds has also been criticized for crowding out private capital from environmental financing (EAPS 1997). Anderson and Żylicz (1997) examined the issue empirically and concluded that a certain degree of oversupply is provided by the fund.[23] They suggest a reassessment of the funds' financing terms as the imperfections of private capital markets diminish and commercial credit becomes more easily available. This seems to have taken place in the meantime, as (see above), the share of the funds in financing environmental investment has decreased significantly during the past years.

d) Reporting

According to the Decree of the Council of Minister from August 5, 1998, creating a regional register of air pollution data (Dz. Ust. 102 poz. 647, 7.7.1998), the data on air emissions and fee payments reported by firms is stored in a regional register with the Marshal of the Voivodship. The information include the amount of emissions, ways of measurement, and amount of payments for emissions. For sources smaller than 0.5 MW of installed capacity, the reporting of emissions data is replaced by reporting of fuel consumption (§ 2). The data reported to the register is open to the public (§ 6). However, firms can apply for confidential treatment of their data if their commercial interest is affected (§ 5).

The act does not specify details of how the data are going to be used, and whether they will also be reported to a central agency for creating a nation-wide emissions database. It is feared by experts that the regional authorities will use differing methodology, which could make cross regional comparison cumbersome (Personal communication Dębski). This might be mitigated by the fact that there is a clear market leader for software solutions in environmental reporting in Poland. The SOZAT software developed by Atmoterm is being used in 14 of the 16 new Voivodships (Personal communication Pazdan). It contains reporting formats based on the new legislation and warrants that the data stored in the regional registers is collected in a consistent manner. Also, there are software solutions for environmental reporting within large enterprises which rely on the same methodology, and which deliver the data required by the environmental authorities. This software is used in approximately 200 large enterprises in Poland (Personal communication Pazdan).

In addition to the data on air emissions reported to the regional register, a multitude of relevant data reporting requirements for the national statistical system are imposed. They are collated and given legal enforcability as "Decrees" of the Council of Ministers. The group of entities, required to report

22 There is also "Ekofundusz" which is financed by a dept-for-nature swap agreed with the governments of the US, Finland, Switzerland and France.
23 This result was based on a survey among projects proposals that were turned down by the fund. The study (Anderson and Żylicz 1997) showed that most of the failed projects found other sources of finance and were implemented. This indicates that the funds do not necessarily contribute to financing projects "on the margin" but are used as a source of cheap finance for projects that would also otherwise be implemented.

data in 1999 is listed in an annex to the decree from September 22, 1998 (Dz. Ust. No. 129 Poz. 854, 22.9.1998). The reporting forms, which had to be filled in by the firms in 1999, gained legal power by means of a separate decree and are published in an annex to that decree (Dz. Ust. No. 160 Poz. 1075, 28.12.1998). With regard to a tradeable permit system for CO_2 emissions, reporting requirements concerning atmospheric emissions, fuel production as well as energy consumption are of relevance. Table 5 lists a selection of data reporting requirements that could be relevant for GHG emissions trading.

Table 5: Reporting forms for official Polish statistics

Respondents and form code	Content	Receiving institution and frequency
Approximately 1600 large polluters from all sectors. OS 1	Includes data on all aspects of environmental protection, including CO2, methane emissions as well as energy consumption.	Regional Statistical offices collect the data and send it on to GUS, yearly
All firms in energy producing sectors. G-03	Fuel consumption in tons and energy content, usage as input for derived energy production or direct consumption. Energy consumption for production of goods. Fuel consumption for energy/non-energy purposes.	Regional Statistical offices collect the data and send it on to GUS, yearly
Hard Coal Mines. G-09.1	Production according to type of coal. Own consumption. Sales, weight, calorific value, sulfur, dust and moisture content.	PARG, monthly
Professional CHP plants. G-10.1	Electricity production, own consumption. Fuel consumption according to fuels, including average calorific value and domestic or foreign source.	ARE, monthly
Industrial CHP plants G-10.3	Electricity from autoproducers	ARE, quarterly
Heat plants with sales of heat > 100TJ. G-10.9	Heat production and fuel consumption according to fuels. Average energy content of coal used.	ARE, quarterly

Sources: Dz. Ust. No. 129 Poz. 854, 1998 and Dz. Ust. No. 160 Poz. 1075, 1998.

In most cases, firms are supposed to report their data to the regional statistical offices. These process the received forms and send on the aggregated results to the central statistical office as well as to the specific Ministries, on the behalf of which the data was collected (Personal communication Żerawski). Data accuracy is not controlled at source, but comparisons are made with historic data to spot sudden and significant changes in the reported indicators. Also, the possibility exists to cross-check indicators reported to differing entities. But such efforts are only undertaken in case of serious doubt of data accuracy (Personal communication Żerawski).

2.4 Regulation concerning CO_2 and other GHG

Having provided the general principles of environmental regulation in Poland, this sections highlights the most relevant pieces of environmental legislation affecting GHG mitigation options.

The 1994 update of environmental policy guidelines contains no explicit reference to climate protection and lists no concrete projects or funds in this area (MEPNRF 1994). Hence the pledge of the 1991 policy guidelines to fulfill international commitments in environmental protection is the only expression of a political goal in the field of climate protection (MEPNRF 1991). The 1999 draft environmental policy guidelines which might eventually replace the 1991 policy, do make this more explicit by mentioning Poland's Kyoto target as the aim of environmental policy (MEPNRF 1999b).

Poland has not specified any abatement target for particular sectors of the economy. Also, the draft policy ranks global environmental protection as less important than any national environmental problem. From this, it can be inferred that Poland is not aiming at taking a particularly active role in GHG abatement.

In fact, most of the GHG emission reductions during the past years were the result of overall economic restructuring and rising efficiency in the economy (MEPNRF 1997). In addition, positive side-effects of energy efficiency and renewable energy projects as well as some of the environmental investments in the fields of SO_2 and NO_x abatement are likely to have contributed to some extent to the fall in CO_2 emissions.[24]

The only policy which directly addresses GHG emissions explicitly are the fees levied on emissions of CO_2 and methane. N_2O emissions are, converted into a NO_2 "equivalent" and are thus indirectly subject to NO_2 emissions fees (Personal communication Rachobińska). However, as CO_2 and methane are not among the pollutants for which ambient standards exist, there are no emission limits for these gases specified in the operating permits issued by regional authorities. Additional legislation concerning emission standards from fuel combustion also does not include CO_2 emissions. As a result, no standards for CO_2 and methane emissions are set, and with that there is no basis for fines or administrative measures in the case of high CO_2 emissions. The low fee of 0.17 PLN per ton of CO_2 (compare Table 4) is tax-deductible and places practically no incentive to abate CO_2.

While continuous monitoring of SO_x, CO, NO_x and dust from large emission sources is soon to be required, this does not include CO_2. From a technical point of view, however, it would be simple to add CO_2 to the list, as it would involve practically no additional monitoring cost (Personal communication Rachobińska). For smaller sources, the monitoring requirement is and will be considerably less stringent, requiring emission analysis only twice a year and relying on input-based calculations for the rest.

The newly created regional register for air pollutants does include self-reported, quarterly data on CO_2 emissions of all emission sources. This data is verified to a very limited degree, paying attention only to implausible and sudden changes in year on year reporting. While the keeping of records in each of the 16 regional administrations might lead to differing reliability and availability of the data collected, the fact that one software solution is largely applied in Poland can help to unify the regional databases.

Hence, although it is correct that there is no regulation that would directly achieve a reduction of CO_2 emissions, it would be wrong to state that CO_2 is a completely unregulated pollutant in Poland. There are important monitoring and reporting provisions already in place, which appear to make increased attention to CO_2 not too difficult.

Also, the recent establishment of an "Office for the Implementation of the UNFCCC" in August 1999 might add more emphasis to explicit climate protection policy. The office is dealing with the information requirements surrounding the UNFCCC process, and it is also destined to elaborate

24 This is true for investments that lead to fuel switching from coal to gas, improved insulation, and combustion. However, an important share of SO_2 abatement investment went to end-of-the-pipe technology, which does not lead to GHG reductions. In fact, IPCC (1996) states that de-sulfurization leads to marginal increases in CO_2 emissions.

policy recommendations and manage the Polish program under the Joint Implementation pilot phase (Personal communication Konopko).

An final and important factor which will influence Polish climate policy is the EU accession process. At present, all possible attention is given to implement legislation, which is part of the EU "acquis communitaire", in order to be ready for membership by the year 2003 (Personal communication Sobiecki). This task binds considerable resources of the Ministry of Environmental Protection, which are hence not available for considering fundamentally new policy proposals that are not a part of the "aquis." On the other hand, the apparent preference of the EU for tax-based solutions (compare Finnish Presidency 1999a,b, and c) means that Poland would find it difficult to embark on a policy that the EU does not favor (Personal Communication Sobiecki). However, in early 2000 the European Commission has published a Green Paper on the feasibility of EU-wide GHG trading (EC 2000), which might shed a new light on this argument.

In conclusion, it can be stated that despite the absence of an active climate protection policy in Poland, numerous provisions such as CO_2 fees and reporting requirements are in place which would make stricter regulation possible. While these provisions could also be helpful when thinking about the introduction of an emissions trading regime, any such departure from the present system would need justification.

2.5 Existing experiences and analysis of emissions trading in Poland

The concept of emissions trading is well known among academics, environmental policymakers and professionals in Poland. It has been proposed several times as a means of SO_2 emission abatement and was officially acknowledged as an option in the environmental policy adopted by Parliament in 1991 (MEPNRF 1991). Also, with the possible exception of the most recent attempt, emissions trading has been continuously considered as an option for the different drafts of the project of a comprehensive ecological law. Furthermore, two pilot projects on tradeable emissions permits were implemented in Poland and a number of studies contributed to the discussion. This sub-section briefly reviews these efforts. It attempts to extract some lessons learned from earlier experiments and studies which might be useful in the context of a CO_2 emissions trading system.

2.5.1 Negotiated standards: the Chorzów project

In 1991, the Economics Department of the Ministry of the Environment initiated a project which attempted to show the potential of a tradeable permit approach. Due to the lack of a legal foundation of emission permits trading in Polish law[25], the project took the form of negotiations of standards between a steel mill, a power plant, local small-scale heat producers and the local environmental administrator (Personal communication Beblo). The negotiations resulted in stricter standards for the steel mill, which had relatively low abatement cost. More lenient emission standards were agreed for the power plant, because it had only high-cost abatement options. Also, some of the local boiler houses were closed, and the power plant extended its heat deliveries instead.

The firms and municipal agencies accepted this arrangement as the power plant paid additional fees for its increased emissions to the regional administrator. These funds were used to subsidize the introduction of abatement technology in the steel mill, enabling it to fulfill the stricter standard. As a result the joint emissions of the steel mill and the power plant firms fell by 51% for particulate matter, 93% for carbon monoxide and 31% for sulfur dioxide between 1990 and 1992, much faster than they would have done otherwise (Żylicz 1998).

25 Polish law does not recognise emissions credits or permits as a property. This, however, is a precondition to the transfer of such property rights.

While this project successfully showed the environmental benefits and cost saving potential of introducing flexibility into the standard system (Żylicz 1999), it was not a full blown test of a permit system. No trading took place between the firms due to the lack of a legal basis for such transfers (Personal communication Beblo). Instead, a deal was struck, involving the regulator who promised a subsidy to one enterprise while allowing the other one to emit more than previously intended and convincing other sources to close down. While this can be interpreted as a successful case of stakeholder negotiations in pollution prevention, the experiment could not be replicated, as it was not in all instances in compliance with legal procedures (Personal communication Beblo), and would have required extensive administrative effort (Żylicz 1998).

2.5.2 Simulating a "real" emissions trading system: the Opole project

In 1994, a study on a tradeable emissions permit system was commissioned by the Ministry of the Environment with support from the EU PHARE program. It was initially meant to be an implementation exercise, but had to be redesigned to include computer simulations of theoretic trades within the system of trading rules developed under the project (Żylicz 1998). This is, as before in the Chorzów project, a reflection of the fact that environmental legislation did not allow for actual emission permit trading among enterprises. While the project had a regional focus, its design was intended to be applicable to the whole of Poland and should merge into the existing legislative framework for pollution control (Atmoterm 1996).

The detailed trading rules elaborated for the program comprised the following main features (Atmoterm 1996): annual permits for SO_2 emission were to be traded among enterprises, using their actual emission data as starting points. Considerable attention was given to maintaining ambient pollution concentrations. This was done by requiring "heavy polluters" (that is: potential hot spots) to hold more permits per unit of SO_2 emitted than relatively small polluters.[26] Permits were auctioned to enterprises, which received vouchers for free permits based on average historic emissions.

This meant that permits were free for the firms, but the advantages of an auction mechanism (in addition to providing a possibility for new entrants to enter the market) was included in the system. Banking of permits was allowed. The enterprises were assumed to monitor their emissions based on the common practice of applying coefficients to their fuel use. These data were to be reported to a computerized accounting system (SOZAT) and controlled by a central environmental institution.

The designed system was tested through computer simulations accompanied by workshops for practitioners. These practioners were introduced to the system and were asked for their comments. The results are held to confirm the feasibility of a stable trading scheme and "its superiority to traditional management solutions" (Atmoterm 1996, p. 24).

The Opole program certainly suffered from the fact that it remained a theoretic exercise despite the rather extensive preparations. While some potential for cost savings was shown by the project, the complicated design feature in order to meet ambient air standards made the system rather cumbersome. This would, however, not affect the workings of a potential GHG system. Also the project certainly was an important contribution to the discussion on emissions trading in Poland, and is frequently mentioned in conversations with policymakers and representatives of industries. The lessons from the Opole project, which can be useful also for CO_2 emissions trading are the analysis of necessary changes to the legislative framework and the investigation in how far the

26 This was done with a system of "exchange rates" to determine the permit requirements dependant on the ambient air quality. It led to a significant complication of the program (Atmoterm 1996).

computerized and widely used SOZAT reporting system (compare Section 2.3.2) could be the basis for the reporting requirements.

2.5.3 Testing Joint Implementation: the Polish AIJ program

The introduction of a pilot phase for Activities Implemented Jointly (AIJ) under the UNFCCC has led to the establishment of a "Secretariat for Joint Implementation (JI)" in the National Fund for Environmental Protection in 1994 (Galon-Kozakiewicz 1997). In August 1999, the JI Secretariat became a part of the "Executive Office for Climate Convention" (see Section 2.4).

In the previous years the Secretariat developed guidelines and criteria for the implementation of projects and implemented a few projects. A coal-to-gas boiler conversion program, which includes a USD 1m grant from the government of Norway, is the largest project so far. By summer 1999 around 30 boiler conversions, as well as accompanying energy efficiency improvements, have been agreed upon within the framework of this project. While the total project cost amounts to roughly USD 48m, the AIJ component is restricted to USD 1m from Norway. In addition two projects are ongoing while about ten more are in preparation. These focus on fuel switching (coal to gas) and boiler modernization, but landfill gas utilization and biomass combustion projects are among the projects awaiting implementation (Personal communication Galon-Kozakiewicz).

The main impediment to increased implementation is seen to be the lack of a legal basis for the sale of "carbon credits" created by the projects. This refers to the international framework which still has to be worked out, but also to the fact that the Polish ministry of environmental protection has not yet decided on how to grant potential investors a guarantee that they will receive emissions credit in case the international regulations will allow so (Personal communication Reklewski). This is a reflection of a rather cautious approach to JI within the Ministry of Environmental Protection, which had already in the past delayed the formation of the necessary institutions for the project phase (Househam et al. 1997). All in all, the Polish AIJ experience does not indicate that there will be a particular strong political will to develop mechanisms that lead to a sale of emission credits to foreigners.

2.5.4 Academic analyses of emissions trading in Poland

This section reviews three important pieces of literature, which shed some light on the questions of whether an emissions trading system should be introduced in Poland, which factors should be paid attention to if doing so, and why such a system has not been implemented yet.

An attempt to answer the first question is represented by Bates, Cofala and Toman (Bates et al. 1994) who model the cost saving potential of employing market-based instruments as opposed to Command and Control (CAC) measures in Polish atmospheric pollution control. Their focus of attention is particulate matter, SO_2 and NO_x, but CO_2 is also examined. Among the four scenarios involving "alternative economic instruments" (Bates et al. 1994, p. 22), one includes an SO_2 emissions permit trading mechanism.

The modeling results for the emissions trading mechanism indicate only modest cost savings when compared with the CAC approaches. Also, SO_2 emission trading is slightly more expensive than a tax scenario, which is modeled as an alternative. The results for the emissions trading scenario are, as the authors mention, due to the "fairly expensive controls in the transport sector [which] account for almost one-half of total emission control cost" (Bates et al. 1994, p. 31). Abandoning the attempt to include emissions from transportation hence decreases the control cost significantly. Combined with expected, positive dynamic effects of emissions trading and tax approaches, which are not included in their model, Bates et al. (1994) explain that the modeling results "understate[s] the potential contribution of an incentive-based approach" (p. 31).

In conclusion, Bates et al. (1994) propose a combination of the existing CAC and fee system and market-based instruments. They suggest that CAC measures could continue to play a role where an emission trading system or a tax approach would face high transaction cost and/or high political resistance, for example, if affecting private households or when trying to regulate emissions from transportation. At the same time, the level of fees should be raised in order to increasingly function as an incentive to pollution abatement. In order to reach the environmental goals in an cost-effective manner, Bates et al. (1994) suggest that "an evolutionary movement toward emissions trading among large stationary sources is needed" (p. 47). But they also point out, that the overall influence of environmental policy on abatement efforts "is likely to be dwarfed by the forces of economic restructuring and energy price reform [...]" (Bates et al. 1994, p. 46).

Stavins and Żylicz (1994) come to similar conclusions concerning the difficulties associated with introducing a comprehensive emissions trading system. According to their analysis, which compares the US emissions trading experience with Polish circumstances, a low level of monitoring and enforcement of standards calls for a fairly simple approach, using, for example, easy-to-measure *carbon inputs* as permit currency. Where this would create disincentives with regards to emission abatement, the next "step toward greater sophistication but also substantially greater administrative complexity and transaction cost [...]" (p. 8f.), that is: an *emissions* permit trading system would need to be considered. A crucial issue in this context is, in how far requiring continuous monitoring would increase overall transaction cost to unacceptable levels. Nevertheless, Stavins and Żylicz (1994), similar to Bates et al. (1994), could imagine gradual or partial introduction of emissions trading in combination with existing CAC measures.

Stavins and Żylicz (1994) further stress the need to provide for new entrants in the dynamically growing economy of Poland. Following the US experience in the Sulfur Allowance Trading program, a periodic auction of a certain share of permits is recommended. This is also thought to help in the presence of dominating firms in the market. The ability of permit systems to be designed in a way to accommodate specific distributional issues as well as its responsiveness to rapid structural change is highlighted in this context.

In order to allow for a long term investment strategy in the affected sectors, banking of emissions should be allowed. Such a provision combined with a short (one year) duration of permits is also thought to mitigate problems of sectoral concentration and market barriers (Stavins and Żylicz 1994). At the same time, they stress the relatively low level of experience in Poland concerning trading at stock exchanges and an underdeveloped broker network as a possible impediment to permit market efficiency.

Żylicz (1998) analyzed reasons for the fact that, despite repeated attempts and far going analysis, tradeable emissions permit systems did not emerge as an instrument of actual environmental policy in Poland. The barriers which he identifies are mostly connected with in the political economy of introducing new policy instruments. Żylicz (1998) argues that emission trading competes with areas of policy making which enjoy higher priority. Debating a controversial idea such as emissions trading is feared and political lobbying in favor of emissions trading is thus not likely to be successful. For Polish environmental policymakers the current priorities are set by EU environmental policy. As the EU has largely ignored tradeable permit systems, policymakers focus on other policy tools.

As another argument against emissions trading from the point of view of the environmental authorities, Żylicz (1998) mentions that the money available from environmental funds allows for quick and visible fixes of environmental degradation. Showing such successful cases of emission abatement might be politically more attractive than spending time to lobby for cost-effective instruments. Along the same lines he argues that environmental inspectors favor negotiated compliance schedules whenever flexibility is required. An emission trading system would take away power and prestige from them.

Nevertheless Żylicz (1998) identifies some developments, which are seen as potentially helpful to the introduction of a permit system. First ranges an increasing need to reach cost-effective solutions as environmental targets tighten. This takes up the argument of Stavins and Żylicz (1994) and assumes a superior efficiency of emissions trading versus other policy instruments.

Żylicz (1998) also suggests that power plant managers might represent a group of stakeholders who are aware of the potential benefits of the instrument and could help in winning larger support of the business community. This would help "champions" among environmental policymakers to achieve a breakthrough. However, Żylicz concludes that "winning the support of the Polish Parliament for tradeable pollution permits will be a process that still requires a lot of communication and educational effort." (Żylicz 1998, p. 15).

2.5.5 Lessons learned

With the exception of the Polish AIJ program, all of the discussion concerning emissions trading presented in the section referred to studies and attempts to introduce a tradeable permit system in SO_2 abatement. This underlines the absence of any study or project which would explicitly address a domestic trading system for GHG emission permits in Poland.[27] Nevertheless, some lessons for a potential CO_2 emissions trading system can be learned from the experiences and studies discussed.

Most studies or experiments simply assume that there will be a neutral or positive environmental effect from emissions trading. In the only case where a project had an impact on actual emissions (Section 2.5.1), a positive environmental effect was shown to have been achieved.

Whether cost-effectiveness, which commonly is put forward as the main quality of emissions trading, could be reached is hard to answer in the absence of actual and wide-spread implementation of a trading system. In the Chorzów case, the scheme is seen to have saved considerably on cost (Section 2.5.1). In a computer simulation based on Polish circumstances cost-savings are also seen to result from the trading mechanism (Section 2.5.2). Other studies simply assume that the theoretic advantages will prevail (Section 2.5.4). In one case, however, a comparison with a tax solution suggests that a tax might be slightly more attractive with regards to cost-effectiveness. Taken together, there is certainly some empirical reason to believe that cost savings are possible by means of an emissions trading system in Poland. Whether a permit system is *superior* to all other instruments of environmental policy, can however not be regarded to be proven for Poland.

Concerning dynamic aspects of an emissions trading system such as its impact on technological progress and economic growth there is little to be learned from the reviewed programs or studies. Dynamic effects were either not modeled or the few projects implemented under the AIJ phase, for example, do not allow for any generalization. Where the analysis included dynamic aspects, the recommendations seem to be based more on theoretic advantages and the US experience concerning

27 Żylicz, Sadowski, Gaj and others confirmed this statement.

emissions trading than on an empirical analysis of the Polish situation (Section 2.5.4). It is pointed out in several instances that a cost-effective approach to pollution control is advantageous especially in a restructuring economy where money is scarce, and that the speed of economic growth make it particularly important that an emissions trading regime would be designed in a way to not impede the entry of new enterprises.

The adaptability of the instrument to changing circumstances established as a lesson from the US experience does not seem to be fully exploited by the Polish discussion, which appears to have focused largely on SO_2 abatement from large point sources. However, different sectors included in the Chorzów project (Section 2.5.1) and the features thought practicable in the Opole project (Section 2.5.2) show a certain level of adaptability.

With regard to the compatibility to international efforts of climate protection policy, the Polish experience under the AIJ program does not necessarily recommend the JI mechanisms as an effective tool, which would make a significant contribution to climate protection. However, once the implementation problems of the mechanism are resolved internationally, the long-standing preparation efforts in Poland might bear fruit. JI could then emerge as a tool the Polish policymaker might prefer over emissions trading (compare Section 2.5.3).

The political difficulties related to the introduction of an emissions permit system mentioned in Section 2.5.4 do not shed a promising light on the feasibility of such a system in climate protection policy. Even though the previous projects have certainly led to a rising level of awareness about the potential merits of an emissions trading mechanism among policymakers, it remains to be seen whether emissions trading in climate protection policy will gain enough support to overcome the barrier every new policy tool is faced with. It might turn out to be an advantage, that CO_2 is not strongly regulated to date, (compare Section 2.4) which implies that there is no status quo that any constituencies might fiercely defend.

Finally, the most important *difference* between CO_2 and SO_2 trading should be stressed again: CO_2 is a uniformly mixed pollutant and there is thus no need to meet ambient air standards. Meeting the Polish ambient standards (compare Section 2.3), however, was the main difficulty of the trading systems tested or discussed in Poland to date. From that perspective, a CO_2 emissions trading system might expect less difficulties than the futile attempts to introduce SO_2 trading to date. In how far there might arise new, CO_2 specific problems will be analyzed in the remainder of the paper.

3 An empirical approach to the feasibility of emissions trading in Poland

3.1 Purpose of the empirical approach

The objective of the empirical approach of the study was to raise first hand information from and about potentially affected enterprises concerning:

- their awareness and opinion of climate change and permit trading as an instrument,
- current and projected emissions by enterprises as well as their monitoring practices,
- their experience with and exposure to existing environmental legislation and data reporting requirements,
- enterprise ability and possible willingness to participate in a permit trading system, and
- number and size of enterprises in relation to the emission concentration in a sector.

Such empirical information is an important supplement of the above discussion of the framework for climate policy and of previous research and pilot projects (Section 2). It brings in explicitly the perspective of the affected enterprises when looking for a feasible way to introduce a tradeable emission permit system in Poland. Valuable insights concerning technical and political diffculties that would need to be adressed when wanting to introduce a trading system can thus be gained.

Looking at awareness and opinion, for example, might indicate a need for substantive information campaigns and training prior to any introduction of an emissions trading system. Experiences and opinion of the sectors concerning the current framework of environmental regulation and reporting might help to assess in how far a new instrument would be readily accepted or likely to face resistance. Also, taking account of the emissions monitoring and reporting systems already in place allows for a better understanding of how the transaction cost of a trading system in Poland could be kept low.

The degree of enterprise exposure to market mechanisms such as stock markets can serve as a rough indication of how likely the emergence of a functioning market for emission permits is. Taking account of the number of enterprises in a sector and their size distribution in relation to CO_2 emissions is essential to assess the costliness of the inclusion of certain sectors under an emissions trading system. This might also allow for the identification of priority groups of entreprises, which are responsible for much of CO_2 emissions and could be relatively easily integrated.

The study aimed at raising data directly from enterprises. In the downstream sectors of power and heat generation and energy intensive industries this was done by means of a questionnaire. The approach and overview results from the questionnaire-based survey are described in Section 3.2. The upstream sectors (coal mining, oil and gas) did either not respond to the questionnaire-based survey or are dominated by a single firm. In these cases, the empirical research relied on in-depth interviews with sector representatives, as well as the analysis of statistical data as described in more detail in Section 3.3.

The empirical information obtained from this approach was then analyzed with the aim of identifying a feasible "point of regulation" for an emissions trading system in Poland. The notion of an ideal point of regulation has been used for example by Hargrave (1998) and Festa (1998) for the US, and is defined in more detail in Section 3.4.

3.2 Survey on emissions trading in downstream industries and in the coal sector

3.2.1 Survey methodology

Six questionnaires for the power and heat generation sector, coal mines, chemical industry, metallurgical industry, mineral industry and other industries, were drafted. The questions vary only slightly in order to allow for cross-sector comparisons while nevertheless adapting to sector-specifc situations. Questions asked in all sectors included, for example, in how far enterprises considered themselves informed concerning climate change in general, the UNFCCC process and instruments like emissions trading and JI. Enterprise opinion whether climate protection is necessary, how they think of existing policies and whether they expect the Government to introduce additional regulation was also surveyed to assess the likely reaction of the affected enterprises if an emissions trading system should be introduced. Questions concerning the type of emissions and installed monitoring systems as well as about the firms' emission projections and their exposure to market mechanisms such as stock markets was asked in order to give an indication in how far enterprises might be willing and are able to participate in a trading system.

The drafts were discussed with several experts before being translated into Polish and sent out to 276 firms during the last week of June 1999 (see Table 6 for the breakdown according to sectors). Two samples of questionnaires are, in their English translation, included in Annex 1.

The selection of enterprises which received questionnaires was undertaken in cooperation with experts from the Energy Market Agency (ARE), who made their database available. In the power sector, all professional power and CHP plants were selected. In cases where several plants belonged to one operating company, only one questionnaire was sent to the company. A small sample of heat and municipal enterprises was chosen at random. In the coal sector, all Polish coal companies and all independent coal mines were addressed. In addition, a questionnaire was sent to a random choice of three to four dependent coal mines per coal company, in order to ask questions "at source." In the chemical, metallurgical and mineral industry, a sample of about 30 large energy consumers of each sector was selected. Comparatively high energy consumption was also the criteria in "other industries," which included coking plants, large pulp and paper producers, sugar plants, and large companies of the automotive and textile sector. While the samples are not representative (with the exception of professional power plants and coal companies), the enterprises questioned do include the largest energy consumers in Poland.

Each questionnaire was accompanied by a Polish cover letter, stating the purpose of the study, the institutions involved[28] and a brief explanation of emissions trading in environmental policy. Two and a half weeks after mailing the 276 questionnaires (a letter can be expected to take up to five days in Poland), telephone phone follow-ups were conducted at over 150 enterprises which had not responded yet.[29] This led to a renewed sending of about 35 questionnaires by fax. In several cases, the phone follow-up resulted in longer conversations about emissions trading. The views expressed by the representatives of the firms provided additional information on their awareness and opinion concerning emission trading.

3.2.2 Survey results

The overall turnout of the survey amounted to 75 (27%) returned questionnaires, which is surprisingly high given that the survey focused on fairly specific questions about a largely unknown and rather theoretic topic. Also, the questionnaires were sent at the beginning of the Polish holiday season, an unfortunate but unavoidable timing.

28 The project was introduced as a thesis project of Jochen Hauff, receiving support from the UNEP Collaborating Centre on Energy and Environment, the Energy Market Agency, and the World Bank Mission in Poland.

29 Not all companies that were initially sent questionnaires and did not react were contacted. In some cases it proved difficult to obtain (working) phone numbers, in other cases (for example coal mines) the attempt was given up as it became clear that no responses could be expected.

Table 6: Questionnaires sent and returned by sector		
Sector	Questionnaires sent	Returned questionnaires (response rate in %)
Power, Heat and CHP plants	80	40 (50%)
Professional power and CHP plants	*46*	*28 (61%)*
Heat and municipal plants	*34*	*12 (35%)*
Industry - total	150	33 (22%)
Chemical	*29*	*9 (31%)*
Mineral	*31*	*10 (32%)*
Metallurgical	*32*	*8 (25%)*
Other industries	*58*	*7 (12%)*
Coal mines	46	1 (2%)
Total	**276**	**75 (27%)**

As Table 6 reveals, the turnout differs widely depending on the sector questioned. Best results were achieved in the professional power and CHP sector, where more than 60% of enterprises responded, while only one coal company returned a filled-in questionnaire. Phone follow-ups revealed some of the reasons for this uneven distribution. In the case of the coal sector, the survey design was partly inadequate for the situation in the sector. It turned out that most coal mines have separated their energy production from the coal mining activities. The questionnaire sent to the coal mines was often deemed irrelevant, as it was, at first sight, solely dealing with emissions from fuel combustion. In some cases this led to a forwarding of the questionnaire to the energy producing company, where, however, the questions on coal handling caused confusion.

As the sample in industry was very limited, the results do not allow for meaningful generalization for the sector. Also, the return rate was lower than in the power and CHP sector. During the phone follow-up, reasons given by those who did not intend to answer included: "holiday season, no staff available for filling in the query"; "fierce competition in the sector hence no voluntary information of enterprise data"; "emissions trading an abstract idea with no relevance to the business activities of the firm."

The good, representative turnout in the power and CHP sector can to some extent certainly be explained with the fairly low degree of competition in the sector. A main reason, however, appears to be a relatively higher level of awareness concerning emissions trading in the power sector, which had been the subject of previous discussions on SO_2 abatement (compare Section 2.5).

A potential source of bias in the survey results might be attributed to the fact that the survey was conducted from the Warsaw office of the World Bank, which is a potential lender of money to the energy sector in Poland. Also, the fact that it was felt necessary to give some background information on emissions trading in the covering letter to the questionnaire might have influenced some of the answers. With the possible exception of the coal sector, where the World Bank's active role in sector restructuring might have made mine owners reluctant to reveal information, these potential sources of bias are not thought to have played a major role. This judgement is based on the impression the author received from dozens of direct conversations with enterprise representatives.

In conclusion, the survey can be regarded as fully successful only with regards to the power and CHP sector. The results in the industry sector are useful to increase the understanding of the sector by highlighting singular issues and, including the phone follow-up, give an impression of the awareness concerning emission trading. But they cannot serve as a representative basis of information on the sectors.

A summary of the answers and conclusions drawn from the survey are included in the discussion of the downstream approach in Section 4. There, the results are presented in the context of a more detailed review of the structure of the power sector and industry. Tables containing all answers of the enterprises are included in Annex 2.

3.3 Interviews and statistical analysis in upstream industries

The discussion of the upstream sectors coal, gas and oil is based on published statistical data and on interviews with sector representatives instead of a questionnaire-based survey.

In the coal sector, the attempt to raise data from 46 coal mines by help of questionnaires failed (as described in the previous section), so that interviews and correspondence with relevant institutions dealing with coal restructuring and coal trade had to be relied on.[30]

Due to the highly integrated nature and single ownership of practically all installations in the gas sector, no questionnaire was sent to the sector. Instead, interviews were conducted with several representatives of the Polish Oil and Gas Company (POGC). Additional information was sought during a site visit at a regional production unit of POGC in Zielona Góra.[31]

A sending of questionnaires was also thought unlikely to generate results in the oil sector, as oil processing is dominated by one refinery, and because the "mid-stream" gasoline wholesalers are only indirectly involved when it comes to GHG emissions. Instead the analysis relies on interviews with representatives of the Polish Oil Company (Nafta Polska), the holding company of the sector, and professional associations of liquid fuel companies.[32]

In addition, published statistical data concerning the energy flow in each sector was analyzed with the aim to identify all possible entry ways of carbon into the Polish fossil fuel market. The charts presenting these data also allow for an overview of actors and installations which are engaged in the distribution of fossil fuels in Poland. Knowledge of the physical flow of carbon containing fuel is a key precondition to finding a feasible point of regulation, as defined in the following section.

3.4 Identifying an ideal point of regulation for an emissions trading system

To compare a downstream and an upstream approach to emissions trading, the notion of a *point of regulation* is used (compare Hargrave 1998 and Festa 1998). This point of regulation refers to the point in a trading system, where a legal entity is required to use a permit for the CO_2 emitted (downstream system) or embodied in the fuel produced or sold (upstream system). This means that at this point, the number of permits to be deducted from a companies' emissions account will be determined.[33] To find an *ideal* point of regulation, the following aspects are relevant:

30 Information was provided by Paweł Kamiński, World Bank; Mr. Tausch, Hendryk Aleksa and Ms Róg Główny Instytut Górnictwa; Mr. Burowski and Mr Karbownik, PARG; Ms Joanna Kulczycha, PAN; Ms Wojciechowska, Węglokoks and a member of the marketing department at Węglozbyt.
31 Meetings were held with Tomasz Zdun, Director of Strategic Studies, Bolesław Rey, Director of Foreign Cooperation,Waldemar Skwarczyńsnki, Director of Maintenance and Operation, Paweł Stańczak, Head of Gas Measurements Office. Paweł Hołownia, Director Gas Acquisition Division. Regional Subsidiary Zielona Gora: Janusz Kuś, Production Department, Jan Tatarynowicz and Kazimierz Dzeciątkowski, Environmental Protection Department.
32 Meetings were held with Maciej Powroźnik, Polish Chamber for Liquid Fuels, Władysław Maciejowski, Polish Organisation for Liquid Gas. Stantisław Łańcucki (Director) and Grzegorz Kozakowski (Chief Expert), Market Policy Division of Polish Oil Company.
33 A domestic cap and trade system is assumed, where every participant in the market holds a certain amount of (freely obtained or otherwise acquired) permits.

- **Coverage.** The overall purpose of the policy is, to facilitate the achievement of a CO_2 emissions reduction target in the country. The degree to which occurring or potential emissions are covered by the system is important because a policy that would affect only few entities might be perceived as unjust, could lead to economic distortions among the sectors or have low environmental effect.
- **Transaction cost.** While some transaction costs are certain to occur in any system, it is important that they remain in reasonable relation to the environmental effect. To reduce the administrative cost, it is assumed that regulation would ideally affect a small number of large entities, and that the amount of data that needs to be raised for the system should be as small as possible. Also, monitoring equipment or reporting procedures already in place should be used wherever possible to reduce cost imposed on enterprises. Enterprises also bear cost when trying to find trading partners or when gathering information on prices in the permit market. It is assumed that high familiarity with such trading mechanism and a larger size of the market can help to lower these costs to the firm.
- **Market power.** The number and size of potential participants in a trading market is an aspect to be looked at, if market power of some actors is thought to lead to monopolisitic structures on a permit market.
- **Integrity.** To assure the integrity of the trading system, reported data needs to be verifiable at reasonable cost. This means that both technical possibilities and economic incentive for data manipulation or underreporting should be as low as possible and that the verification of information is not obstructed by technical circumstances or legal provisions.
- **Political feasibility.** From a political perspective, the regulation would ideally affect entities which can be expected to cope fairly easily with the system. This means, for example, that the overall (profit) situation in the sector is an important factor to be considered. Furthermore, it is assumed that acceptance of the need to protect the global climate as well as the level of awareness concerning emissions trading can help the political feasibility of a permit system.
- **Adaptability.** The ability of a permit system to adapt to changing circumstances is thought to be an important criteria due to the evolving character of national and international efforts in climate protection. With regard to the point of regulation this can mean, for example, the possibilities of expanding the CO_2 trading system to include other GHG or the compatibility of the domestic system with an emerging international regime.

The term *feasibility* (or *practicability*) of a certain system is chosen intentionally to open some room for interpretation. It refers to a mixture of aspects which include the administrative effort, technical possibilities, the awareness concerning the instrument as well as the political difficulties or experience with regulations in place, which may support or constrain the implementation of a particular trading system. The discussion thus does not strictly follow the criteria of cost-effectiveness which would be the main criteria in standard economic analysis (compare Baumol and Oates 1988), but includes several other, "soft" aspects which are nevertheless relevant in practical policy making.[34]

When discussing the cost of implementation, terms such as *reasonable cost* or *comparatively higher/lower cost* are used, in order to not provoke the wrong impression that the arguments in these sections would be based on "hard" cost estimates.

---

34 It is acknowledged, that many "soft" criteria such as "awareness" could be expressed as cost (of information for example) and could thus be integrated in a cost-benefit analysis to determine which of the two approaches is superior. However, such an attempt would involve the need to empirically determine or estimate a large number of individual cost information, which this paper cannot deliver. Also, such an approach would face its limits when it comes to aspects of political cost and technical or legal requirements.

Further, it is assumed throughout, that the overall amount of permits/ carbon in the trading system would be limited according to a *cap* set by government in accordance with its national environmental policy aims, which in turn reflect international commitments. The issue whether permits should be allocated for fee or auctioned to enterprises is left open in principle, but where appropriate suggestions are made which approach might be feasible.

In the following Sections 4 and 5 the criteria identified in this section will be applied to the discussion, however not in a rigid way. In order to avoid redundancy and to bring out the main points, emphasis will always be on the most important aspects and problems of each sector.

4 A domestic downstream trading system for Poland

4.1 Introduction: what is a downstream system?

A downstream approach for a tradeable CO_2 emission permit system addresses emissions at the point of combustion of fossil fuels, and, to a less important degree, at sources where CO_2 is emitted during industrial processes (compare Table 1). The downstream system follows the polluters pays principle as emitters of CO_2 will face the burden of holding permits. The incentive to reduce emissions will thus be direct and does not rely on the indirect price effects that final consumers might be exposed to under an upstream approach (discussed in Section 5).

An obvious disadvantage of a comprehensive downstream approach is the large number of points of combustion of fossil fuels. Apart from large-scale industrial installations it would include individual households and mobile sources when aiming at maximum coverage of emissions. While the argument has been made that this alone is not a compelling reason to abandon the project altogether, considering that millions of people pay taxes (Festa 1998), a comprehensive downstream system seems a daring proposal to make in the political reality of environmental policy making in Poland and elsewhere. In this paper, I will thus focus on what Festa (1998, p. 1) identified as a feasible option for the US: a "core program," which includes the power generation sector and energy intensive industries.

However, the important role of district heating in Poland needs to be considered. Hence, CHP and "heat only" production will be examined in addition to power generation and energy intensive industries as the elements of a potential "Polish core program" in downstream emission trading. It would account for roughly 72% of Polish CO_2 emissions in 1997. In order to avoid discrimination against the sectors included in the system, it is assumed throughout the chapter that households and commerce as well as transport would be subject to other types of carbon regulation (compare Festa 1998).

The power and heat sector and the sector of energy intensive industries will be discussed in Sections 4.2 and 4.3 respectively, before coming to a conclusion on the feasibility of a core program for downstream CO_2 emissions trading in Section 4.4. In both sector analyses, the structure and the ongoing restructuring in the sectors as well as results from the empirical survey introduced in Section 3.2 will be used to identify an ideal point of regulation (as defined in Section 3.4).

4.2 Downstream trading in the power and heat sector

Power and heat generation accounted for the majority of Polish CO_2 emissions in 1997 (compare Table 1). It is thus the most obvious target for a downstream trading system as a very substantial share of emissions can be captured by regulating a fairly small number of large emitters. Due to a strong position of CHP plants in the Polish electicity generating capacity, it would not be useful to distinguish sharply between heat and power generation. Instead, a distinction which is common in Polish statistics (compare ARE 1999d) will be followed here. It separates power and (heat producing) CHP plants from the "heat sector," which includes *heat-only* plants in the industry and municipal district heating networks.

To complicate matters further, Polish statistics and official documents distinguish among two main groups of power and heat producers: the "Professional Power and CHP Plants" (elektroenergetyka zawodowa),[35] and the "Industrial Power and CHP Plants" (elektrownie i elektrociepłownie przemysłowe) or "Autoproducers." In the heat-only sector, distinctions between "professional," "municipal" and industrial are common. These categories reflect different ownership structures but also have a bearing on size and market behavior of these plant.

4.2.1 The power and CHP sector

The group of professional power and CHP enterprises comprises more than 120 large-scale plants, which are presently grouped in 46 companies (ARE 1999b). All of these plants are connected to the national transmission grid,[36] but do not necessarily deliver all their electricity output to it. To an increasing degree, they also deliver directly to regional energy markets. Roughly 100 of the thermal plants use CHP technology and deliver heat to industrial or municipal customers. Practically all professional plants are coal-fired, and the five brown coal-fired plants (in three companies) accounted for 36% of electricity produced in 1998 (compare Table 7).

Table 7: Installed electric capacity in 1997 and share in production 1998

Type	Installed capacity in MW_e	Share in total capacity in %	Share in production in %
Professional power and CHP plants	30,759	91.2	95
Hard coal-fired	*19,693*	*58.4*	*56*
Brown coal-fired	*9,058*	*26.9*	*36*
Hydro power	*2,008*	*6.0*	*3*
Industrial CHP plants	2,958	8.8	5
Total	**33,717**	**100**	**100**

Source: Capacity data: ARE (1998a): Table 1.9.(9), Share in production: PSE (1999), p. 14.

Industrial power and CHP plants represent roughly 160 industrial enterprises which produce electricity (usually in combination with heat) mainly for their own purposes, but also for sale to regional distribution grids (compare ARE 1999d). As a consequence of the restructuring process in the economy, the group of professional power plants is growing as formerly industrial plants are spun off and become separate business entities (Personal communication Dębski).

An emerging group of power and CHP producers are the so-called "Energy Companies" (zakłady energetyczne), which are responsible for running the regional distribution networks.[37] As these companies begin to invest in the generation of power on a regional scale, the distinction between distribution companies and producers becomes blurred.

The restructuring of the electricity sector is a field where policy and legislation are evolving. In Fall 1999, the government was preparing a strategy for the privatization of generation and distribution companies (Personal communication Pawliotti). In a preliminary paper made available by the Secretary of the Economic Committee of the Council of Ministers (KERM 1999) it is envisaged that all Polish power and CHP plants should be privatized by the end of the year 2002.[38]

35 The translation "Public Power Plants" is common but misleading as the ownership structure of the plant is not the decisive criteria for its inclusion in this grouping.

36 The high-voltage power transmission grid is managed by the Polish Power Grid Company (PSE). It has, during the early stages of sector restructuring, signed long-term contracts with power generators, which resulted in the fact that 70% of all power sold in Poland goes through the grid of PSE. Due to its strong position in the sector and its close links to producers as well as distributors, PSE exerts important influence on political decisions concerning the development of the Polish power sector.

37 These 33 companies are buying electricity from the national grid or from regional power generators such as industrial plants or producers from renewable energy and sell it on to the final customers within their region. In effect, they are regional monopolies, as most of the consumers in a region cannot (yet) make use of the TPA principle, which allows for purchases also from other firms or directly from producers.

38 The first partial privatization has already happened in 1998 (EIU 1999) and additional tenders for singular power plants were published in 1999. Talks with strategic investors are at an advanced state concerning Bełchatów, the largest Polish power plant. In one case, a 166 MW gas-fired power plant was built as a greenfield investment on the site where Poland's first nuclear power plant was once meant to be constructed.

The privatization of generation capacity is an issue of substantial political debate in Poland as it is directly correlated with the future of coal production in the country and therewith the social issues surrounding mine closures (compare Section 5.2). Moreover, fears of dependency from Russian gas deliveries are aggravated by fears of a national sell-out when large Western companies secure shares in the capital-starved sector (Bojarski 1999). Despite calls for strong governmental involvement and a gradual approach to freeing prices and enticing fuel switching to gas, the main thrust of governmental policy seems to be directed at integrating the EU Directive (96/92/EC) and to increase the exposure of the sector to competitive markets.

Żmijewski (1999), the president of the Polish Power Grid Company (Polskie Sieci Elektroenergtyczne, PSE), concludes that the main aim of the power sector has shifted from securing energy supply (as it can be considered secure) to reach a competitive position on the European power market. He hints at the fact that the marginal cost of Polish power production is in the case of some old plants already higher than in Western Europe, and that the lack of capital and the highly dispersed structure of the market are a serious obstacle to withstand pressure from increasingly competitive EU producers.

Prices for electricity charged to the final user are regulated by the Energy Regulation Authority. This implies that every distribution company has to ask for the consent of the regulator before raising their prices (URE 1999). The level of electricity prices is approximately half of the level in West European countries when using nominal exchange rates to compare (ARE 1999c). Using purchasing power parities, however, Polish households pay considerably more. The high share of energy expenditure in total household expenditure (Hauff 1997) is the main reason why it proved politically difficult to liberalize electricity prices for consumers as intended by the Energy Law.[39]

A heatedly debated issue is the creation of a market for electricity in Poland, which would function in the way of a stock exchange, and which is seen as a crucial exercise for the sector to adapt to international energy market liberalization (Popczyk 1999). Currently, the potential of such a market is limited by long-term contracts,[40] which grant generators a certain price for their electricity: PSE has to pay the cost of generation, including capital and variable cost of the power and CHP plants.

This approach to pricing was taken in order to assure generators a certain level of income which allowed them to obtain private financing for the modernization of plants and environmental protection installations (Południkiewicz 1996). The system poses a risk to PSE, as with increasing liberalization of the market, new, cheaper producers might take over customers, or, electricity imports could crowd out domestic supply, which would force PSE to sell energy below the price it paid to the generators (Personal communication Kamiński, P). There is thus considerable will on the side of PSE to restructure the contracts in such a way that would allow for more flexibility in the power market.

4.2.2 The heat-only sector

Apart from the heat production in combination with power generation, heat is produced in more than 5260 enterprises in Poland (ARE 1998c). Roughly 360 of these heat producing enterprises operate the district heating networks. They also buy heat from other producers and sell it on (ARE

39 The date of January 1, 1999 which was originally envisaged for liberalising electricity prices (RP 1997), was thus abandoned. Instead, the government set a ceiling for the maximal price increases which amounted to 13% in 1999, which is about 40% higher than the expected rate of inflation (MoE 1999).

40 These long term contracts run far into the next century and cover 60-70% of electricity sold in Poland.

1998c).[41] About 1550 heat plants are run by housing cooperatives, and more than 3350 "non-professional" heat plants, mostly industrial heat plants, make up for the rest (ARE 1998c). The district heating networks supplied 70% of heat requirements in urban areas in Poland (IEA 1995).

Since 1989, the district heat enterprises that used to be organized according to voivodship were split up in local companies and are now mostly in the ownership and of local government on gmina level (RP 1996a).[42] This has been strengthened with the provisions in the new energy law (RP 1997), which gives communities an important role in planning the heat and other energy supply of their towns. The role of the government is thus, different than in the power and CHP sector, not that of the owner of the heat enterprises. The privatization of the sector is thus, to a large degree, under the control of local self-administration (Personal communication Rydzidski).

Due to the increasing availability of small-scale CHP units in Poland (GEF 1994) it is likely that more and more plants will also become small-scale power producers when replacing obsolete coal-fired heat boilers with gas-fired CHP units.[43] While this process is still in its early stages (Personal communication Rabiak), it is expected to pick up considerably due to the fast return on investment of these installations (Popczyk 1999).

Local heat markets are currently emerging in Poland and due to the absence of a central agency responsible for these developments, little information could be obtained concerning the overall development. Representatives of the sector, however, stated that there is a clear trend towards small and mid-scale CHP production and that an increasing number of municipal heat distribution companies are engaging in small-scale electricity generation (Personal communication Rabiak).

4.2.3 Renewable energy sources

In addition to the traditional enterprises, there exists an increasing number of very small-scale producers of electricity and heat from renewable energy. The most important group among the power producers are small-scale hydro plants, followed by an emerging wind power sector. Also, biomass fired heat or CHP plants emerge as a viable option in some rural areas of Poland (Hauff 1996). These producers are guaranteed access to electricity and heat distribution networks by means of the Third Party Access (TPA) principle, and network operators are required to buy the electricity or heat offered (Dz. Ust. No. 13 Poz. 119, 2.2.1999).

While the contribution of renewable energy carriers is marginal at present, numerous initiatives exist, which are intended to increase the share of renewable energy in Poland. Many biomass and wind power projects were financed by environmental funds and under the Polish AIJ program (compare Section 2.5.3). Political support for renewable energy has been recently stressed by a resolution of the Polish Parliament, requesting a comprehensive study on the renewable energy potential as well as initiating work on a separate law on renewable energy use (Sejm 1999). This development is to some degree driven by the aim of the EU to increase the share of energy produced from renewable sources (EC 1997), but is also a result of a growing awareness on the possible contribution of renewable energy carriers in rural development issues (Personal communication Wiśniewski).

---

41 In recent years, an increasing number of the municipal heat suppliers replace heat boilers with (gas-fired) small or mid-scale CHP units and thus also appear as power generators. Popczyk (1999) refers to them as "Multienergy Enterprises," as they use their customer base to diversify into other energy carriers.

42 See footnote 13 for an explanation of the administrative structure in Poland.

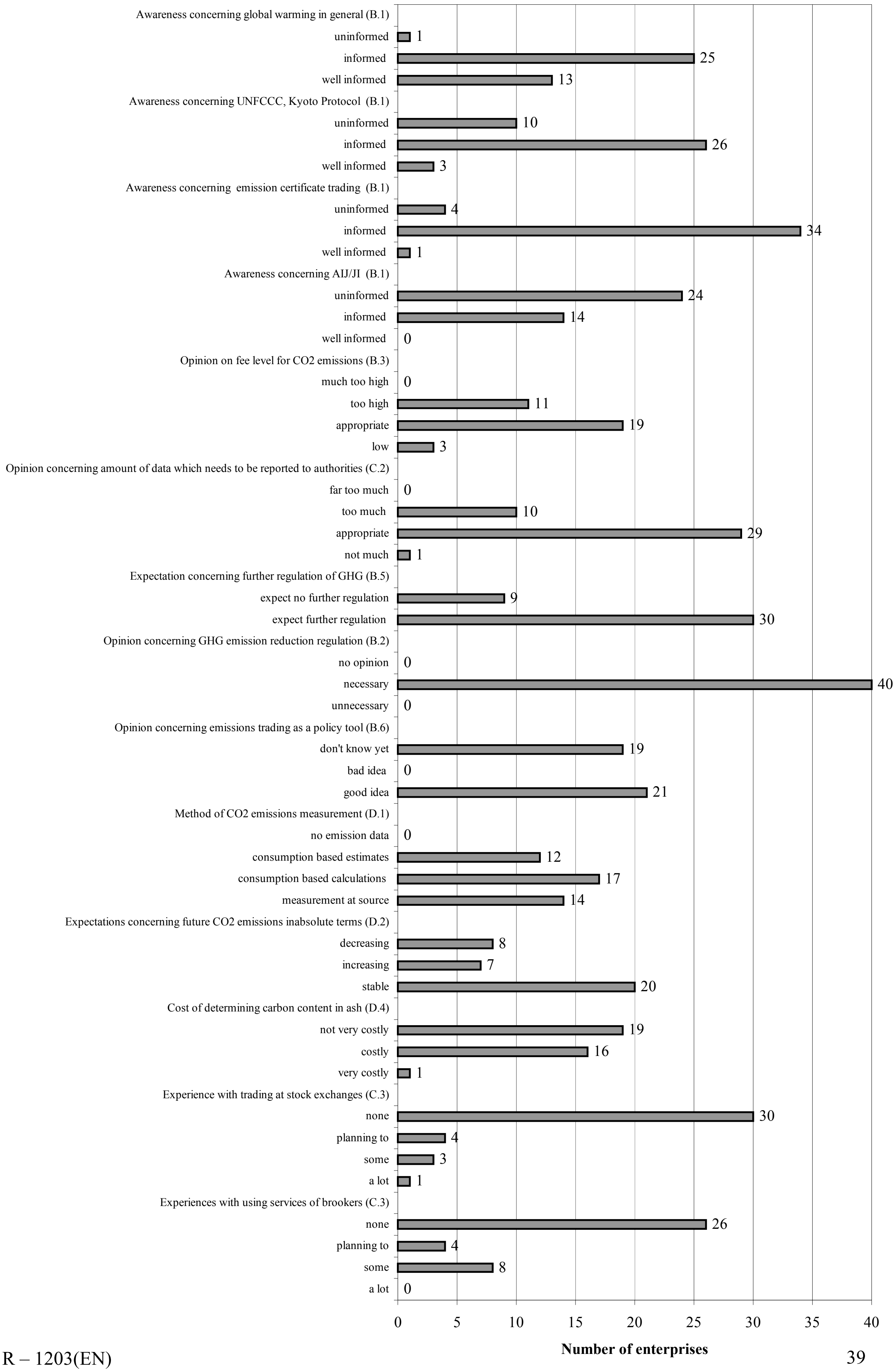
43 Larger scale coal boilers profit from economies of scale in cost of coal handling and pollution control, which makes coal cheaper than gas for them. In small-scale applications, however, the cost of coal handling and pollution control is a relatively large factor, so that the switch to gas is financially attractive (GEF 1994).

4.2.4 *Survey results for the power and heat sector*

This section presents and discusses results from 28 out of 46 surveyed professional power and CHP plants as well as from 12 out of 34 surveyed heat enterprises and municipal distribution companies.[44] Selected results on enterprise awareness and experiences, monitoring equipment installed and other factors influencing enterprises' ability to participate in an emissions trading system are summarized in Figure 1.

44 The methodological approach of the survey was described in Section 3.2. Sample questionnaires to which the question numbers given in Figure 1 refer as well as a table including all individual responses are included in Annexes 1 and 2 respectively. Where the total number does not add up to 40, not all enterprises answered to the specific question.

Figure 1: Selected survey results in the power and heat sector



Asked for their awareness concerning climate change and policy instruments, professional plants and heat plants consider themselves best informed concerning (in this order): global warming in general and emissions trading, followed by the UNFCCC process and JI.[45] Concerning emissions trading, 25 professional plants feel informed, one well informed and only two enterprises uninformed. In the heat sector, however, nine out of 12 respondents considered themselves uniformed with regard to emissions trading. While the results for the heat sector are not representative, those of the Power and CHP sector are and show a very high awareness of emissions trading. The fact that general awareness of other aspects of climate policy is lower among those enterprises shows clearly that emissions trading is well known mainly due to previous experiences and discussion with regard to SO_x abatement in Poland (compare Section 2.5).

All entreprises in the sector pay fees on their CO_2 emissions but none for methane (compare Section 2.3.2). The sums given by some respondents concerning their payment for CO_2 emissions in 1998 range between PLN 20 - 80 thousand (about 5 - 20 thousand USD) in smaller and mid-sized power and CHP plants and municipal heat companies. Large-scale plants with an installed capacity of over 1000 MW_e paid fees ranging between PLN 700 thousand and 1.6 million (roughly 170 - 400 thousand USD) for a large brown coal plant. As Figure 1 displays, 19 enterprises think that these payments are appropriate, three think they are low while eleven state that they are too high. No company thinks that the fee level is much too high. Considering that companies are likely to overstate the actual burden that the fee poses to them, these results indicate a relatively wide acceptance of the current fee level. A similar high level of acceptance appears to exist with regard to the current data reporting requirements (compare Section 2.3.2). Figure 1 shows that three quarters of enterprises think that these requirements are appropriate, while one quarter think they are too high and no enterprise thinks that they are far too high.

As evident from Figure 1, all respondents in the power and heat sector consider action concerning climate protection necessary, and two thirds of all respondents state that they expect further regulation from government with regard to GHG emission reduction. Furthermore, half of the enterprises state that this expectation has already led to emissions reduction investments on their side. Examples like fuel improvements and boiler modernizations given by enterprises are, however, generally the same actions as stated as a reaction to SO_2 and NO_x regulation, so that one should certainly not put much emphasis on the conclusion that Polish power and CHP plants already invest in expectation of GHG regulation. The fact that there is almost unanimous acknowledgement of the need for additional GHG regulation, however, sends a positive signal if it comes to the acceptance of additional climate protection efforts. This result, however, might be influenced by the fact that it was mostly the person in charge for environmental issues who filled in the questionnaire. Nevertheless, the questionnaires were often also signed by the technical director or the CEO of a company, which might counteract the potential bias of the "environmentalist" in a company.

Asked for their opinion on emissions trading as a policy tool, the results presented in Figure 1 show that more than half think that emissions trading is a good idea. But the results show also that many enterprises do not have an opinion yet, so that further discussion and information concerning the topic is needed. The fact that none of the responding firms thinks that emissions trading is bad indicates that there is no strong opposition to emissions trading in the sector. While this is true for all respondents, differing opinions were encountered during the phone follow-up among plants that had not answered to the survey. In one case, emissions trading was thought to be "immoral."

45 The questionnaires also included a question concerning the Clean Development Mechanism (CDM). The results are not used, however, as some respondents mixed up the Polish translation of the CDM with the "Clean Production Principle," which is widely known in Poland. In several cases respondents thus considered themselves better informed about the CDM than about the UNFCCC process, which seems unlikely.

All but one respondent in the professional power and CHP sector rely to more than 98% on hard or brown coal for energy production. In the heat-only sector, too, coal dominates by far, but gas was mentioned in half of the cases as an additional fuel. Figure 1 displays how enterprises measure the CO_2 emissions resulting from the combustion of these fuels. While three quarters of the enterprises measure SO_2, NOx and dust directly at emission source, only in half of these cases CO_2 is measured as well. Only rarely seems continuous monitoring to be in place, as most of the plants supplement the measurements at source with consumption based estimates/calculations.

CO_2 is in half of the firms only measured based on consumption-based calculations or estimates. For a functioning emissions trading system, reliable and comparable CO_2 monitoring would thus still have to be installed. The cost of determining the carbon content of ashes was surveyed, as a combination of input-based monitoring with an analysis of the ashes might pose a less costly alternative to continous emissions monitoring. The results included in Figure 1 suggest that such measurements would not be prohibitively expensive and could thus be considered as a way to monitor emissions.

Half of the enterprises expect CO_2 emissions to remain stable in absolute terms, only a fifth expect growing absolute emissions (Figure 1). This result might have an impact on the feasibility of an emissions trading regime, because enterprises which project an increase in their emissions are more likely to oppose stricter regualtion. On the other hand, they might argue in favor of a flexible instrument such as emissions trading as it would allow them to cover their emissions increase with purchased permits.

With regard to enterprises' ability to participate in a permit trading system, Figure 1 includes survey results showing that very few enterprises in the professional sector have experience with trading at stock exchanges. More surprisingly, only three of the professional plants indicate that they plan activities at the stock exchange. In the heat sector, none of the respondents claim to have had experiences with trading stock. Slightly more professional companies say that they have experiences with using brokerage firms. But here, too, more than half neither had used nor planned to use such services. In the heat sector, only two enterprises state that they had some experiences with services of brokers. If any, all stock market or broker experiences were national. While these results show a snapshot on the situation in 1999, they can be expected to be outdated fairly soon due to the beginning privatization of the professional power and CHP sector. It appears unlikely that enterprises can afford much longer not to deal with the option to trade at the stock market.

In conclusion the need for climate protection is generally acknowledged in the sector, and the expectation prevails that more government regulation concerning climate protection will be introduced. The survey shows that there is already a significant level of awareness and openness concerning emissions trading as an instrument in the professional power sector which is likely to facilitate a potential introduction of the system. At the same time the answers from the non-representative sample of the heat enterprises suggest that further information and discussion is necessary to increase awareness of the specific aspects of a CO_2 trading system.

Measuring methods for CO_2 emissions vary considerably among responding enterprises and continuous monitoring is the exception. As SO_2 and NO_x emissions are measured more thoroughly, it seems possible to tighten CO_2 measurement requirements at relatively low additional cost. In sector segments where this is thought to be too costly, input measurements combined with determination of the carbon content of ashes might be an alternative. Also, as the current data reporting requirements are not perceived as a very substantial burden, additional reporting appears acceptable to the sector. This might again be less true for the heat sector, where the few answers obtained might indicate a higher opposition to current reporting requirements.

Fuel switching from coal to gas in professional power & CHP plants has not occurred in great measure yet. Hence, there exists an untapped potential for CO_2 emissions reductions, where a permit system might serve as an incentive. In the heat sector, the introduction of gas seems to have happened in more cases, but still, none of the respondents reported substantial gas shares.

Experiences concerning market mechanisms are fairly scarce, not only in the heat sector. As privatization is only setting in and electricity spot markets are not yet in place, there will be some need in the sector, to get acquainted with stock exchanges or broker services before a permit market could be expected to function smoothly.

4.2.5 Finding an ideal point of regulation in the power and heat sector

When trying to assess the administrative effort connected with an emissions trading system in the sector, the number of enterprises (and with it the cost of monitoring, and reporting) should be put in relation to the CO_2 emissions which the system would cover. Table 8 presents the number of power generating companies and their cumulative share in CO_2 emissions of the sector in 1998.

Table 8: Number of power and CHP plants and their cumulative CO_2 emissions

Installed electric capacity in MW_e	Professional power and CHP plants in 1998		Industrial power and CHP plants in 1998	
	Number of entities	Cumulative share of CO_2 emissions in %	Number of entities	Cumulative share of CO_2 emissions in %
> 1000	10	71.5	0	0
300-1000	10	91	0	0
100-300	9	96.6	8	34.3
50-100	17	100	4	47.3
10-50	0	100	41	81
5-10	0	100	57	92.5
< 5		100	71	100
Sum	46		181	

Source: Professional Power plants: Source Table in Annex 3. Industrial power plants: Information prepared by ARE for the purposes of this study.

As evident from the table, more than 90% of the emissions from the professional plants could be covered by a trading system that would only include the 20 biggest companies in the sector. As these are at the same time the plants which are required to introduce continuous monitoring until the year 2001 (compare Section 2.3.2), a trading system could be installed at fairly low additional cost.

From the point of view of avoiding distortions in the sector and reducing the incentive for gaming, it seems advisable to extend the system to cover all professional plants. This would increase the number of reporting companies to 46. At that point, however, the right side of Table 8 shows that 180 industrial CHP plants exist in Poland, some of which match or even exceed the smaller professional plants in size (and consequently probably also in emissions). Unless the CO_2 emissions of these industrial plants are regulated in another way, their inclusion in the trading system is desirable.

Here again, drawing a line at a certain amount of installed capacity (or, alternatively, production or emissions) would provoke issues of distorting competition in the sector and giving incentives to firms to avoid regulation by "re-sizing" their firms. In the end, it will depend on the priorities of the policymaker and the actual cost of monitoring equipment whether comprehensive coverage or smaller administrative cost are acceptable. This study suggests that a full coverage of the roughly 210-230 entities in the professional and industrial power and CHP sector would be feasible and certainly desirable, as a very substantial amount of Polish CO_2 emissions would be covered.

For the heat sector, Table 9 presents data for production and distribution enterprises separately from other heat producers, that is the industrial and residential heat plants. As an indicator of the size of CO_2 emissions of the heat producing companies, the amount of heat produced and sold is available in public statistics.[46]

Table 9: Number and production share of heat producers

	Production and distribution enterprises		Other heat producers	
Production in TJ	Number of enterprises	Cumulative share in production in %	Number of enterprises	Cumulative share in production in %
> 1000	37	51.6	74	70.3
500-1000	40	69.7	61	76.8
100-500	160	96.3	420	91.0
50-100	48	98.7	309	94.4
10-50	61	99.9	1163	98.8
< 10	29	100.0	2317	100.0
Sum/ Total	**375**	**149838.8 TJ**	**4344**	**628384.8 TJ**

Source: Calculated from ARE (1998c), Tables 45, 46, 49 and 50.

As evident from the table, obliging all 375 heat distributors to participate would cover less than a quarter of all heat produced in the sector. To include all other heat producers, however, would mean that more than 4700 entities would need to be administered. The bulk of these would come from roughly 3500 small-scale heat producers in industry producing less than 50 TJ of heat per year, which jointly only account for 5-6% of heat production in their sector.

Exempting these small producers seems likely to be justifiable as the environmental drawback and the possible distorting effect on competition in the sector would be rather small problems compared with the advantage of the significant reduction of the number of entities to be regulated. But even after the exemption of these companies, the heat sector would still contribute around 1200 entities to be covered under an emissions permit system in the power *and* heat sector.

An administrative cut-off line already in place for the heat sector is the 5.8 MW of installed thermal capacity, which marks the size of a heat producing company, above which it needs to hold a license from the Energy Regulation Authority (URE 1999). Assuming a fairly low operating time of 1000 hours per year, this would translate in the production of slightly more than 20 TJ.[47] Hence, all enterprises above this figure ought to be known to the authorities. If small producers are, as is recommended above, not included in the trading system, they could be subject to alternative carbon regulation such as an increased carbon fee in order to avoid discrimination against those entitites which are included in the system.

46 While heat production is probably a sufficiently close approximation also for the size of CO_2 emissions in coal-fired heat plants, the table distorts the picture for large, gas-fired installations. As coal to gas fuel switches have only set in recently in Poland, the fault by equating size of production with CO_2 emissions is assumed to be low. It would certainly be desirable to look at actual CO_2 emissions in relation to the number of heat plants, which unfortunately, are not available in the statistics.

47 Using the conversion factor of 1kwh = $3.6*10^6$J (Kraushaar and Ristinen 1993).

4.2.6 Conclusion: the feasibility of including the power and heat sector

The introduction of an emissions trading system for CO_2 in the power sector seems feasible. From an administrative point of view, only very few large entities would have to be regulated to cover a substantial part of emissions. These enterprises show at the same time a high level of awareness and positive attitude towards the instrument. Monitoring equipment in place and/or required by law would allow for continuous monitoring at the biggest plants. In order to avoid gaming and to increase the incentive for technological change provided by the permit system, the inclusion of the all professional companies and the 160-180 industrial CHP plants is recommended. This would result in an overall figure of about 220 reporting entities, which operate roughly 280-300 power and CHP plants in Poland. The joint share of CO_2 emissions covered by such a system would have amounted to approximately 48% of total Polish CO_2 emissions in 1997 (based on source table in Annex 3 and ARE 1998c).

Establishment of an emissions trading system could be facilitated once electricity is traded more freely in Poland (compare Section 4.2.1). The electricity market could also function as a secondary market for CO_2 emissions permits. Under the current system of long-term contracts and administered price increases, the potential of emission permits to increase the efficiency of pollution abatement is difficult to estimate, as the incentive for emission reduction might be blunted by a permission of the regulatory authority to pass on cost of emission permits via electricity price rises to local consumers.

Inclusion of the heat sector would require a significantly higher administrative effort. Even when exempting small heat boilers, roughly 1200 additional entities would have to be covered. Also, the empirical results indicate that the awareness of emissions trading and climate change as well as the exposure to market mechanisms such as stock markets or brokers is lower than in the power and CHP sector. This suggests that the inclusion of the heat sector is not likely to be feasible at present.

A major difficulty that arises when solely addressing the Polish power producers is the interdependence of power and heat markets. CHP producers would be discriminated against producers with heat-only boilers. This would create inefficiencies on the heat market and a disincentive on investing in highly efficient CHP technology.

A solution to the problem might be found by following the Danish example in their endorsement of CO_2 quota trading in early 1999, where CHP producers are only required to hold permits for a share of their emissions which can be attributed to power production (compare Folketinget 1999). While this is a way to avoid distortions in the heat markets, it certainly increases the administrative effort to run the system and decreases CO_2 coverage. When designing a system for power and CHP plants, the policymaker should thus envisage the later inclusion of at least the larger enterprises from the professional, industrial and municipal heat sector.

4.3 Downstream trading in energy intensive industries

The emphasis on heavy industries under socialism left Poland with an industrial structure relying strongly on energy intensive industrial production (World Bank 1997). Since then, the share of industry in GDP fell continuously (PAIZ 1999). This was accompanied by significant efficiency improvements through modernization and activity shift towards less energy intensive sectors (GUS 1998a). Nevertheless, together with the construction sector, industry accounted for more than 22% of CO_2 emissions in 1997. These emissions stem mainly from the use of energy (19.3% of total Polish emissions), but, in some industries, also process-related CO_2 emissions occur, which accounted for 2.9% of total CO_2 emissions in 1997 (compare Table 1). This makes the industry sector a potential candidate for a downstream emissions trading system in Poland.

The discussion in this chapter will first identify the most relevant sectors to be included in a downstream trading system, and provides brief information on their progress in the restructuring effort. In a second step, the approximate number of enterprises of the identified sectors which can or should be subject to permit requirements is determined. A discussion of survey results among others provides information on enterprise awareness concerning climate protection policies as well as their experience with existing environmental regulation. Finally, a downstream "point of regulation" for energy intensive industry will be proposed.

4.3.1 Relevance of specific industry sectors

The number of enterprises which are classified under "Industry" in the Polish statistical system ranges around 315,000, which includes large to very small-scale emission sources (GUS 1999c). When looking for an administratively feasible approach of an emission permit system, it is inevitable to find a way to reduce this number. This does not mean that it is inconceivable that all these enterprises could be covered by a trading system, but it would go far beyond what is realistic at present in Poland or within the scope of this paper to propose such a comprehensive approach.[48]

The task to identify the most relevant industry sectors and enterprises within these sectors is difficult due to a lack of relevant data on CO_2 emissions by branch of industry and cumulative number of enterprises in published statistics. Instead, this paper relies on approximations to CO_2 emission data such as the amount and structure of energy consumption in different industrial sectors or the number of employees as an indication for company size.

The dominance of five sectors in energy consumption is apparent in Table 10: chemical, mineral, metallurgical and food processing industry together with the coking and refining represent roughly 80% of total energy consumption of Polish industry.[49] By focusing on these industries, a comparatively substantial share of Polish industrial CO_2 emissions could be captured in an emissions trading regime. Concentrating on these top-five energy intensive industries also has the advantage that they account for most of of the non-energy CO_2 emissions in Poland, which could thus theoretically be captured by such a core emissions trading system.

48 This is again following the approach of Festa (1998) who found it necessary to propose a system for a select group of enterprises within the US industrial sector.

49 If the total *primary* energy consumption would be used as an indicator, the concentration would be even stronger. However, in such a case coking and refining which sell on a substantial share of their primary energy consumption to other consumers would be held accountable for all carbon contained in their input. Hence final energy consumption and not primary energy consumption is chosen as indicator.

Table 10: Total energy consumption of the industry sector in 1997			
Industry[50] sub-sectors	Total final energy consumption		
	Absolute consumption in TJ	Share in consumption in %	Cumulative share of selected sectors in %
Coke and refining	268,256	19.5	19.5
Chemical industry	247,827	18.0	37.5
Metallurgical	302,237	22.0	59.5
Mineral	153,115	11.1	70.6
Food and beverages	140,273	10.2	80.8
Pulp and paper	56,448	4.1	84.9
Machinery and equipment	37,940	2.8	87.6
Textiles	27,340	2.0	89.6
Wood	26,648	1.9	91.5
Rubber and plastics	16,444	1.2	92.7
Fabricated metal except machinery	18,636	1.4	94.1
Automotive industry	15,055	1.1	95.2
Furniture	20,462	1.5	96.7
Others	46,031	3.3	100
Data compiled and calculated from: GUS (1998a), Section VI.			

The status of commercialization[51] as well as the degree of privatization of the identified energy intensive sectors is likely to affect the possibility to introduce new policy tools and should thus not be ignored in a country with an enconomy in transition.

As is evident from Table 11, the status of commercialization in some sectors of interest is less advanced than the average. This refers in particular to coke and refining, mineral and metallurgical industries. Nevertheless, in all sectors, around 80% have commercial structures and the percentages where the State Treasury has full control are low. However, there is certainly a bias in the data presented, as many of the large firms are still under stronger influence of the state than the average numbers imply.

50 In Polish energy statistics, mining activities, power and heat generation as well as warm water supply are subgroups of "Industry." As these sectors were discussed in separate sections, they will not be included here, and industry is understood in a narrower sense, equivalent to what in Polish statistics is called "Manufacturing."(Compare, for example, GUS 1998a).

51 The privatization of the formerly state-owned enterprises is mainly conducted by means of a staged process during which, first, the commercialization of the enterprise, that is its registration as, for most cases, a limited liability or joint stock company, subjects it to the bookkeeping and bankruptcy regulations in place. Such transformed enterprises are initially in the ownership of the State Treasury before they are either sold to bidders, transferred to employees or mass-privatized by their inclusion in the National Investment Funds, which hold controlling stakes in their enterprises with the aim of assisting their restructuring and gradually privatizing them.

Table 11: Status of commercialization and privatization in Polish industry in 1997						
Sectors	State owned or municipal enterprises*	Joint stock companies*	Limited liability companies*	Ownership of joint stock or limited liability companies		
				100% State Treasury**	100% Private**	Some foreign**
Industry total	**4.5**	**6.4**	**79.4**	**1.1**	**53.0**	**25.8**
Coke and refining	7.0	15.8	73.7	7.0	47.4	24.6
Chemical industry	2.8	9.3	79.5	1.0	52.3	29.5
Metallurgical industry	10.4	17.7	67.6	3.7	42.8	22.3
Mineral industry	7.7	6.9	80.8	1.0	54.9	23.7
Food and beverages	3.8	8.0	74.7	1.8	49.0	27.2
* in % of total enterprises in Poland; ** in % of all joint stock and limited liability companies *Source: Calculated from GUS (1999a), Table 8 (566).*						

4.3.2 Approximating the number of enterprises to be included in energy intensive industries

A decisive question for the feasibility of a trading system is, how many entities of each sector would need to be included. For this it would be ideal to consider a cumulative account of CO_2 emissions in relation to the number of companies (compare Festa 1998). In the absence of such data in published statistics in Poland,[52] however, the number of entities in relation to the number of their employees may serve to approximate such information. It is therefore assumed, that the enterprises with most employees in a sector are also those with highest energy consumption of a sector. While this seems a rough-yet-reasonable assumption *within* a sector, it cannot be used for cross-sector comparison. The data presented in Table 12 will be used as indication to which depth the inclusion of a sector may be feasible from an administrative point of view.

Table 12: Number of firms in energy intensive sectors in relation to number of employees					
Sectors	Number of employees				
	<5	6-20	21-100	101-250	>250
Coke and refining	20	18	12	1	11
Chemical industry	1,999	516	225	100	101
Metallurgical	379	178	120	37	87
Mineral	15,970	1,911	696	157	115
Food and beverages	16,964	7,335	2,426	525	420
Sum	**35,332**	**9,958**	**3,479**	**820**	**734**
Source: GUS (1999c)					

Covering the first two groups of enterprises in the five sectors would result in around 1550 enterprises to be included in a trading system. This is slightly less than the number of all enterprises (not only industry) which are currently subject to annual reporting requirements on environmental

52 The data necessary to produce such a table is collected by the Polish statistical system, at least with regard to the largest sources (Personal communication Debski). However, it was not possible to retrieve this data within the time frame and with the financial means available for this study.

impact (see Section 2.3.2). Going a step further down in terms of enterprise size raises this figure to more than 5000 enterprises, which seems likely to exceed what is feasible from an administrative point of view. However, one might choose to vary the depth of coverage between sectors if it seems easy to do so administratively (see Festa 1998).

Coke and refining might be such a case, where all enterprises could be covered at reasonable additional administrative burden. Also, the relatively low numbers in chemical and metallurgical industries seem to make coverage of mid-sized firms possible. Food industry, on the contrary, has a lot of mid-sized firms. Here, selection of only the large firms might be necessary to reduce the administrative burden. Including a few large enterprises from other, less energy intensive sectors might be desirable (compare Table 10), but it would require analysis of their actual CO_2 emissions to recommend in favor of such an inclusion.

A factor that would improve the coverage and reduce the overall administrative burden of the system is the overlap of energy use of industry with the power and heat generation sector discussed in Section 4.2.5. There it was suggested that all industrial CHP plants should be included in an emissions trading system. The consumption of these plants would thus be covered for all sectors of the economy. Table 13 shows a sectoral breakdown of industrial heat production, and where it is concentrated.

Table 13: Number of industrial CHP and heat plants and share in heat production

Sector	Number of plants 1997		Share in 1997 industrial heat production in %
	CHP	Heat only	
Coal mining	4	18	4.1
Food and beverages	76	607	15.8
Textiles	12	95	3.2
Wood	6	58	2.6
Pulp and paper	12	37	9.1
Coke and refining	8	7	10.6
Chemical industry	24	87	18.8
Rubber and plastics	5	56	2.4
Mineral	1	172	2.7
Metallurgical	9	69	10.5
Manufacturing	1	85	3.4
Aggregate numbers/ share in total industrial production	**158**	**1291**	**83.2**

Source: Number of plants: ARE (1998c), Table 2. Share in production: GUS (1998a), Table 68

More than 83% of all heat is produced in "non-professional" heat and CHP plants. Including these as part of the covered entities would affect consumers of energy also in sectors, which would not be included if the selection criteria according to Table 10 is chosen. This would reduce the possibilities to significantly circumvent the regulation by outsourcing electricity supply to firms registered in sectors which are not subject to the permit requirement.

While process-related emissions from the sector are relatively minor, they should nevertheless be taken into account when designing the trading system for a long term perspective. Significant process-related CO_2 emissions occur mostly in the mineral, but also in the metallurgical and chemical industry of Poland (compare Table 1). As these sectors all happen to also be among the energy intensive enterprises mentioned above, addressing process related emissions would not require the widening of the system to include new sectors.

However, it would require a refinement of monitoring to cover these gases under the system. While some data was raised in the empirical survey (compare questionnaires in Annex 1), this issue will not be examined in detail in this paper, as it would not affect the design of the system per se. It needs to be noted, however, that the regulation of sectors where process-related emissions occur is an advantage over an upstream approach, where they would have to be covered (if at all) by addressing entities that are otherwise not included in an upstream system (compare Section 5.1).

To sum up the above, it appears that the inclusion of the following number of enterprises per sector would maintain a relatively large coverage of industry emissions at relatively low administrative effort:

- All enterprises in coking and refining: about 50 companies;
- Large[53] and mid-sized[54] chemical industry: about 430 companies;
- Large and mid-sized metallurgical industry: about 240 companies;
- Large mineral industry: about 270 companies;
- Largest[55] or selected enterprises of the food industries (sugar production): 420 companies.

The overall number of about 1400 companies indicates the order of scale with which an emissions trading system among energy intensive industries might have to deal. More than 100 of those enterprises can be assumed to operate CHP plants and would thus also be considered under the approach discussed in Section 4.2.5, so that the administrative effort might be slightly lower in these cases. However, repeating a word of caution from the beginning is appropriate here: the recommendations of this section are, due to the absence of better data, based on the weak approximation from number of employees to relative size of CO_2 emissions.

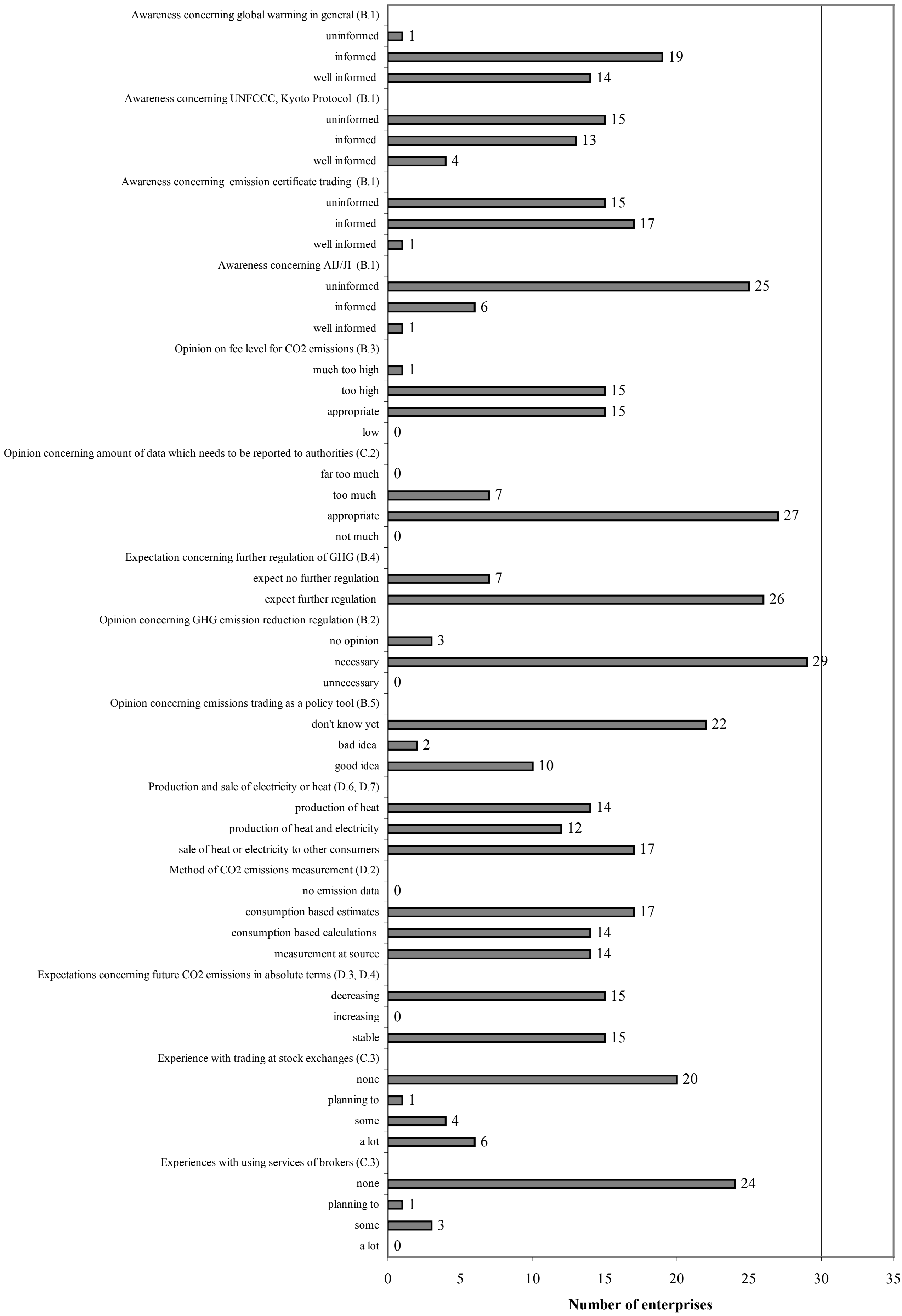
4.3.3 Survey results for energy intensive industries

This section will present and discuss survey results for energy intensive industries with a focus on enterprise awareness and experiences of environmental policy as well as monitoring equipment installed and other factors influencing enterprises' ability to participate in an emissions trading system.

Figure 2 presents answers from 34 out of 150 questioned enterprises from energy intensive industries on selected topics[56]. The methodological approach of the survey is described in Section 3.2, and questionnaires to which the question numbers in Figure 2 refer, as well as a table including all individual responses, are included in Annexes 1 and 2 respectively. As the selection of questionnaire recipients was guided by the energy consumption of the enterprises, the results are not representative for the specific sectors. However, they allow for careful conclusions concerning the awareness and opinions among the most energy intensive companies in Poland.

53 more than 100 employees
54 more than 20 employees
55 more than 250 employees
56 Where the number does not add up to 34, not all enterprises provided answers to the specific questions.

Figure 2: Selected survey results in energy intensive industries



The results concerning enterprise awareness displayed in Figure 2 show that firms seem best informed concerning global warming in general, where more than half of the enterprises consider themselves "informed" and a substantial number "well informed." Next range, at fairly equal levels, emissions trading and the UNFCCC process. With regard to emissions trading, half consider themselves informed and fifteen enterprise answered "uninformed," which, in the case of joint implementation was even more pronounced.[57] These results indicate that while the awareness concerning climate change is not necessarily lower than in the Power and Heat sector (compare Section 4.2.4) emissions trading is significantly less known among energy intensive industries. This is hardly surprising, as these sectors were not involved in the previous discussion on emissions trading in Poland.

Concerning the satisfaction with existing policies, only careful conclusions are possible from Figure 2: practically all enterprises pay fees for CO_2, and half of them think that their payments for CO_2 are appropriate. The other half think that they are too high, and one firm thinks that they are far too high. Assuming that enterprises would tend to overstate their dissatisfaction to send a signal to lower the fee, one can derive that the CO_2 fee d
oes not impact largely on enterprise profit. This was also confirmed in phone conversations during which enterprise representative stated that other environmental fees and the fines connected with exceeding limits are more significant cost factors. With regard to data reporting the picture appears more clear cut: three quarters responded that data reporting requirements are appropriate, while six firms think these requirements are too high. No enterprise thinks that they are far too high. This may imply that there is currently no excessive reporting burden on enterprises, and additional requirements could be introduced.

No enterprise considers action concerning climate protection unnecessary. Only five enterprises had "no opinion" or did not answer the question. At the same time, more than two thirds expect further regulation from government with regard to GHG emission reduction, so that the general attitude concerning additional climate protection policies seems relaxed. With regard to emissions trading, however, two thirds of the enterprises are unsure whether it is a good idea or not. Seven enterprises state it is a good idea, two think it is bad. Given that there is likely to be a positive bias in the study as supporters of emissions trading seem more likely to respond, emissions trading is certainly far from being endorsed by Polish energy intensive industry.

Most of the respondants produce energy for their own purposes. In all cases, this referred to heat, but one third also generates electricity. While the heat usually covers all of the enterprises' needs, electricity generation usually covers between 20-40% of an enterprises' electricity needs. As Figure 2 shows, about half of the responding enterprises also sell energy. These were mostly insignificant amounts, but there are also cases where more than 20% of generated heat and electricity are sold. The widespread tendency of Polish enterprises to sell energy as a by-product needs to be considered in particular if one thinks about a partial emissions trading system for the energy sector.

Twenty-seven out of the 33 enterprises measure some pollutant directly at the source. In practically all cases, however, this referred to dust, NO_x and SO_x. CO_2 (displayed in Figure 2) is measured at source by a little less than half of the respondents. The other firms conduct consumption-based calculations or estimates. Only in few cases continuous monitoring seems to be in place, as most of the plants supplement the measurements at source with consumption based estimates/ calculations.

57 The questionnaires also included a question concerning the Clean Development Mechanism. The results are not used, however, as some respondents mixed up the Polish translation of the CDM with the "Clean Production Principle," which is widely known in Poland. In several cases respondents thus considered themselves better informed about the CDM than about the UNFCCC process, which seems unlikely.

As reflected in Figure 2, about half of the enterprises expect CO_2 emissions to decrease in absolute terms and only one firm expects an absolute growth. It seems that more stringent CO_2 regulation would thus not necessarily hurt industry. However, if one believed in a decreasing emission trend one might also argue that regulation would be superfluous.

Out of the 24 firms that responded to the question on their exposure to energy price increases, 14 answered that price increases for heat and electricity would affect their profits significantly. Five stated it would affect them to a small degree while four see themselves strongly affected and one "very strongly." With regard to price increases for coal, gas or oil, only four enterprises see themselves affected to a "small" or a "certain" degree while 11 state that their profits are significantly affected, five strongly and four very strongly. Dependence of profits on energy prices seems to be highest in the mineral industry. While the sample of this survey is too small to allow for a generalization, the issue of energy price increases should be assessed with a view on the sectoral impact an emissions trading system might have.

A surprisingly high number of twenty enterprises stated that they neither have been nor plan to get involved with trading at stock exchanges. Of the nine firms which state that they did trade at stock exchanges, five consider themselves as having "a lot of experience." In only one case did this experience refer to international markets. Only three companies say that they have used the services of brokers before. Only one company says it plans to. Hence, differences among enterprises with regard to their ability to deal effectively with market-based instruments can be expected initially.

In conclusion, the results show that emissions trading is not an unknown instrument among the respondents, but that the attitude of the enterprises is rather hesitant. The fact that current CO_2 regulations seem bearable to most of the enterprises does not necessarily stimulate interest in a new instrument, so that information campaigns would be necessary to increase awareness before an eventual introduction of an emissions trading system. As almost all responding firms expect their CO_2 emissions to decrease, they might not be strongly opposed to a permit system that would be based on historic emissions. However, it seems likely that firms which expect increases in emissions are among those who did not respond. Also, those enterprises which state a strong impact of energy prices on their profits will certainly turn against any instrument which raises the cost of energy to them. A problem are the monitoring methods applied which show large variability. Currently most of the CO_2 data raised by the responding enterprises relies on calculations and occasional measurements. These methods would need careful evaluation whether they are comparabe in all sectors of industry and verifyable to allow for an emissions trading system.

4.3.4 Finding an ideal point of regulation for energy intensive industries

As the choice of sectors and the number of enterprises to be included in an emissions permit system was already discussed, the remaining issue to be clarified is at which point in the "carbon flow" enterprises would be required to hold permits for their CO_2 emissions. The question is, whether an emission-based monitoring system is realistic, or whether input-based calculations will have to suffice. As the empirical results suggest, continuous monitoring is currently by no means a standard procedure even among the relatively large enterprises questioned. At the same time, there is no obligation in place like in the power sector (compare Section 4.2), which would lead to a change of that situation in the foreseeable future. For the most part, input-based calculations with occasional measurements prevail empirically, and self-reported data determine the fee payment to environmental authorities (compare Section 2.3.2). Relying on these practices would make the introduction of a permit system a lot easier. This is increasingly true, as the size of enterprises included in the system decreases.

Verification of the data could take place through consistency checks in reported data over time accompanied by random site visits during which the quality parameters of fuel input and documentation of fuel purchases would be controlled. Nevertheless, there would certainly remain possibilities for enterprises to understate the amount of fuel used. This might be a small problem, as long as permit prices and with them the incentive to cheat are low. Additionally, it might be countered by imposing high fines on underreporting to increase the risk associated with breaking the rules.

The input-based approach suffers from the drawback that it is difficult to account for non-fuel use of energy carriers and for fuel that is sold on to other consumers.[58] In both cases, enterprises should not be required to hold CO_2 permits. Hence, a way needs to be found for enterprises to credibly document other usage or the sale of mineral fuel in order to be exempt from the permit requirement. This creates additional administrative effort, which increases the cost of running the system.

The disadvantage might be offset partially by the advantage of input-based calculations over emission-based measurements when co-firing of biomass in heat boilers is considered. CO_2 emissions from burning renewable resources would be registered by an emissions monitoring system even though no permits would be necessary to cover them. In an input-based system, this complication would not occur. As the empirical results indicate that biomass use is not wide-spread in large industrial enterprises today, this advantage of an input-based system seems to be small.[59]

From an environmental point of view, input-based reporting has the disadvantage that the application of coefficients for CO_2 emissions for certain fuels introduces some uncertainty concerning the actual amount of CO_2 emitted. However, if requiring a costly emission-based measurement technique would make it infeasible to include smaller sources under the system, the environmental disadvantage might be greater.

Finally, it will depend on the actual cost of emissions monitoring systems, whether one could justify choosing the superior, emissions-based approach. A fact that should be considered is that continuous monitoring equipment would not only be useful for a CO_2 trading system but could also increase the accuracy and integrity of the fee system on other air-bound pollutants in Poland.

4.3.5 Conclusion: the feasibility of including energy intensive industries

This section could only deliver a rough indication for the feasibility of an inclusion of the most energy intensive sectors from Polish industry in an emissions trading system. The absence of data linking the number of enterprises with cumulative CO_2 emissions introduces considerable uncertainty in the analysis, and the actual administrative effort of accounting for non-fossil fuel use or, alternatively, of imposing an emissions monitoring requirement on firms could not be analyzed in sufficient detail to recommend a particular approach. Nevertheless, the identification of the five most relevant sectors to be included (Section 4.3.1) and the order of scale of 1,400 entities to be regulated (Section 4.3.2) can serve as input when looking at the overall feasibility of a downstream system in Poland.

A significant lesson is also the overlap of industrial energy consumption with the occurrence of "industrial heat and CHP" plant. While energy use of industry certainly exceeds the input in heat and CHP boilers, the largest enterprises would be captured also if industry was not explicitly

58 This is highly relevant when incorporating the oil refining and coking sector into the system.
59 However, this might not be true in the future or in certain sectors (pulp and paper or furniture) where biomass use might become increasingly important.

included in a downstream system. Also, depending on the financial requirements for continuous monitoring equipment for an emissions-based accounting system, this method would clearly be preferable to an input-based method. This not only results from the reduced need for case-by-case regulations but also from the compatibility of emissions data from the power and heat sector in a downstream approach.

4.4 Summary: the feasibility of a downstream trading system in Poland

The discussion in Section 4.2 has identified a feasible approach to emissions trading in the power and CHP sector, where a significant amount of CO_2 emissions could be captured by regulating fairly few entities. The exclusion of the heat sector seems necessary at present, but should be considered for a later improvement. Incorporating energy intensive industries to the extent recommended in Section 4.3 would put permit requirements also to emissions from energy use in industrial processes, and it might eventually facilitate the inclusion of process related CO_2 emissions in the chemical, mineral and metallurgical industry. The large number of enterprises, however, forces a selective application of the trading system to the most important sectors. To avoid distortions at least within sectors, a full inclusion of all major enterprises of a sector should be attempted. The analysis presented suggests that this is difficult. However, analysis of actual CO_2 emissions data might cast a different light on this.

Table 14 sums up the basic figures and trends concerning the administrative effort connected with a core downstream system. The colums distinguish between the number of market participants and the possible number of monitoring entitites. This reflects the fact that, for example, several power plants might be owned by one reporting company. The monitoring efforts affect all physical power plants whereas some of the reporting and the trading of emission permits will probably be taken care of by the company. The likely number of market participants will impact on the overall transaction costs and the efficiency of the market. To assess overall cost of monitoring and verification, however, the number of physical entities serves as a better indicator.

The shaded colums in Table 14 point out how the numbers of participants and physical entities are likely to develop in the mid-term future. It shows that, in the case of power and heat generation, there is likely to be some consolidation in the sector at the company level, which indicates that larger and more experienced companies would act on a permit market. At the same time, the number of physical entities to be monitored under the system might increase due to a trend of converting heat-only boilers into CHP generation units. In energy intensive industries, the overall trend is hard to assess as the sectors develop quite differently. The future number of market participants in an emissions trading system will partly depend on the question whether industries continue to produce a substantial share of their own heat and electricity, or whether "outsourcing" to professional power and CHP plants will take place.

Table 14: Number of entities subject to a downstream approach				
	Now		Future	
Sector	**Number of commercial permit market participants**	**Number of physical entities with monitoring requirements**	**Expected number of commercial permit market participants**	**Expected number of physical entities with monitoring requirements**
Power and heat generation	46 professional power and CHP companies plus 160-180 industrial CHP producers.	120 professional power and CHP plants. All 160-180 industrial CHP plants.	Less professional power plants if consolidation takes place, also growth as large industrial plants become "professional." Inclusion of 1200 larger heat plants an objective.	Likely to exceed 280-300 entities, as the trend is towards mid-size and small units in both professional and industrial power and CHP production. Very significant increase in case the inclusion of heat-only boilers becomes feasible.
Energy intensive industries	1400 large enterprises in five energy intensive sectors. About 100 of these belong to the CHP producers in the power sector.	Minimum of 1400.	Some sectors are in decline (metallurgical, coke) but others (food) are not, so that the overall trend is uncertain.	not assessed
Total	About 1620 entities.	1700 or more.	not assessed	not assessed

5 A domestic upstream trading system for Poland[60]

5.1 Introduction: what is an upstream system?

The upstream system makes use of the fact that the carbon contained in fuels is converted to a known amount of CO_2 upon combustion within a limited error margin (IPCC 1996). Therefore, the regulator needs information concerning the quantity and the carbon content of the fuel, in order to require the producer or importer to hold a certain amount of permits for the potential CO_2 emissions embodied in the fuel.[61] CO_2 is thus regulated as soon as (or shortly after) it enters the national energy flow, and not at the "end-of-the-pipe" as in a downstream approach.

Such a system has the advantage that there are a lot less points of production or import of carbon containing fuels than there are points of CO_2 emissions. Hence, under an upstream approach, a comprehensive coverage of all carbon eventually emitted as CO_2 in an economy might become an administratively feasible option (Hargrave 1998).

General disadvantages of an upstream approach are related to the fact that the emitters of CO_2 and the entities affected by direct regulation are not identical. An upstream system can thus be criticized for not following the polluter pays principle. Also, upstream systems give enterprises no reason to avoid emissions through CO_2 scrubbing or sequestration technology.[62] Next, the incentive to switch to low-carbon fuels or to improve energy efficiency could be fairly modest, given that fuel users are only affected indirectly through a price signal if the producers or importers of mineral fuels attempt to roll over their additional cost. Any estimate concerning the incentive placed for fuel switching or efficiency improvements will thus depend on the ability of fuel producers/importers to charge customers their compliance cost under the system.

A possible solution to these and similar problems is the creation of permit set-asides (compare Hargrave 1998), which give the policymaker the ability to reward desirable behavior of firms in cases where the upstream trading system would not do so. Another "correction mechanism" are permit refunds, which are necessary if energy carriers are used for non-energy purposes or are exported.[63]

The following sections discuss the coal, gas and oil sector in Poland. For each fuel, a point of regulation that seems most feasible will be proposed. For this purpose, the current situation in the industry is presented to give an idea of the transformation process and its implication of the structure of a possible market in emission permits. A graph displays the flow of each energy carrier as well as basic statistical data to give an idea of the importance of certain flows. Information about relevant technical properties of fuels as well as monitoring possibilities and reporting practices will be addressed as seems appropriate. Comments on the awareness and opinion of the entities in a sector are included in the conclusions to each of the fuel specific sections. Apart from public statistics and documents, the discussion of the upstream sectors is based on interviews and correspondence with representatives of the coal, gas and oil sectors, as pointed out in more detail in Section 3.3.

---

60 Hargrave (1998) has examined the feasibility of an upstream system for the case of the US. This chapter relies greatly on his ideas and proposals, but makes adjustments and enhancements where necessary when looking at the specific situation of Poland.
61 Where information on the carbon content of a fuel is not available, the heating value or calorific value is a sufficiently precise substitute, as it correlates closely with carbon content (IPCC 1996).
62 While such end-of-the-pipe CO_2 abatement technology is not an economic option at the moment (Hargrave 1998), it might well be one in the future as research and development efforts are underway (see, for example, Audus 1997).
63 Examples are gas as a feedstock in the chemical industry or coal as reducing agent in metallurgy (IPCC 1996).

5.2 Upstream trading in the coal sector

With a share of almost 70% in 1997, coal is by far the most important source of energy in Poland (compare Table 3). While projections foresee a declining role of coal, it will continue to be the main energy carrier in Poland for decades to come (compare NOBE 1999). Almost 60% of coal supply in 1997 were burnt in the electricity and CHP sector, which in turn accounted for more than half of Polish CO_2 emissions in that year (compare Table 1). The coal sector is thus the most important sector to be included in an upstream permit system.

5.2.1 The coal sector

The "Law on the adaptation of the hard coal sector to the circumstances of a market economy [...]" (RP 1998b) laid the foundation for a fundamental restructuring program which the Polish government presented in July 1998 (RP 1998a). It aims at achieving commercial viability of the coal companies, which have been generating losses and accumulating debts for many years. On a longer time-line the privatization of the coal companies or individual mines is intended. The full and partial closure of a number of mines is underway with an expected reduction of coal output by more than 30% between 1997 and 2010 (RP 1998a, p.11). The number of active mines is planned to decrease from 54 mines operating in July 1999 (PAN 1999) to around 45 by the year 2003 (RP 1998a, p. 27f.).

Social problems in the hard coal regions of Poland are substantial. The policy of the government thus focuses on buffering the social impact of sector downsizing (RP 1998a). Nevertheless, the restructuring program is accompanied by an environmental plan, meant to provide for some of the most urgent environmental investments. This is part of an arrangement with the National and Regional Funds for Environmental Protection, who are asked to forgive 3.7 bn Złoties[64] in outstanding payments for environmental fees and fines from the sector (RP 1998a, p. 26).[65]

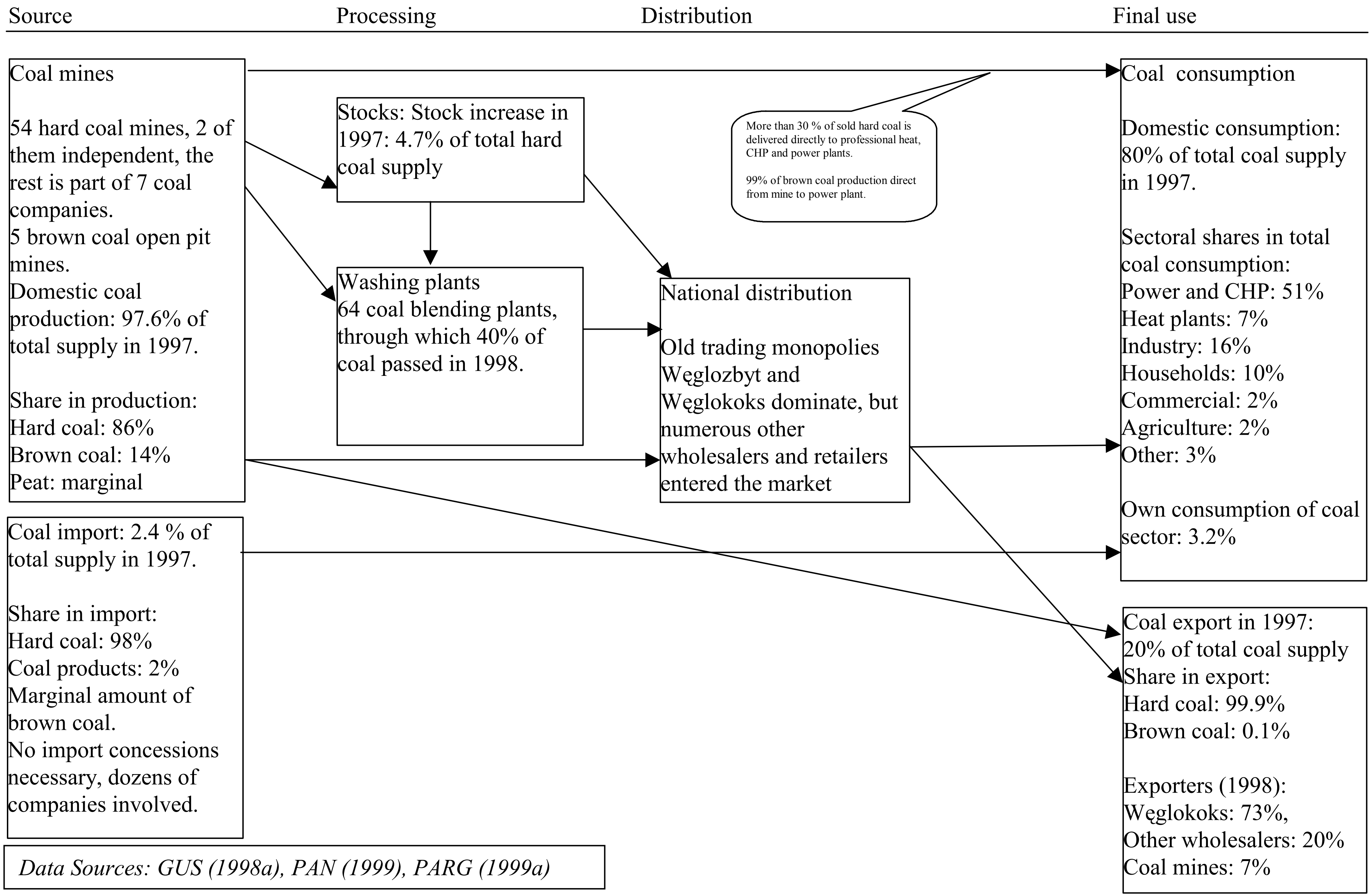
Brown coal is produced almost exclusively for immediate combustion in the country's largest power plants (PPWB 1999). At the end of 1999, the major brown coal mines and power plants are forming separate companies, the commercialization of which is not in all cases completed yet. Mines and power plants are economically dependant on each other as the mines cannot realistically deliver the coal to other consumers.[66] Also, it would not be economically viable for power plants to switch their whole generation capacity to hard coal or gas. Further mine development and delivery to power plants are thus fixed in long-term contracts lasting well into the next century (PPWB 1999). Also, the prices which brown coal mines are able to charge to the power plants are fixed by law. A possible solution under discussion is that a mine and the receiving power plant could be reunited in one company (Personal communication Kamiński, P).

64 About 920 million USD in September 1999.

65 The governmental program states explicitly that under the current financial situation of the mining sector the liabilities arising from environmental fees and fines "couldn't and can't" be met (RP 1998a, p. 70).

66 For the most part, brown coal is delivered directly via conveyer belts to the power plant. Other means of transport for large amounts of brown coal is generally not economic due to the low energy-to-weight ratio.

Figure 3: Coal flow in Poland



5.2.2 Coal flow

Polish hard coal production declined by about 7% (on a weight basis) between 1990 and 1995. In 1996 and 1997 production showed a slightly increasing trend despite the expressed intent of the former government to reduce output. For 1998 production figures show a significant decline in coal production (RP 1998a). As represented in Figure 3, the supply of hard coal is almost exclusively produced by Poland's 54 hard coal mines. In 1997, steam coal made up for roughly 76% of total coal production, while coking coal accounted for 24% in energy terms (GUS 1998a, p. 48).

Hard coal imports are marginal at present (compare Figure 3), but they might increase in the future, provided trade liberalization in this sector proceeds. This is due to the fact that imported coal is cheaper than Polish coal in particular in northern Poland, where the proximity to the ports gives imports a transport cost advantage over the Polish hard coal, which is mined in the southern part of the country (Personal communication Kamiński, P).

A considerable amount of hard coal is exported. In 1998, about 73% of all coal exports were undertaken by Węglokoks, the former monopolist in that field, while other wholesalers accounted for less than 20%. Roughly 7% of total exports where exported directly by the coal mines (PARG 1999b).[67]

Brown coal is produced at five active open pit mines in the country, of which four are delivering practically all of their production directly to electric power plants. These brown coal-fired plants provided for 38% of power supply in 1997 and constitute the cheapest source of electricity in Poland (PPWB 1999). Only a marginal amount of brown coal supply is used in the form of briquettes in small-scale appliances. Export as well as import of brown coal is negligible.

5.2.3 Finding an ideal point of regulation in the coal sector

Requiring permits for the carbon contained in hard or brown coal will necessitate regular measurements, as calorific value (and with it the carbon content) of the coal varies significantly between the types of coal produced or imported (PARG 1999a). The considerable differences do not allow for applying simple, weight-based indicators for all producers. Hence a point of regulation needs to be identified for domestic production and imports, where reliable data on quantity and quality of coal can be obtained.

a) Domestic coal production

Quality and quantity of domestically produced coal can be controlled either at the points of sale or directly at shaft exit of the individual coal mines.

Regulation at point of sale appears possible, as quality measurements are certain to be conducted directly before sale to customers (Personal communication Róg). The hard coal is analyzed either at the cleaning and blending plant or, if the coal does not undergo blending, at some point before delivery. In an increasing amount of cases, but not always, customers receive a certificate stating the quality of coal sold to them (Personal communication Tausch). Data on quality and quantity of coal sold by mines is reported on a monthly basis to the Polish Coal Sector Restructuring Agency (PARG),[68] and could well be the basis for determining the permit requirement for coal sold. In the case of hard coal mines which are owned by coal companies, it would have to be decided whether the permit requirement affects the sale from an individual mine to its holding company, or the sale

---

67 These exports are subsidized by the government as domestic production exceeds domestic demand and as average production cost per unit of coal exceed prices on the international market for coal (Personal communication Kamiński, P).

68 For reporting the forms G-09.1 and G-09.2 are used. Compare Table 5.

of coal from the holding companies to wholesalers and consumers. The later approach would reduce the number of entities in the permit market considerably, and allow for the formation of a type of intra-coal company bubble, as high and low-calorific coals from different mines could be blended.[69] For the brown coal sector, too, the calorific value of the coal prior to delivery to the power plant is known (PPWB 1999), and could thus be the point of regulation.

A disadvantage of making the point of sales also the point of regulation is that CO_2 emissions from the coal sector itself would not be covered. These include CO_2 from burning waste or storage heaps (IPCC 1996) as well as consumption in heat or electricity producing entities. While the former problem might be small enough to be ignored (compare IPCC 1996) the latter is significant. In many cases, activities of the mines have been unbundled so that energy generating entities are commercially separate from mining activities. However, the CHP plants still belong to the coal companies. Because these plants can, and in some cases already do deliver heat and/or electricity to third parties (GUS 1998a), their fuel input cannot be exempted from carbon regulation, as this would discriminate against power and heat plants which are not owned by coal companies.

This problem strongly suggests that regulation should set in at a mine level, that is requiring to report data on quantity and calorific value when it leaves the ownership of the mine and is transferred to the coal company. Such an approach, however, gives the companies a lot of possibilities to manipulate the data, as the overall accounting for coal inside that company is likely to constitute a "black box" to any control effort. It might be a more feasible way to allow the inter-company bubble, and check for consumption at company-owned power plants separately, deducting the carbon utilized from the permit account of the company.

Regulation at shaft exit would require mines to hold permits for the carbon contained in their product at shaft exit, that is before any blending or cleaning process would be conducted. This approach would have the advantage that all emissions of the sector itself would be captured in the system, and the problems concerning intra-coal company usage for energy generation would, theoretically, not occur. However, new measurement and reporting requirements would have to be imposed on mines. These measurements would not be easy to verify, as the coal investigated at shaft exit would then undergo the blending and cleaning process, and discrepancies could not easily be discovered.[70] Measurements at shaft exit would also require to account for the share of non-coal in the extracted material which in 1998, accounted for more than 28% of gross extraction (PARG 1999b). Altogether it can be concluded that measurements at shaft exit are impracticable.

b) Coal imports

For coal imports, customs office records could be used to determine the amount of imported coal (Personal communication Klecha). To account for the carbon content, however, credible data concerning the calorific value would need to be reported as well. This would not be easy to control, as coal can be imported without a license (compare URE 1999; Personal communication Klecha), that is by an unknown number of enterprises, and can occur also in relatively small amounts. The only feasible way to resolve this seems to be to apply uniform carbon content indicators for different types of coal, and require the importer to hold a sufficient number of permits when importing the coal.

69 The degree to which this could happen is limited by the possibilities to actually transport coals to a central blending plant. In many cases, coal is delivered directly from mine to the customer. The prior "sale" to the holding company is merely happening in the bookkeeping but does not involve physical relocation of the coal (Personal communication Aleksa).

70 There might be a way to find out whether incorrect data was reported as the output after blending could not have a higher calorific value as the weighted average of all reported inputs. While it might thus be possible to determine that underreporting of the calorific value took place, it might be impossible to figure out who was responsible for it in cases where coal from different mines enters a blending plant.

This would introduce some fault in the system, as the uniform coefficient would not always match the actual amount of carbon imported. As total coal imports are fairly small at present, the overall departure from the environmental goal would, however, remain small. To avoid discrimination of single importers, there could be a provision that the coefficient is applied unless the importer proves that the carbon content in his fuel is lower than the assumed coefficient (compare Hargrave 1998). In such a case, the permit requirement would be based on the actual carbon content. Coal imports cannot be waived from a permit requirement as any discrimination of domestic coal sales is likely to be politically unacceptable.

c) Coal exports

Permits should not be required for potential CO_2 emissions contained in exported coal. This should be easy to regulate in cases where the producer exports coal directly, as the producer could simply prove that the coal of a certain quality left the country and deduct the amount from its permit requirement. The issue becomes more complicated for the frequent case, where domestic wholesalers function as exporters. Here, the producer would need a permit for the coal sold to the exporter, even though the coal actually leaves the country. This could be taken into account by issuing free compensation permits at the border, which the exporter could sell on the permit market (compare Hargrave 1998). The overall amount of emissions would not increase, as the free compensation permits would merely offset the fact that the coal mine expended permits for potential emissions which will not actually occur.

The problem is that the coal producer expends permits, while the exporter receives the compensation. It will then depend on the negotiation power of producers versus exporters, whether this imbalance will be persistent, or whether the producer manages to charge the whole permit price to the exporter. In any case, such a compensation regulation increases transaction cost of the system.

5.2.4 Conclusion: the feasibility of including the coal sector in an upstream trading system

An upstream system for the coal sector would affect the nine domestic coal companies, which run almost all of the 64 coal preparation plants in the country (compare Figure 3). These producers of coal would act as players on a permit market and be subject to permit quotas and reporting requirements. Nevertheless, each of the 54 hard coal mines would be affected by monitoring requirements because significant amounts of coal do not pass through preparation plants, and because the coal consumption in CHP plants run by the mine or coal company would have to be taken into account.

Hence, it would be necessary to monitor and verify the data at mine level, but reporting and accounting of permit requirements would be at the level of the 7 hard coal companies and 2 independent mines, plus the 3 brown coal companies. In addition, an uncertain number of importers and exporters would have to be covered by the system. Due to the uncertainty mostly concerning the number of (small) importers, the total number of entities from the coal sector which would act on the permit market cannot be easily determined. Looking at the present structure, however, approximately 15-20 companies (coal companies and individual mines plus large importers and exporters) would account for the bulk of market potential from the sector (Personal communication Wojciechowska).

If the procedures for dealing with imports and the compensation system for exporters are kept simple, it seems possible that the administrative burden of keeping track of coal transfers and the monitoring of its quality could be done at reasonable cost. This judgement is mainly based on the fact that existing practices governing coal sales and the import of coal could largely be relied on. In the future, a decreasing number of mines and eventual consolidation of coal companies might decrease the administrative burden. The fact that the sector is shrinking also implies that the potential problem of "new entrants" is small.

The failed attempt of this study to raise data on the opinion and awareness of the sector concerning emissions trading in climate protection can, to some degree, certainly be explained by the absence of such awareness in the sector. Also, the experience with market mechanisms such as trading at stock exchanges is certainly lower in the coal sector than elsewhere, as privatization has not yet taken place.

There can thus be little doubt, that the present economic situation of the coal sector in Poland makes it politically difficult to introduce a permit system for previously unregulated pollutants such as CO_2. Such an attempt can be expected to meet hefty resistance from the strong coal lobby as it would be seen as a further move in energy policy to support the use of gas over coal in Poland. In addition non-compliance and non-payment under the current environmental fee system is rampant (compare footnote 65). Inclusion of the coal sector in its current situation would destabilize any permit system by undermining compliance.

While participation of the coal sector in an upstream trading system seems feasible from the point of view of administrative effort, the financial and political problems of the ongoing restructuring of the sector make it unlikely that an inclusion of the coal sector in a trading system would reach political approval. Good progress of the restructuring program in restoring the commercial viability of the mining companies is thus a pre-requisite to the inclusion of the coal sector in an upstream permit system.

As such a successful restructuring of the sector is likely to bring along significantly decreased output levels, considerable CO_2 emission reductions from coal can occur without any additional climate policy, provided that the decrease in Polish coal production is not balanced by increased coal imports. A permit system which would be based on historic output levels would then have to be designed carefully in order to warrant that it does not counteract decreasing carbon shares in energy supply by permitting higher amounts of carbon than would actually be produced. On the other hand, carbon permits distributed to coal companies could play a supporting role in the restructuring effort, as they would place an incentive to reduce coal production and sell carbon permits instead.

5.3 Upstream trading in the gas sector

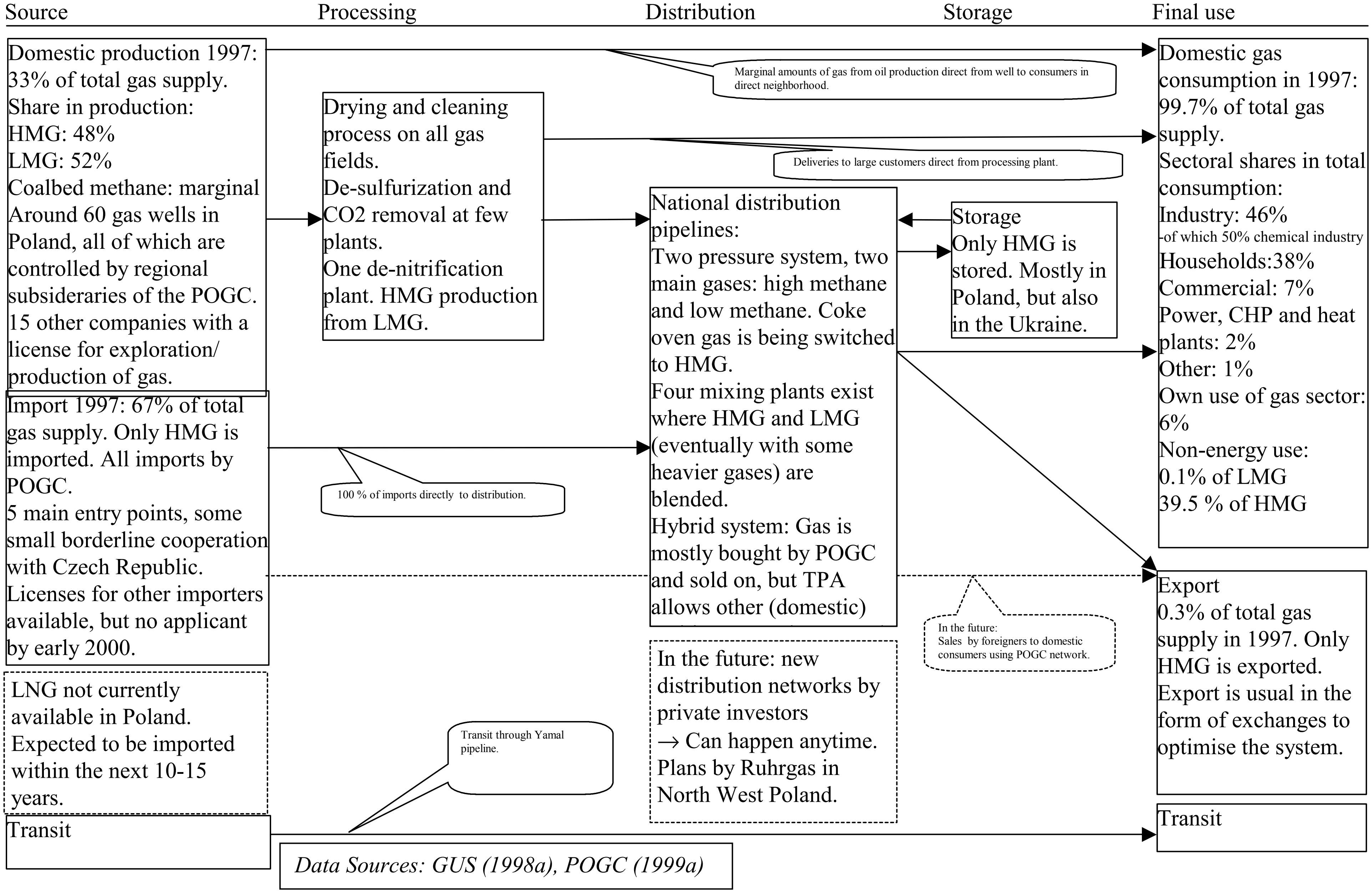
Natural gas accounted for roughly 9% of Polish energy supply in 1997 (compare Table 3). This share is expected to increase considerably in the coming years due to fuel switching from coal to gas in municipal heat production and an increasing share of households being connected to the grid. Also, new power generation capacity is likely to be gas-fired because Poland lacks peak generation capacity (Personal communication Kamiński, P). Increasing the share of gas in energy supply can play a key role for any CO_2 mitigation strategy.

5.3.1 The gas sector

The gas sector in Poland is to a very large degree dominated by the Polish Oil and Gas Company (POGC). It is a vertically integrated monopoly which covers all functions from exploration of gas reserves to gas production, processing, transport and distribution. Since its conversion to a joint stock company in October 1996, the company is in the process of substantial restructuring. Regional subsidiaries form separate firms, which are fully owned by POGC, which in turn is to 100% owned by the Polish Treasury. Privatization of these regional entities might occur but is unlikely to happen very soon (Personal communication Rey).

New entry to the sector is allowed, and few other companies already hold concessions for exploration, production and trade in gas (MEPFW 1999a; URE 1999). So far, however, none of these firms started producing gas. The sector is preparing itself for participation in the emerging international gas market. The European Council Directive concerning common rules for the internal market in natural gas (Directive 98/30/EC) plays a crucial role in that respect and defines key targets for the restructuring aims in the Polish gas sector.

Figure 4: Gas flow in Poland



5.3.2 Gas flow

The gas flow in Poland is depicted in Figure 4. Data included represents the status of 1997. Developments to be expected in the future are included in the graph.

High methane gas (HMG) is produced in the western and south eastern part of the country. Currently, only the three regional production subsidiaries of the POGC produce gas, which they purify on their gasfields and, to more than 97%, feed into the national distribution network (POGC 1999a). A small but increasing amount of gas is delivered directly from the processing plant to large customers such as power plants and larger industrial users of gas. Gas occurring in minor amounts during oil extraction operations is mostly flared at the well, as its collection and treatment is uneconomic. In a few cases such unpurified gas is sold directly to individual consumers (Personal communication Kuś).

Derived high methane gas is produced by converting a share of the low methane gas. The process involves de-nitrification of the gas, blending it with high methane gas and enriching the mixture with heavier gases. In 1997, 1147 million cubic meter of low methane gas were converted to a net output of 295 million cubic meter of high methane gas (GUS 1998a).

Low methane gas (LMG) is produced in the western parts of Poland. Apart from being converted and mixed with high methane gas, it is distributed in a separate pipeline system in the region of its production (POGC 1999a). In the past years, part of this low methane network was converted to high methane, but it is likely that two systems will coexist in the foreseeable future (Personal communication Skwarczyński).

Coalbed methane is a serious environmental problem as large amounts are released into the atmosphere through the ventilation of coal mines. There is a significant potential for methane capture from coal seams (PGI 1996) and four concessions for production (two coal mines, two gas companies) have been granted (MEPNRF 1999a).

Coke oven gas and town gas used to account for important shares of Polish gas supply. They were distributed with regional pipeline systems. In recent years, these networks were retired or switched to high methane gas. POGC does no longer buy or sell these types of gases (POGC 1999a). In one instance, however, the network of POGC is still used for transport of coke oven gas by a third party, making use of the TPA[71] principle (Personal communication Stańczak).[72]

An important part of the high methane gas supply stems from imports. These are bought by POGC and sold on to consumers. Most gas enters Poland via three connections at the eastern border. Two connections with Germany are also used for some exchanges, as well as for the transit of Russian gas. Two connections with the Czech Republic exist, they are however only of small capacities and are not regularly in use (Personal communication Hołownia).

POGC is not obliged to grant access to the network in case a Polish customer wants to buy gas abroad. This is because the TPA principle, included in the Energy Law (RP 1997) is not yet applicable to foreign gas producers. As a consequence, POGC is the only company that has a

71 TPA implies that the network is open by law to enterprises other than the network owner, who may however charge for the usage.
72 Coke-oven gas, as well as other derived gases (refinery gas, town gas, blast furnace gas) are, of course, nevertheless produced as they are by-products of other industrial activities. For the most part, these gases are used directly in the facilities where they occur or are sometimes delivered to consumers in the neighborhood. As they are derived from coal or oil, their carbon content would, in a (comprehensive) upstream approach, already be subject to regulation at the stage of the "original" fuel. To avoid double-counting they would not be included in an upstream system and will consequently not be discussed in this chapter.

concession for gas imports. The inclusion of foreign producers under the TPA principle can, however, be expected as soon as the EU Directive 98/30/EC for gas has validity for Poland. Theoretically, it is nevertheless possible for a Polish enterprise to import gas (provided it wins a concession for import and trade of gas), as it could build its own pipeline for gas import. In such a case, import other than through the network of POGC would be possible.

Gas transit from Russia to Germany is going through the POGC system. This gas enters the Polish system at a border point with the Ukraine. The outgoing gas is measured again at the German border. The difference (withdrawals by POGC and losses) is counted as import. By the end of 1999, the Polish section of the Yamal pipeline[73] is was to be put in operation (Rz 24.09.1999). It will then take over the transit function, but will be interconnected with the Polish network to allow for withdrawals by the POGC (Personal communication Hołowina).

Liquid Natural Gas (LNG) is not utilized in Poland. While there are strategic considerations to construct a terminal at one of Poland's ports to allow for the import of LNG, this seems unlikely in the near future due to high cost (POGC 1999b).[74]

Industrial consumers and households account for the bulk of gas consumption. Gas for energy purposes is used in particular, where well-regulated process heat is essential (glass production, chemical industry) (POGC 1999a). An increasing number of communal heat and CHP plants switch to gas for environmental considerations. Gas is used only to a very limited degree in the power sector to date.

More than 40% of the gas delivered to industrial consumers in 1997 was consumed for the production of nitrogenous fertilizers (POGC 1999a). These deliveries account for most of the gas used for "non-energy purposes." As the process of ammonia production for fertilizers is a substantial source of process-related CO_2 emissions (IPCC 1996), however, non-energy use does here not imply that the carbon contained in the methane is sequestered.

Export is negligible, but border exchanges are likely to increase as POGC and German companies seek to cooperate in cases where it allows them to optimize distribution to certain areas (Personal communication Holowina).

5.3.3 Finding an ideal point of regulation in the gas sector

a) Domestic gas production

Regulating domestic production of natural gas is in principle possible at well, that is upon entry of the gas to the processing plant, at the point of entry to the distribution systems and at point of sales to consumers.

Quantity measurements[75] of the gas produced are taking place regularly at the point, where the pipeline from a well enters the processing plant. The quality of this gas is measured frequently at big wells and at wells delivering relatively unstable gas qualities. It is determined less often (once a year) at small and/ or stable-quality wells. Requiring continuous quality measurements for

73 The Yamal pipeline will link substantial natural gas reserves in Northern Siberia with Western Europe.

74 Liquefied Petroleum Gas (LPG) will be included in the discussion of the oil flow, as LPG shares many properties of liquid fuels if it comes to production and distribution in Poland.

75 Quantity measurements are conducted with differing equipment, which results in some uncertainty concerning the quantity actually produced. But there are legal guidelines as to the allowable fault in measurement so that this sets a ceiling to the possibilities of underreporting.

individual wells would be very expensive and could lead to rendering some wells uneconomic (Personal communication Stańczak).

Continuous quantity measurements are taking place at the point where the dried and purified gas (from several wells) leaves the processing plant and enters the gas pipeline system. Here, gas quality is fairly stable and regularly monitored. Quantity and quality delivered to the system is documented on a monthly basis in a protocol, which experts both from the producing and the distribution firm sign (Personal communication Kuś). This protocol serves as a basis for payments for delivered gas and could be used to determine the amount of carbon for which permits are needed. This procedure would cover over 97% of the gas produced in Poland.

Deliveries of purified gas to individual consumers especially via installed pipelines do occur. These cases would need to be accounted for, as they represent large industrial customers which cannot be ignored without undermining the viability of the permit system. In such cases, measurements of quality and quantity depend on the contract between producer and customers. Here, the documentation of the sale could serve as the basis for determining permit requirements.

As Figure 4 shows, a marginal amount of gas goes directly from (oil) well (or the coal mine, in case of coalbed methane) to customers. The quantity of this gas, which would otherwise be flared or emitted, is measured, as companies are required to pay emission fees for it if they would not sell it. Here too, the documentation of the sale could be used as a reference point for determining the permit requirement of the producer. As the gas is unpurified, the carbon content depends on the natural parameters of the well and would need to be established from time to time.

Requiring permits at point of sales to the customer seems feasible, as all companies which trade in gas need a license for their activities. They are thus known, and could be required to hold permits for the quality and quantity of gas delivered. As sales are usually documented in terms of quantity and quality, permit requirements could be based on the conditions of the sale. Also, exports can easily be accounted for, and the approach would warrant equal treatment of importers and domestic producers of gas. One has to be aware of the fact, however, that this would create an incentive for both, seller and the client, to understate the quantity or quality[76] of the gas delivered.

The saved cost of permit acquisition (or expenditure of grandfathered permits) could be shared by the parties involved. Also, this approach would mean, that all gas usage of the sector itself (as well as losses and theft) would not be accounted for. While this might be a fairly small inconsistency in the context of CO_2 emissions, the problem would be amplified if the system were to be extended to cover methane emissions.[77]

b) Gas import and export

The current practice of large quantities of high methane gas entering Poland at its eastern border, where quantities are registered by the customs office (to determine the VAT due by the importer), relies on measurements conducted on the Ukrainian side of the border. As a large part of the gas is in transit, the gas leaving Poland at its western border is deducted. The permit requirements would have to be reduced by the amount of carbon contained in the gas which leaves the country again. At present, quality measurements of this gas are not continuous. This means that the precise carbon content is not known with certainty.

---

76 The quality, however, can be assumed to be stable for the gross number of consumers. Only some large industrial consumers buy gas of a specific quality (Personal communication Kuś). The number of cases which would necessitate the departure from a default value for the quality is thus likely to be low.

77 Fugitive methane emissions from the gas network account for less than 15% of all methane emissions reported in the 1997 inventory (MEPNRF 1999d).

A permit system could either rely on a fairly stable fuel quality, or require increased (and costly) monitoring efforts. Even though monitoring using chromatographs is costly, this could be justified as there are only very few points to control. With the opening of the Yamal pipeline, this issue might become easier, as the transit will be under the auspices of a company that only deals with transport. POGC (and by then eventually also other companies) will withdraw gas at a few points along the pipeline. These points would then be the point of import and of regulation within the permit system. The fact that these points will be located within the country will make control of measurements easier.

Border exchanges with German or Czech gas companies are relatively small. Gas quality can be assumed to be stable so that the measured amounts of gas could be easily subject to permit requirement. As these flows are taken place in the form of exchanges, that is imports are offset by exports at another time or another location, it could be considered to allow the companies to hold permits only for the net import or receiving permits for net exports. This could decrease the administrative burden as the permit requirement would be determined only once a year rather than at every border transaction. No border regulation of imports would be necessary, if permits were required at the point of sale. The advantages and disadvantages of this option were discussed above.

5.3.4 Conclusion: the feasibility of including the gas sector in an upstream trading system

Combining permit requirements for net imports with permit requirements for domestically produced gas at the moment of introduction to the gas distribution system seems to be the best point of regulation for a tradeable permit system. At these points, the quality of the gas is fairly stable and already well documented, so that the permit requirement of each firm could be determined on the basis of the quantities of gas sent through the system. In the few cases where gas is sold directly from well to (usually large) customers, the well owner should be required to hold permits for the amount and the quality of the delivery. Only in cases where the waste gas is sold to individual consumers, a permit system might prove to be cumbersome in relation to the low value of the gas sold. This drawback is, however, marginal.

A substantial share of gas is used for non-energy purposes. To the degree to which carbon contained in the methane can be considered as being permanently sequestered, methane deliveries should be exempt from permit requirements.[78] This could be done by allowing for the possibility that if a firm proves, that the gas it bought is sequestered, this would be regarded as a carbon sink, which could receive permits from a set-aside pool. Another way would be, that the customer could "sell" such a proof to the gas company, which could then deduct the amount of carbon sequestered from its permit requirements.

A possible problem is related to the fact that methane from coalbeds and landfill sites are assumed to be treated equally with gas from "normal" sources. At present, coal mines or landfill site operators are required to pay low fees for emitted methane (see Table 4). In an upstream carbon permit system, however, they would be required to hold permits for capturing the methane, which they would otherwise emit. It is important that the introduction of a tradeable permits system focusing solely on carbon does not place a disincentive to methane capturing activities. This would be counterproductive from an environmental perspective, as methane emitted directly has a significantly higher greenhouse warming potential than the CO_2 from the combusted methane. While one could rely on the hope that the economic potential of coalbed methane is sufficiently large to make its capturing profitable despite the carbon permit system, the problem could also be

78 Fertilizer production is an example for this in Poland. The issue would need more detailed examination to determine which products can be considered to sequester all or parts of the carbon used in their production for a sufficiently long time span.

mitigated by increasing the fee level on methane emissions, or by exempting captured methane from the permit requirement.[79]

Awareness concerning permit trading is low in the POGC at present. But as POGC is preparing itself for privatization and for increasing exposure to competition in the European gas market, there is sufficient reason to believe that they would be able to deal with the institutions and the dynamics of a permit market fairly easily. It would not force them to get acquainted with an otherwise unknown trading mechanism.

As imports of gas would be subject to the same requirements as domestically produced gas, and because exports will be exempt from permit requirements, a trading system would not directly affect the competitiveness of Polish gas producers on international markets. It might still do so, if the transaction cost of running the system would be substantial to the firm, and if their competitors would not face such, or similar, regulation in their home countries. Hence keeping the system as uncomplicated as possible is in the interest of firms and would help the introduction.

Because a permit system, which addresses the carbon content of all fuels traded in Poland would likely increase the incentive to switch from coal to gas, the gas sector might also be politically supportive to the idea of introducing such a system. This support will obviously also critically depend on the way the distribution of permits will take place, but independent of auction or grandfathering, a permit system on carbon is certain to strengthen the position of gas on the domestic energy market. However, the political support of the gas sector, which represents only 9% of the energy supply might be futile against the political might of the coal sector.

79 The ideal solution would be to include methane emissions in the trading system. Then, coal mines or landfill sites would be required to hold permits for their methane emissions to the atmosphere, and would not need these (but cheaper carbon permits) when the methane is captured and sold as fuel.

5.4 Upstream trading in the oil sector

In 1997, crude oil supply and net liquid fuel imports including Liquified Petroleum Gas (LPG) accounted for 18.2% of Polish total energy supply (compare Table 3). Consumption can be expected to increase significantly due to the strong increase in road-based traffic expected for the years to come (Ministry of Transport 1998). Including the oil sector in an upstream permit system would be a desirable feature from the viewpoint of climate protection policy, mostly because this would capture all CO_2 emissions from the transportation sector. Their current share in total CO_2 emissions is 7.4% (compare Table 1), and their absolute amount is expected to rise significantly in the future (FEWE 1999).

5.4.1 The oil sector

The state-owned monopolies which managed the oil sector in Poland still in the early 90s (IEA 1995) have, in principle, given way to markets, in which oil import, refining, and distribution is open to private and international direct investment. While oil processing continues to be dominated by Poland's largest refinery, Petrochemia Płock, numerous international oil companies as well as private wholesalers and retailers have entered the fuel market (PIPP 1999). With the liberalization of gasoline prices in January 1997 the process towards competition in the market took an important step. Most of the sector is, however, still in the ownership of the State Treasury-owned holding company Nafta Polska, which is in charge of privatizing the sector. Gradual privatization was scheduled to begin in late1999.[80]

Independent of ownership structure, the Polish market is, and for the foreseeable future will be dominated by Petrochemia Płock (Personal communication Łańcucki). The refinery (which owns two of the five smaller Polish refineries) represents 75% of Polish crude refinery throughput. Due to its merger with the former monopolist distributor Centrala Produktów Naftowych in May 1999, the newly created Polski Koncern Naftowy (PKN) controls roughly 30% of all Polish gas stations (PIPP 1999) and claims to deliver 60% of Polish supply in liquid fuels (Petrochemia Płock, 1999b). Petrochemia Płock and Gdansk Refinery, the countries second largest, were profitable companies in 1998 and have invested heavily in modernizing their production facilities (Petrochemia Płock 1999a, Rafineria Gdańska 1999).[81]

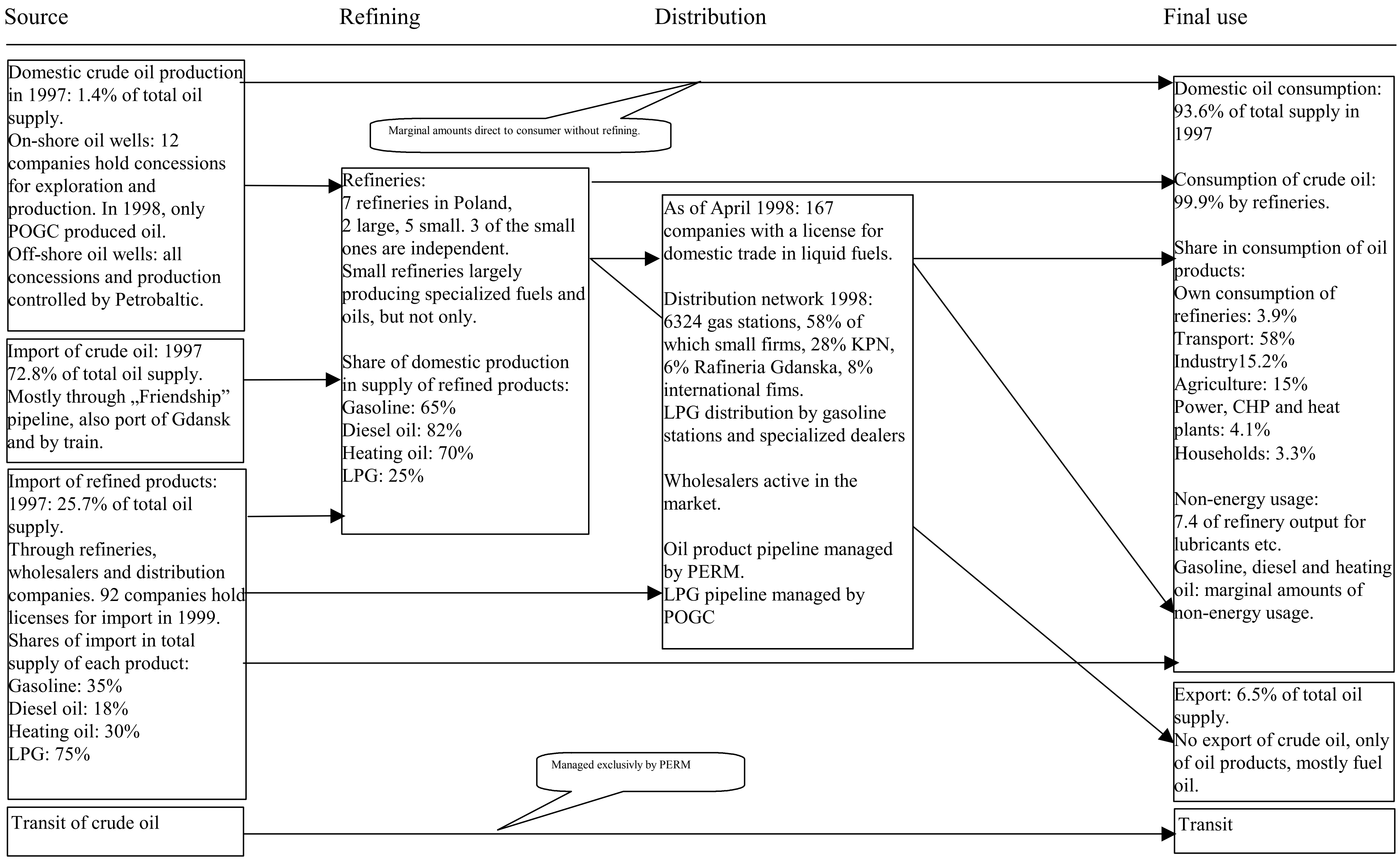
5.4.2 Oil flow

As Figure 5 displays, import is the dominant source of the Polish crude oil supply. Also, a substantial share of refined fuel consumption is imported, as the refining capacity of the seven refineries in the country only covers about two thirds of the supply of gasoline, diesel, fuel oil and

80 A first attempt to sell part of Rafineria Gdańska, Polands second largest refinery, to a strategic investor failed in late 1998 and a new tender is planned (Rafineria Gdańska 1999). A first public stock offering of PKN was planned for Fall 1999 (Petrochemia Płock 1999).

81 These and continuing efforts are conducted already with a view to meeting increasingly stringent fuel quality standards as prescribed in the Directive of the European Commission relating to the quality of petrol and diesel fuels (Directive 98/70/EC), which will be binding for Poland in the case of accession (Personal communication Łańcucki).

Figure 5: Oil flow in Poland



Data Sources: GUS (1998a), PIPP (1999), POGP (1999) aviation fuel. Hence, when designing an upstream system, substantial attention needs to be given to the regulation of imports.

Crude oil enters Poland mainly through the "Friendship" pipeline but also, and increasingly so, by ship. Import via rail is minimal (Personal communication Kozakowski). Refined fuels are imported via truck, train and ship by refineries, wholesalers and distribution companies. Direct imports by consumers are marginal, but do occur (Personal communication Kozakowski). All imports are recorded by the customs authorities.

Imports of gasoline, diesel, heating oil and jet fuels require a license by the importer. In July 1999, 92 companies held a license for oil imports (Personal communication Klecha). Crude oil destined for Germany passes through Poland via the Friendship pipeline, which is also used for oil imports by Polish refineries. The quantity of oil is measured by customs authorities upon its entry at the eastern border, where it is already designated for a specific customer or for transit (Personal communication Łańcucki).

The small amount of domestically produced crude oil was extracted by only two companies, mostly in connection to natural gas extraction but increasingly off-shore in the Baltic sea. More firms may do so in the future, as 12 companies hold concessions for exploration and production (MEPNRF 1999a). The overall share of domestically produced crude oil in total supply, however, is not likely to increase substantially (Personal communication Kozakowski).

Production of gasoline is to a large extent concentrated in the two main refineries of the country. Most is produced from refined crude oil, but there are also cases of blending with imported oil products or with products bought from other refineries. Up to 5% of ethylene alcohol derived from biomass is added to 70% of the gasoline produced in Poland (Foltynowicz and Kozakowski 1998). A small part of the crude input is used for non-energy production such as asphalt.

About a quarter of the total supply of LPG in Poland is produced domestically. The propane, butane or mix of the two, is a side-product of oil extraction but is also produced in refineries. The supply is showing a dynamic increase over the past years, which is expected to continue (POGP 1999). More than half of total LPG supply is distributed in bottled form or larger containers to households and industry, about a third is delivered to gas stations for use as a motor fuel[82] (POGP 1999). In the North East of Poland, a small network owned by POGC distributed LPG to 27,800 households in 1998 (POGC 1999a).

Apart from POGC, numerous wholesalers and distributors are active in the LPG market. The biggest firms are gasoline producers who offer LPG at their gas stations, but there are also companies which trade exclusively with LPG. While such trading needs a license issued by the Energy Regulatory Authority, there is no separate license required for the import of this fuel. Hence the number of importers is uncertain. It was estimated to range around 30 in 1998 (Personal communication Maciejowski).

Concerning the consumption structure, it can be noted that some households switch from coal boilers to fuel oil-fired heating systems, but it is expected that in most cases natural gas (or LPG) will be the option of choice for individual households (Personal communication Powrożnik). The main product of the sector are automotive fuels which have a significant growth potential (compare Ministry of Transport 1998).

82 There are about 340,000 cars running on LPG in Poland (POGP 1999, p. 19).

5.4.3 Finding an ideal point of regulation in the oil sector

Regulation in the oil sector has to address the difficulty that a substantial share of total oil supply enters the country as crude oil, which is processed further, while another part enters in the form of oil-derived products. In order to define permit requirements, which would treat imported oil products in the same way as crude oil it would thus be necessary to translate the carbon content of the products into an equivalent measure for crude oil or vice versa.[83] This is made difficult by the fact that produced or imported crude oil is only measured for density and sulfur content. Carbon content or calorific value bear no useful information to refineries and would be costly to conduct (Personal communication Kozakowski).

Subjecting crude oil to carbon regulation would thus require measurements solely for purposes of the carbon permit trading system. As Polish crude oil production is taking place at many small-scale wells and shows varying quality, the introduction of such measurements might not be economically justifiable in some cases (Personal communication Kozakowski). An additional problem with the regulation of crude oil is, that eventual non-energy use of the products derived from it (such as asphalt, for instance) could hardly be considered. It is thus assumed in the following, that a permit system should be based solely on oil products rather than on crude oil.[84] In order to capture the carbon contained in Polish oil use, regulation could thus be introduced:

a) at the point of production in Polish refineries as well as the import of oil products,
b) at the point of sale of oil products to consumers.

a) Regulation at Polish refineries and at the point of import of oil products

The four companies which operate the seven Polish refineries together with the roughly 160 licensed importers of refined oil products could be required to hold permits for the energy products they intend to sell. The parameters of these products are already thoroughly analyzed before sale. A complete list of the hydrocarbons and other elements contained in the fuel is part of a certificate, which accompanies fuel deliveries (Personal communication Kozakowski).[85] According to expert opinion, the content and the kind of hydrocarbons in the fuel is a better indicator than the calorific value when it comes to determining potential CO_2 emissions from fuel combustion (Personal communication Kozakowski).

Measurements of the carbon content of fuel would thus be unnecessary, provided a credible certificate stating the chemical composition of the fuel is available upon sale or import. However, a methodology would have to be found to convert hydrocarbons in the fuel into CO_2 equivalent. As the parameters of oil products in Poland vary across producers and importers (Personal communication Kozakowski) applying a singular coefficient for each type of product might not be sufficient.

A way to address this issue is through a "challengeable" coefficient (compare Hargrave 1998). It would mean that uniform CO_2 factors are assumed to apply to each of the various types of fuel, but gives firms the possibility to prove that their product is in fact less carbon intensive and should be treated differently. In such a case, a producer-specific coefficient would be used. In order to keep the number of specific regulations low, the uniform coefficient should be set at the lower end of the possible spectrum. While this would lead to some of the carbon going uncovered by permits, it would facilitate the administrative side of the system.

---

83 This means that for oil products, some type of borderline adjustment would have to be found. If the carbon in products will be treated the same as the carbon in crude, then the import of products has the advantage of not holding permits for the CO_2 emissions during production.

84 This has the disadvantage, that oil consumption within the refining sector would not be included in the system. For such cases, however, other ways could be found to regulate the emissions from the few refineries in Poland.

85 Only in the case of heating oil, the calorific value is calculated as well because it is of relevance to the user (Personal communication Kozakowski).

When determining such a coefficient, it would be useful to follow the typology for hydrocarbon products, which is used to determine the excise tax levied on motor fuels in Poland (Dz. U. Nr 157, pos. 1035, 16.12.1998). As all refineries and importers of oil products have to report the type and quantity of products they sold[86] (Personal communication Uzbiak), it seems fairly straightforward to use this data also for determining the permit requirements. This would, however, require cooperation between the customs offices to which the data is reported (also for domestic production), the Finance Ministry, which imposes the excise tax and the eventual environmental agency in charge of the permit system.

Refineries would, however, have to be freed from holding permits in as much as they prove that alcohol from renewable energy sources has been used in the production. Regulation on non-energy usage would not be a problem as products such as asphalt would simply not be included in the reporting scheme. For products where a partial emission of the contained carbon may occur (compare IPCC 1996) a reduced permit requirement could be put in place.

Addressing refineries would have the negative effect that the considerable consumption of the refining sector itself might not be fully captured. However, as they have to report their energy consumption to the statistical office (compare Table 5) it would seem simple to include regulation to cover the own usage of the sector.

Awareness in the sector has not been sufficiently analyzed to make a well-funded statement. The people interviewed had all heard about the mechanism with regards to sulfur abatement, but were unaware of proposals concerning an upstream system from which they would be affected. It is clear that the sector has a long experience in dealing with technical standards.

b) Regulation at the point of sale of oil products to consumers

Requiring the distributors of products to hold licenses would affect around 200 companies. All these companies are known to the regulator, because they need a license for the domestic trade in liquid fuels (URE 1999). However, their turnover is not reported to the tax authorities in physical terms, as the excise tax is imposed on the refineries. Hence, a new reporting system would have to be established for the purposes of carbon regulation.

Another difficulty arising is the fact that some of the fuel, which the distributors buy from refineries is mixed with ethanol from produced from biomass. This percentage of the fuel should not be penalized by a carbon permit system, but it seems rather complicated to trace the origins of the fuel to every distributor.

A potential advantage of regulating the distributors, is that they are already fully involved in a competitive market and could thus be expected to cope with a permit market as well. However, for small gas stations and wholesalers, the additional effort might be more difficult to stomach than for the large players on the Polish market and international oil companies.

5.4.4 Conclusion: the feasibility to include the oil sector in an upstream trading system

Regulation at exit of refinery appears to be the most feasible option. This option would have the advantage of requiring less than 200 entities to report data and keep permit accounts with the regulator. Accordingly, monitoring and verification efforts would be smaller than in a system which

86 The fact that the import of LPG is not subject to a license requirement does not impact negatively, as the actual border transaction is still recorded. However, it makes it difficult to assess the actual number of entities which would be affected.

includes all distribution companies, as occasional checks on the documentation of refinery output and imports would suffice. The biggest advantage of requiring refineries to hold permits, however, is the fact that the system could be based on existing reporting requirements in place for the excise tax.

As during the past years, competition in the oil sector was far more intensive in comparison to the Polish gas or coal sector, and because the privatization process of the sector is comparatively advanced, it seems safe to conclude, that the oil sector would be the least complicated sector to include in an upstream approach.

A remaining question concerning the regulation of the oil sector is the fact that there seems to be little what refineries can do to limit the CO_2 emissions from their products, as numerous factors are fixed due to technical requirements of the engines combusting the fuel (Personal communication Kozakowski) and environmental regulation concerning emissions of carcinogenic substances. While permits for carbon would place an incentive to increase the share of ethylene produced from renewable resources in the fuel, this would not be capable of significantly reducing CO_2 emissions. Lowering overall fuel consumption would be the main target, and a permit system could contribute to that, as long as price signals are recognised in the market and induce such decreases in consumption. A system of grandfathered permits might not place enough incentives here, so that an auction system might be preferable in order to impact on carbon emissions.

5.5 Upstream trading and electricity imports/exports

Electricity is imported solely through the network of PSE and accounted for 4,604 GWh in 1998 (PSE 1999). These imports were mainly from Ukraine and the Czech Republic, with which Poland has a number of high-voltage interconnections from the times of the Integrated Power System, which connected the networks of the former Soviet Union with those of other Central and Eastern European States. Nowadays, the Polish electricity grid is integrated in the CENTREL grid, a cooperation of the national grid companies of Hungary, the Czech and Slovak Republic and Poland.

CENTREL is in synchronous operation with the West European UCPTE grid, which CENTREL is envisaged to join soon (Househam et al. 1998). In addition, PSE participates in the BALTREL project, an initiative to intensify the linkages between the networks of all countries bordering to the Baltic sea in order to allow for load sharing and trade in electricity (Zimmer 1999). PSE endorses the aims of the Energy Charter Treaty which Poland signed in 1994 and prepares for competition on a pan-European power market as outlined in the Council decision concerning the EU electricity market (Directive 96/92/EC; PSE 1999).

From this it follows, that international cooperation, and with it the accessibility of the Polish power market to foreign generators will be increasingly important during the next decade. This poses a serious challenge for an upstream approach to a tradeable permit system: assuming that an upstream system would cover all primary energy carriers utilized in Poland, the import of electricity could constitute a way to receive energy that was not subject to carbon regulation in the country of generation. It could thus undermine the domestic permit system as the electricity imported would be in an advantageous position if the permit price is a significant cost to domestic producers. Hence, the issue of electricity imports and exports in a potential trading system in Poland needs to be addressed.[87]

In order to assure a "level playfield" among competitors, the regulator could theoretically impose a permit requirement for the CO_2 emissions released during the production of the imported electricity.

87 In his proposal for an US upstream system, Hargrave (1998) was able to avoid this issue, as electricity imports of the US are marginal.

This is plainly impracticable because no physical units of electricity exist that could be traced back to a particular source. Also, electricity produced from nuclear power plants could not be included, which might be detrimental to other policy aims of the environmental authority. Hence, it seems that the issue of electricity imports would need an internationally agreed solution to enable a permit system in accordance with the free trade arrangements (Personal communication Hargrave). Another way might be to ensure that domestic producers are not actually suffering any significant cost increases despite the permit system. This would practically rule out an auctioning approach to a permit system and could result in designing solutions similar to those chosen in Denmark, where a low fine for excess emissions poses an upper ceiling to the permit price (compare Folketinget 1999).

5.6 Summary: the feasibility of an upstream trading system in Poland

Table 15 sums up the discussion of the previous section with regard to the number and type of entities that would now and in the future be affected, and that would thus determine the administrative feasibility of an upstream system in Poland.

Table 15: Regulated entities in an upstream approach

	Now		**Future**	
Sector	**Participants in a permit market**	**Installations where carbon would be monitored**	**Participants in a permit market**	**Installations where carbon would be monitored**
Coal	Nine producers uncertain number of (small) importers	64 coal preparation plants and/or 54 coal mines, all importers.	Nine coal companies, eventually increasing amount of importers.	Decreasing number of mines (and coal preparation plants), all importers
Gas	One producer and importer	About 60 gas fields, some direct deliveries from well, one importer	Three to ten gas producers, uncertain number of importers	Increasing number of gas fields, all importers
Oil	Four independent refineries, 160 importers	Seven refineries, 160 licensed importers	Two to four refineries, uncertain number of importers	Seven refineries, uncertain number of importers
Electricity import	One importer	One importer	Maybe 10 consolidated regional distribution companies, one transmission company, plus uncertain number of large and medium-sized consumers	10-33 distributors, one transmission company and all industrial importers.
	Approximately 200 entities of which 20-25 major companies	Approximately 270-350, of which around 185 major installations.	At least 50-60 participants	At least 180-200 major points plus all importers

It can be concluded that an upstream system could be introduced fairly easily from a technical point of view in the coal, gas and oil sector. It would now and in the future affect only a limited number of entities to be monitored and verified. Uncertainties exist with regard to the effective regulation of imports in the coal sector, where existing reporting requirements would have to be enhanced.

Looking at the political difficulties, however, which can be expected when introducing regulation affecting the coal sector, it seems doubtful that a comprehensive upstream approach would be a feasible option. Also, the question is whether it would be worth the effort, as much of the effects of an upstream approach will be achieved through the restructuring efforts currently underway.

Another key issue is the treatment of electricity imports, as they could become significant in the future and seem hard to regulate without an internationally harmonized approach to it. While a full blown upstream trading approach seems thus unlikely to be feasible in the near future, a partial approach in the oil sector might be possible. This sector is most advanced in its privatization and would not be affected by the problem of electricity imports.

6 Conclusion: which type of emissions trading system for Poland?

Before attempting to answer the above question, two words of caution are necessary. First, as stated in the introduction, the aim of this paper is not to recommend in favor or against the introduction of a permit system as opposed to any other possible approach to climate protection policy. Instead, the analysis presented is based on the assumption that a permit system is desired in the first place.

Second, although the study is extensive in the coverage of relevant issues, it remains at the surface of many aspects which would need to be answered before the superiority of a particular design can be determined with sufficient certainty. This refers in particular to the lack of an in-depth financial analysis, which would be needed to replace the rough cost comparisons with actual data. Also, the distortions in the economy which are likely to be triggered by a sectoral application of the policy would have to be analyzed in greater detail than was possible here. The proposal included in the following can thus be no more than an "informed hypothesis" concerning which sectors could realistically be included in a Polish CO_2 emissions trading system.

Based on the analysis in this study, neither a far-reaching downstream system (Section 4.4) nor a comprehensive upstream approach (Section 5.6) seems feasible at the moment. Insufficient monitoring and reporting practices and the lack of administrative capacities are a barrier in the case of a downstream system, while ongoing restructuring can be cited as a main reason why an upstream approach is not an option. The conclusion could thus be that we will have to wait and see how the situation changes within the next few years, and then renew the analysis.

However, a "pilot" emissions permit trading system seems a realistic option within the coming three to five years. It would consist of a downstream approach among the 200-220 professional and industrial power producers as recommended in Section 4.2.6. Such a pilot system might then be gradually expanded to include more sectors and cover more of Poland's CO_2 emissions.

With the power sector, the system would cover a very substantial part of Polish emissions and address enterprises which already show the highest awareness of the mechanism in the Polish economy. Also, with the beginning privatization of the sector and the opening of European electricity markets the firms may well cope with market-based mechanisms in the mid-term.

The permits would be denominated in CO_2 emissions and distributed freely (or against the current emission fee) to the power and CHP plants participating in the pilot system. Reporting should be based on continuous monitoring equipment. Accordingly, participation in the scheme would depend on having the necessary equipment in place. This will soon be the case for large firms, who are subject to continuous monitoring of their emissions but smaller firms would have to be required to install such equipment. As the overall number of enterprises would be quite low during the pilot phase, it might be possible to support the installation of such equipment in small firms from sources other than the enterprises themselves. This can be justified, as accurate monitoring would also increase the enforceability of fees levied on other air pollutants. Alternatively, one could consider making participation voluntary. In such a case, incentives to participate could be increasingly high fees on CO_2 emissions outside the system, while enterprises that subject themselves to an emissions quota would get these permits for free (or for a lower fee).

In the initial stage, energy intensive enterprises would be included only insofar as they are CHP producers of electricity, because addressing heat production and all large energy consumers would inflate the number of entities to levels which are not currently manageable by the Polish environmental administration (compare Section 4.3.4).

The next step would be to include mid-size heat producing enterprises as well as large energy intensive enterprises as identified in Section 4.3.4. This presupposes that the pilot downstream system has proven successful in the power sector and/ or that the upstream approach discussed in Section 5 is still not a feasible option due to a slow restructuring of the affected sectors.[88]

A major difficulty that even a pilot system might face was mentioned in section 5.5, when discussing the issue of electricity imports. One way of avoiding the difficulties a domestic system faces in liberalizing energy markets might be to resort to a merely symbolical "training system" as referred to in the Danish example in Section 5.5. In fact, the existence of the Danish system might even allow for a policy experiment of conducting international trades between the electricity sectors of the two countries. With a successful demonstration of such transactions, other CO_2 emitting sectors in Poland might become eager to join the system, as obtaining financial means for modernization investments could be the main driving force of why Polish industry might agree to join an international emissions trading mechanism.

Provided the difficulties concerning electricity imports could be overcome, how would such an "pilot" approach fare from the point of view of economic theory? To answer this question in a structured manner, Table 16 applies a taxonomy of criteria defined by theoretic literature (compare Baumol and Oates 1988, Hanley et al. 1997, Cansier 1996, Schwarze 1997) to the "realistic scheme" proposed above.

In summary, it is evident from Table 16 that the main theoretic arguments which economic theory provides in favor of the introduction of an emissions permit system do not make a compelling case for a pilot emissions trading system in the Polish reality of today. This situation might change as soon as CO_2 becomes a more stringently regulated pollutant under the Polish system of environmental policy. But there are currently no signs that this will soon be the case. Therefore, the main driving force that could achieve a political breakthrough in favor of a domestic tradeable CO_2 emissions permit system is the perspective of eventual participation in international transactions, which could be instrumental in supporting the ongoing restructuring of the Polish economy.Gaining experiences early and being among a pioneer group of countries might be an attractive perspective for Polish policy makers, so that they might want to capitalize on the chance the relatively well prepared power and CHP sector offers in that respect

Table 16: Theory and a realistic approach to emissions permit trading	
Issues	
Environmental Goal	As the current goal of Polish climate policy is certain to be met (Section 2.1), it is not the main purpose of a pilot emissions trading system to assure reaching a set target. The purpose would rather be to examine the usefulness of the approach for relatively more difficult abatement targets expected in the future.
Social optimum	No attempt is made to prove the achievement of a social optimum through the trading system. However, before embarking on a pilot emissions trading project, a detailed cost comparison of different approaches to CO_2 emissions control should be made, as it is still absent in Polish research and policy debate (Section 2.5).

88 Aside from expanding the downstream approach of the pilot phase, one could also consider to embark on an "hybrid approach" (Fisher et al. 1998, p.4). This could most probably be done with the oil sector, which is already now more competitive and, in terms of its restructuring, more advanced than the other upstream sectors, coal and gas. Its inclusion would have the main advantage of covering the increasing CO_2 emissions from the transport sector while regulating only very few entities.

Cost-effectiveness	CO_2 is a small element of a long standing and elaborate system of environmental fees in Poland (Section 2.3). As it is unlikely that the whole system will be abolished, the introduction of a permit scheme will certainly mean additional administrative cost. From an enterprise perspective, the current fee levels are low and manageable (compare survey results in Section 4.2.4 and 4.3.3), so that no incentive exists to demand another policy tool. This might change, in case fee levels are raised so that they would actually impact on enterprise behavior.
Incentive for Innovation	Permits would act as an incentive for fuel switching of the largely coal-fired technology in the power and CHP sector (Section 4.2.1). Even if the quota would not be stringent enough to trigger coal to gas switches in large facilities, the permit system could still induce more investment in new CHP and renewable energy-based generation capacity. In the energy intensive industries, significant potential exists for fuel switching, and this is already exploited in order to adjust to current SO_2 and NO_x emission standards (Section 4.3.3). The question in how far the emissions trading system could act as an *additional* incentive would need further examination.
Allowing for growth, fostering restructuring	Currently, over-capacities exist in the Polish power market, so that there is no significant pressure of new large-scale entrants for base load plants. However, the restructuring in the sector also means that new enterprises are being formed and foreign investors seek a share. The allocation of the permits would need to take account of these facts and should be done in a way so as to support the restructuring rather than delaying it further (compare Section 4.2.1). Hence, set asides for highly efficient power plants should be made. An emissions-based CO_2 trading system in the power sector places an incentive to shift the emphasis of environmental investment from end-of-the-pipe sulfur and NO_x control to fuel switching and efficiency improvements. Nevertheless, there would remain an incentive to introduce CO_2 sequestration technology in case it becomes available.
Reaction to technological progress, economic growth and inflation	The automatic adjustment to inflation or growth is a minor advantage of a trading system in Poland. For one, inflation is decreasing and with it the value of fees that have been set ex ante is decreasing less steeply. Furthermore, environmental charges are levied on 172 emission items in Poland (Section 2.3.2). The administrative effort to also include CO_2 or other emissions in the annual revision of fee levels is rather minimal. An eventual decrease in the incentive that CO_2 permits constitute for technological change is not a major issue considering the high growth rates of the Polish economy (Section 2.2).

Adaptability of the instrument to specific requirements	The possibility to adjust individual quota allocations for specific circumstances of a firm (for example to account for previous emissions reduction effort) is a helpful feature of a pilot trading system in the sector undergoing restructuring. In the initial phase of the program, this would allow the administration to continue the current practice of individually set emission permits (Section 2.3.2). With regard to the inclusion of other GHG and process-related emissions, the proposed pilot approach does not offer much potential. Emissions of other GHG are more relevant in the natural gas sector and in industry. This could only be achieved with an eventual widening of the proposed approach.
Compatibility with international agreements	By basing emissions monitoring on continuous measurements, the regulation of the power sector would be likely to be up to standards of an potentially emerging international system. Also subjecting CHP from enterprises to a quota system and eventually widening the approach to the heat sector could allow for increased interest in project-based CO_2 reductions under the AIJ pilot phase (compare Section 2.5.3).
Political feasibility	Due to the high awareness in the power sector, the political feasibility of a permit system seems higher here than elsewhere (Section 4.2.4). However, the attempt to regulate CO_2 emissions more strictly than is currently done will almost certainly meet with resistance by the sector, and competitiveness issues in the liberalizing electricity markets can be expected to be the main argument of those opposed (Section 5.5). An emissions permit system can gain popularity if it is introduced as an alternative to another policy tool such as carbon taxes, which are discussed most seriously in the wake of access to the European Union. At the same time, the main concern of policymakers is implementing EU regulation in order to be ready for membership. A negative stance of the EU on domestic emissions trading mechanisms might pose the most serious political barrier to any emissions trading system in Poland (Section 2.4). If the permit system was to allow for the influx of investment from other countries in exchange for emissions reduction in Poland, the permit system might become a popular option among power plant operators to finance the modernization investment necessary to face the increasing competition. However, this option suffers from a lack of support among some policymakers, who fear that Poland will lose cheap abatement options this way and might have difficulties meeting environmental targets for coming commitment periods (compare Section 2.1). Other than that the administration might not be opposed to a CO_2 permit system in principle, as it would neither infringe on the source of income (and influence) of the environmental funds, where the current CO_2 fee plays a negligible role, nor would it reduce the work of inspectors in all other fields of emissions control.

References

Agencja Rynku Energii (ARE) (1998a): Elektroenergetyka Polski 1997 [Polish Power Sector 1997]. Warszawa.

Agencja Rynku Energii (ARE) (1998b): Biuletyn Ciepłownictwa [Bulletin of the Heat Sector]. Vol. 24, No.4. Warszawa.

Agencja Rynku Energii (ARE) (1998c): Statystyka Ciepłownictwa Polskiego 1997 [Statistics of the Polish Heat Sector 1997]. Warszawa.

Agencja Rynku Energii (ARE) (1999a): Bilans Energii Pierwotnej w latach 1988-1998 [Primary Energy Balances 1988-1998]. Warszawa.

Agencja Rynku Energii (ARE) (1999b): EMITOR 1998. Warszawa.

Agencja Rynku Energii (ARE) (1999c): Europejski Biuletyn Cenowy Nośników Energii [European Bulletin of Energy Prices]. Vol. 88, No.3. Warszawa.

Agencja Rynku Energii (ARE) (1999d): Catalogue of electric distribution companies. Warsaw.

Anderson, Glen and *Fiedor,* Boguslaw (1997): Environmental Charges in Poland. Environmental Discussion Paper No.16, January 1997. Harvard Institute for International Development. Cambridge, Mass.

Anderson, Glen and *Żylicz,* Tomasz (1997): Maximizing Leverage of Poland's Enviromental Funds: Too Generous or too Restrictive? Environmental Discussion Paper No.30, November 1997. Harvard Institute for International Development. Cambridge, Mass.

Atmoterm (1996): Designing a Programme of Tradeable Emission Permits and Implementing a Pilot Project in Poland. Final Report. Phare Project: EC/EPP/91/1.2.2. Opole.

Audus, Harry (1997): Greenhouse Gas Mitigation Technology: An Overview of the CO_2 Capture and Sequestration Studies and Further Activities of the IEA Greenhouse Gas R&D Programme. In: Energy, Vol. 22 No. 2/3, p. 217-221.

Bates, Robin, *Cofala,* Janusz and *Toman*, Michael (1994): Alternative Policies for the Control of Air Pollution in Poland. World Bank Environment Paper No. 7, Washington, D.C.

Baumol, William, J. and *Oates*, Wallace, E. (1988): The Theory of Environmental Policy. Second Edition. Cambridge.

Bojarski, Włodzimierz (1999): Polska Gospodarka Energetyczna Okresu Transformacji [The Polish Energy Economy in the Time of Transformation]. As made available on the CIRE webpage www.cire.pl/cire/publikacje/prywatyzacja/art.003.html, accessed on August 15, 1999.

Cansier, Dieter (1996) Umweltökonomie [Environmental Economics]. 2^nd^, revised Edition. Stuttgart.

Dales, J.H. (1968): Pollution, Property and Prices. Toronto.

Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC. Official Journal L 350, 28/12/1998, p.0058-0068.

Directive 98/30/EC of the European Parliament and of the Council of 22 June 1998 concerning common rules for the internal market in natural gas. Official Journal L 204 , 21/07/1998 p. 0001 - 0012.

Directive 96/92/EC of the European Parliament and of the Council of 19 December 1996 concerning common rules for the internal market in electricity. Official Journal L 027, 30/01/1997, p. 0020-0029.

Draft Act for Environmental Protection. No year. Made available by the Chancellery of the Sejm, Warsaw.

Economist Intelligence Unit (EIU) (1999): Business Operations Report, Poland 4th Quarter 1998. London.

Environmental Action Programme Support (EAPS) Project (1997): The Market for Financing of Environmental Investment in Poland. Abridged English edition. Warsaw.

European Commission (EC) (2000). Green Paper on greenhouse gas trading within the European Union. Brussels.

European Commission (EC) (1997):Energy for the Future: Renewable Sources of Energy. White Paper for a Community Strategy and Action Plan. COM(97)599.

Festa, David H. (1998): US Carbon Emissions Trading: Some Options That Include Downstream Sources. Center for Clean Air Policy. Washington, D.C. April 1998. Available at www. ccap.org. Accessed on March 19, 1999.

Finnish Presidency (1999a): Main challenges for the EU Environment Policy. Background information. Informal meeting of the EU Environment Ministers and the Environment Ministers of the Candidate Countries of Central and Eastern Europe and Cyprus, July 23-25, 1999, Helsinki. As published on: www.vyh.fi/eng/current/eupresi/council2.htm. Accessed on August 2, 1999.

Finnish Presidency (1999b): Presidency Summary. Informal meeting of the EU Environment Ministers and the Environment Ministers of the Candidate Countries of Central and Eastern Europe and Cyprus, July 23-25, 1999, Helsinki. As published on: www.vyh.fi/eng/current/eupresi/conclus.htm. Accessed on August 2, 1999.

Finnish Presidency (1999c): Climate Change the focus of EU and Candidate Countries' Environmental Policies. Press Release. Informal meeting of the EU Environment Ministers and the Environment Ministers of the Candidate Countries of Central and Eastern Europe and Cyprus, July 23-25, 1999, Helsinki. As published on: www.vyh.fi/eng/current/press/moe/moe9985.htm. Accessed on August 2, 1999.

Fisher, Carolyn, *Kerr,* Suzi and *Toman,* Michael *(Fisher et al.)* (1998): Using Emissions Trading to Regulate Greenhouse Gas Emissions: An overview of policy design and implementation issues. Resources for the Future. Discussion Paper, June 1998.

Fischer, S., *Sahay,* R. and C. *Végh* (1996): Stabilisation and Growth in Transition Economies: The Early Experience. Journal of Economic Perspectives, 10, No. 2, 45-56.

Folketinget (1999): Bill on CO_2 Quotas for Electricity Production. As adopted by the Folketinget on 28 May 1999. Unofficial translation, 30 June 1999. Includes "Notes on the bill." Made available by the Danish Ministry for Environment and Energy on www.ens.dk/uk/energy_reform/index.htm. Accessed on September 3, 1999.

Foltynowicz, Marek and *Kozakowski,* Grzegorz (1998): Polish Refining Industry's Response to 2001 Fuel Requirements. Presentation held at the World Conference, Offering 21st Century Refining. Bruessels, Belgium, June 3-5 1998.

Fundacja na rzecz Efektywnego Wykorzystania Energii (FEWE) (1999): Opracowanie i uaktualnienie makroekonomicznych i sektorowych scenjariuszy redukcji emisji i pochłaniania gazów cieplarnianych do roku 2020. Synteza [Elaboration and Actualization of Macroeconomic and Sectoral Emissions Reduction Scenarios and Absorption of Greenhouse Gases until 2020. Synthesis]. Warszawa.

Galon-Kozakiewicz, Jolanta. 1997. Preliminary Rapport Concerning the Project Proposals in the Framework of Activities Implemented Jointly Program. Manuscript.

Global Environmental Facility (GEF) (1994): Poland Coal to Gas Project. Project Document. Washington, D.C.

Główny Urząd Statystyczny (GUS) (1998a): Gospodarka Paliwowo-Energetyczna w latach 1996-1997 [Energy Statistics 1996-1997]. Warszawa.

Główny Urząd Statystyczny (GUS) (1998b): Ochrony Środowiska 1997 [Environmental Protection 1997]. Warszawa.

Główny Urząd Statystyczny (GUS) (1999a): Rocznik Statystyczny 1998 [Statistical Yearbook 1998]. Warszawa.

Główny Urząd Statystyczny (GUS) (1999b): Biuletyn Statystyczny [Statistical Bulletin]. No. 4, Maj 1999.. Warszawa.

Główny Urząd Statystyczny (GUS) (1999c): Europejska Klasifikacja Działalności, tablica za II kwatał 1999r [European Classification of Business Activities, table for the second quarter 1999]. Warszawa.

Hanley, Nick, *Shogren,* Jason F. and *White,* Ben (1997): Environmental Economics in Theory and Practice. London.

Hargrave, Tim (1998): US Carbon Emissions Trading: Description of an Upstream Approach. Center for Clean Air Policy. Washington, D.C., March 1998. Available at www.ccap.org. Accessed on March 19, 1999.

Hargrave, Tim, *Festa,* David and *Keller,* Sam (1998): Accounting for Non-Fuel Uses of Fossil Fuels in an Upstream Carbon Trading System. Center for Clean Air Policy. Washington, D.C., March 1998. Available at www.ccap.org. Accessed on March 19, 1999.

Hauff, Jochen (1996): Renewable Energy in Poland. Report to the World Bank. Manuscript. Warsaw.

Hauff, Jochen (1997): Energy and food price development and their impact on inflation in Poland 1989 - 1996. Report to the World Bank. Manuscript. Warsaw.

Househam, Ian, *Hauff,* Jochen, *Missfeldt,* Fanny and *Grubb,* Michael (1998): Climate Change and the Energy Sector. A Country-by-Country Analysis of National Programmes. Volume 3: Economies in Transition. London.

Institute of Environmental Protection (IEP) (1996), Strategies of GHG Emission Reduction and Adaptation of the Polish Economy to the Changed Climate. Synthesis. Warsaw.

Intergovernmental Panel on Climate Change (IPCC) (1996): Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. Reference manual.

International Energy Agency (IEA) (1995): Energy Policies of Poland 1994 Survey. Paris.

Jendrośka, Jerzy (1998): Environmental Law in Poland, 1989-1996: An Assessment of Past Reforms and Future Prospects. In: Clark, John and Cole, Daniel (Eds.): Environmental Protection in Transition. Economic Legal and Socio-Political Perspectives on Poland. pp. 81-115. Aldershot.

Kancelaria Sejmu (KS) (1999a): The Water Law from 1974. Consolidated text. Warsaw.

Kancelaria Sejmu (KS) (1999b) Environmental Protection Law 1980. Consolidated text. Warsaw.

Komitet Ekonomiczne Rady Ministrów (KERM) (1999): Reforma Sektora Elektroenergetyki . Prywatyzacja i Wprowadzanie Rynku Energii Elektrycznej. Diagnoza i Kierunki Działan. May 1999. Made available by Mr Jaśkiewić, Secretary of KERM. [The Reform of the Power Sector. The Privatization and Introduction of Electricity Markets].

Kornai, Janos (1992): The Socialist System. The Political Economy of Communism. Oxford.

Kraushaar, Jack and *Ristinen,* Robert (1993): Energy and Problems of a Technical Society. Second Edition. New York.

Meyers, Stephen, *Shipper,* Lee, *Salay,* Jürgen (1994): Energy use in Poland: an international comparison. In: Energy, Vol. 19 No.6, pp.601-617.

Ministry of the Economy (MoE) (1999): Informacja w zakresie działan związanych z tworzeniem warunków dla poprawy efektywności funkcjonowania przedsiębiorstw elektroenergetyki [Information About Activities Concerning Setting a Framework for the Improvement of the Efficient Functioning of Enterprises in the Power Sector]. In: Klient Dystrybucja Przesył , No. 4 1999, pp. 18-22.

Ministry of Environmental Protection, Natural Resources and Forestry (MEPNRF) (1991): Polityka Ekologiczna Państwa [Environmental Policy of Poland]. Warszawa.

Ministry of Environmental Protection, Natural Resources and Forestry (MEPNRF) (1994): Program Wykonawczy do Polityki Ekologicznej Państwa do Roku 2000. Warszawa. [Implementation Program of the National Environmental Policy until the Year 2000.]

Ministry of Environmental Protection, Natural Resources and Forestry (MEPNRF) (1997): Activities Undertaken in Poland to Limit Greenhouse Gas Emissions. Unpublished paper. Warsaw.

Ministry of Environmental Protection, Natural Resources and Forestry (MEPNRF) (1999a): Poland. Hydrocarbon Opportunities. Warsaw.

Ministry of Environmental Protection, Natural Resources and Forestry (MEPNRF) (1999b): Nowa Polityka Ekologiczna Państwa. Projekt. Sierpień 1999 [New National Environmental Policy. Draft, August 1999.] Warsaw.

Ministry of Environmental Protection, Natural Resources and Forestry (MEPNRF) (1999c): Statistical information on sources of environmental funding. Made available by Ms Joanna Spykra in August 1999.

Ministry of Environmental Protection, Natural Resources and Forestry (MEPNRF) (1999d): Sumaryczny Raport dla Krajowej Inwentaryzacji Gazów Cieplarnianych 1997. [Summary Report for the National Greenhouse Gas Inventory 1997]. Made available by the Ministry of Enviromental Protection.

Ministry of Industry and Trade (MoIT) (1995), Energy Policy Guidelines for Poland until 2010, as accepted by the Council of Ministers on October 17, 1995. Warsaw.

Ministry of Transport (1998): Plan Rozwoju infrastruktury transportowej w Polsce do roku 2015. [Development Plan for Transportation Infrastructure until 2015]. Warszawa.

Missfeldt, Fanny and Villavicenco, Arturo (2000): The economies in transition as part of the climate regime: recent developments. In: Environment and Planning, Vol. 27, pp. 379-392.

Mullins, Fiona (1998): Lessons from Existing Trading Systems for International Greenhouse Gas Emissions trading. OECD, ENV/EPOC(98)13/REV1. Paris.

Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej (NFOSiGW) (1999): 10 Lat Działalności Narodowego Funduszu Ochrony Środowiska i Gospodarki Wodnej (1989-1999) [10 Years of Operation of the National Fund for Environmental Protection and Water Management 1989-1999]. Warszawa.

Niezależny Ośrodek Badań Ekonomicznych (NOBE) (1999): Prognoza zapotrzebowania krajowego oraz eksportu energii pierwotnej i energii elektrycznej w latach 1999-2020. Opracowanie przygotowane dla Komitetu Ekonomicznego Rady Ministrów [Prognosis of Domestic Energy Demand as well as Primary Energy and Electricity Exports in the Years 1999-2020. Prepared for the economic comittee of the Council of Ministers]. Łódź.

Organization for Economic Cooperation and Development (OECD) (1995): Environmental

Performance Reviews: Poland. Paris.

Państwowa Agencja Restrukturyzacji Górnictwa Węgla Kamiennego (PARG) (1999a): Hard coal mining industry in Poland. General outlook. Katowice.

Państwowa Agencja Restrukturyzacji Górnictwa Węgla Kamiennego (PARG) (1999b): Statistical information made available upon request for the purposes of this paper.

Pedersen, Knud (1999): Domestic Emissions Trading and Experience with CO_2-regulation of Danish Industry. Presentation held during a side event at the joint SBI and SBSTA meeting in Bonn, 9 June 1999.

Petrochemia Płock, (1999a): Raport Roczny 1998. [Annual Report]. Płock.

Petrochemia Płock, (1999b): Information provided on www.petrochemia.pl/pkn/p2.html. Accessed on July 29, 1999.

Polish Agency for Foreign Investment (PAIZ) (1999): Industry: production and output trends. As published on www.paiz.gov.pl/industry.htm, accessed on September 7, 1999.

Polish Geological Institute (PGI) (1996): Mineral Resources of Poland 1995. Warsaw.

Polish Oil and Gas Company (POGC) (1999a): Annual Report 1999. Warsaw.

Polish Oil and Gas Company (POGC) (1999b): Future of Polish gas industry - development perspectives. As available at www.pgnig.com.pl/pgnigsa/info/topic001.htm, accessed on July 1, 1999.

Polska Akademia Nauk (PAN) (1999): Statistical information on number of operating mines. Made available by Ms Joanna Kulczycha, August 1999.

Polska Izba Paliw Płynnych (PIPP) (1999): Raport. Polski Rynek Paliw 1999[Report. The Polish Fuel Market 1999]. Warszawa.

Polska Organizacja Gazu Płynnego (POGP) (1999): Raport roczny 1998 [Annual Report 1998]. Warszawa.

Polskie Przedsiędbiorstw Wydawnictw Kartograficznych (PPWK) (1999): Polska, mapa administracyjna [Polish Administrative Map]. Warszawa, Wrocław.

Polskie Sieci Elektroenergetyczne (PSE) (1999): Raport roczny 1998 [Annual Report 1998]. Warszawa.

Południkiewicz, Tadeusz (1996): Historia Kontraktów Długoterminowych w PSE i Ich Rola w Tworzeniu Zrębów Rynku Energii Elektrycznej [The History of Long-term Contracts and their Role in the Rreation of an Electricity Market]. In: Biuletyn Miesięczny, PSE. No. 7, July 1996, pp. 14-17.

Popczyk, Jan (1999): Elektroenergetyka: Drugie półrocze 1999 roku i potem [Power Sector: Second Half of 1999 and Onwards]. As published on the CIRE webpage: www.cire.pl/cire/publikacje/prywatyzacja/art.003.htm. Accessed August 25 1999.

Porozumienie Producentów Węgla Brunatnego (PPWB) (1999): Węgiel Brunatny w Polsce [Lignite in Poland]. Warszawa.

Rafineria Gdańska, (1999): Annual Report 1998. Gdańsk.

Republic of Poland (RP) (1996a), Questionnaire Poland: Information Requested for the Preparation of the Opinion (Avis) on the Application for Membership of the European Union 1996; Replies, Chapter 8: Energy .Warsaw.

Republic of Poland (RP) (1996b): Questionnaire Poland. Information Requested for the Preparation of the Opinion (AVIS) on the Application for Membership of the European Union. Replies. Chapter 12, Environment. Warsaw.

Republic of Poland (RP) (1997): The Energy Law. Warsaw.

Republic of Poland (RP) (1998a): Reforma górnictwa węgla kamiennego w Polsce w latach 1998 - 2002. Program rządowy przyjęty przez Radę Ministrów RP w dniu 30.06.1998r. [Reform of the Hard-Coal Mining Sector in Poland 1998-2002. Governmental Program Approved by the Council of Ministers on June 6, 1998.]

Republic of Poland (RP) (1998b): Ustawa z dnia 26.11. 1998 r. o dostosowaniu górnictwa węgla kamiennego do funkcjonowania w warunkach gospodarki rynkowej oraz szczególnych uprawnieniach i zadaniach gmin górniczych [Law from 26.11.1998 on the Adaptation of the Hard Coal Mining Sector to Function under the Conditions of a Market Economy and Particular Circumstances and Responsibilites of Mining Regions]. In: Dziennik Ustaw, No.162, 30.12.1998, Poz. 1112. Warszawa.

Republic of Poland (RP) (1998c): Second National Report to the Conference of the Parties to the United Nations Framework Convention on Climate Change. Warsaw.

Rzeczpospolita (Rz) 21.9.1998. Ochrona srodowiska [Environmental Protection]. Newspaper article. Nr 221, p.15.

Rzeczpospolita (Rz) 24.9.1999. Dostawy w listopadzie [Supply in November]. Newspaper article. Nr 224, Edition 327.

Salay, Jürgen (1996): Electricity Production and SO_2 Emissions in Poland's Power Industry. Lund University, Environmental and Energy System Studies Report No. 23, September 1996. Lund.

Schwarze, Reimund (1997): Taxes versus Tradeable Permits for Climate Change Policy: The Case for New Policy Principles and Criteria for a New Field of Environmental Policy. Technical University Berlin, Discussion Paper 1997/22.

Secretariat of the UNFCCC (1999a): Update on ratification of the Convention (as at 14 June, 1999). As published on www.unfccc.de/resources/conv/ratlist.pdf. Accessed September 1, 1999.

Secretariat of the UNFCCC (1999b): Kyoto Protocol Status of Ratification (as at 16 July, 1999). As published on www.unfccc.de/resources/kpstats.pdf. Accessed September 1, 1999.

Sejm (1999): Rezolucja Sejmu Rzeczpospolitej Polskiej w sprawie wzrostu wykorzstania energii ze zrodel odnawialnych [Resolution of the Sejm Concerning the Increase in Utilization of Energy from Renewable Resources]. In: Monitor Polski No. 25, poz.365, 19.6.1999.

Simeonova, Katia and *Missfeldt,* Fanny (1997): Emission Trends in Economies in Transition. EEP Climate Briefing No. 8, November 1997. The Royal Institute for International Affairs. London.

Śleszyński, Jerzy (1998): Economic Instruments in Polish Environmental Policy. In: Clark, John and Cole, Daniel (Eds.): Environmental Protection in Transition. Economic Legal and Socio-Political Perspectives on Poland. pp.30-67. Aldershot.

Stavins, Robert, *Żylicz,* Tomasz (1994): Environmental Policy in a Transition Economy: Designing Tradeable Permits for Poland. Discussion Paper 95-09, Resources for the Future. Washington, DC.

United Nations (UN) (1992): Framework Convention on Climate Change. Geneva.

Urząd Regulacji Energetyki (URE) 1999: Biuletyn Urzędu Regulacji Energetyki. [Bulletin of the Energy Regulation Authority.] Issues 1 (3), 2 (4) and 3(5) 1999.

World Bank (1997): Poland Country Economic Memorandum. Report No 16858-POL. July 15, 1997. Washington D.C.

Zimmer, Stefan (1999): Przyszłość Elektroenergetyki w Regionie Bałtyku. In: Biuletyn Miesięczny Vol. 95, No. 5, Maj 1999. pp.26-28.

Żmijewski, Krzysztof (1999): Aktualne problemy energetyki w kontekście przekształceń własnościowych. In: Biuletyn Miesięczny Vol. 95, No. 5, Maj 1999. pp.1-5.

Żylicz, Tomasz (1994): Environmental Policy Reform in Poland. In: Sterner, Thomas (Ed.): Economic Policies for Sustainable Development. Dordrecht. pp.82-112.

Żylicz, Tomasz (1998): Obstacles to Implementing Tradeable Pollution Permits. The Case of Poland. OECD, ENV/EPOC/GEEI(98)16. Paris.

Żylicz, Tomasz (1999): The Chorzów project. Manuscript, July 12, 1999.

List of personal communications[89]

Aleksa, Hendryk. Główny Instytut Górnictwa [Central Mining Institute], Katowice.

Barc, Wanda. Environment and Law Regulatory Division, Polish Power Grid Company. Warsaw.

Bayer, Stefan. Faculty of Economics, University of Tübingen, Germany.

Beblo, Wojciech. CITEC S.A. Katowice. (Formerly in the environmental protection administration of the Katowice Voivodship).

Burowski, Mr. Państwowa Agencja Restrukturisacja Górnictwa Węgla Kamiennego (PARG) [State Hard Coal Mining Sector Restructuring Agency]. Katowice.

Dębski, Bogusław. Head of Environmental Protection Division, Agencja Rynku Energii (ARE) [Energy Market Agency], Warsaw.

Dzeciątkowski, Kazimierz. Polish Oil and Gas Company, Regional Subsidiary Zielona Gora

Gaj, Henryk. EnergSys Systems Research, Warsaw.

Galon-Kozakiewicz, Jolanta. Head of Joint Implementation Office, National Fund for Environmental Protection and Water Management, Warsaw.

Gilecki, Ryszard. Agencja Rynku Energii (ARE) [Energy Market Agency], Warsaw.

Hargrave, Tim, Center for Clean Air Policy, Washington, D.C.

Helme, Ned. President, Center for Clean Air Policy, Washington, D.C.

Hołownia, Paweł. Director Gas Acquisition Division. Polish Oil and Gas Company, Warsaw.

Jędrysik, Eugeniusz. Phare Expert, Ministry of Environmental Protection, Natural Resources and Forestry, Warsaw.

Kacprowska, Johanna. Agencja Rynku Energii (ARE) [Energy Market Agency], Warsaw.

Kamiński, Paweł. Energy Sector Operations Officer, World Bank, Warsaw.

Kamiński, Stanisław. Vice Director, Department of Environmental Protection. Ministry of Environmental Protection, Natural Resources and Forestry, Warsaw.

Karaczun, Zbigniew. Ecological Advisor to the Ministry of Environmental Protection, Natural Resources and Forestry, and Warsaw Agricultural University.

Karbownik, Mr. Państwowa Agencja Restrukturisacja Górnictwa Węgla Kamiennego (PARG) State Hard Coal Mining Sector Restructuring Agency. Katowice.

89 While many personal communications provided input that was cited directly throughout the text, many others helped by providing commentary on my ideas or background information on various fields. All personal communications took place between mid-May and the end of September 1999.

Kelly, Cathleen. Senior Policy Analyst, Center for Clean Air Policy, Washington, D.C.

Klecha, Marian. Department Customs, Ministry of Finance. Warsaw.

Kłokocka, Maria. Department of Environmental Protection, Ministry of Environmental Protection, Natural Resources and Forestry, Warsaw.

Konopko, Grzegorz. Director, Executive Office for Climate Convention. National Fund for Environmental Protection and Water Management, Warsaw.

Kozakowski, Grzegorz. Chief Expert, Market Policy Division of Polish Oil Company, Warsaw.

Kulczycka, Joanna, Institute for Mineralogical Research and Resource Economy, Polish Acadamy of Science, Cracow.

Kumanowski, Marek. Vice Director, Agencja Rynku Energii (ARE) [Energy Market Agency], Warsaw.

Kuś, Janusz. Deputy Manager, Production Department, Polish Oil and Gas Company, Regional Subsidiary Zielona Gora.

Łańcucki, Stanisław. Director, Market Policy Division of Polish Oil Company, Warsaw.

Lefevere, Jürgen, Staff Lawyer, Foundation for International Environmental Law and Development, FIELD.

Letachowicz, Barbara. Environmental Specialist, World Bank, Warsaw.

Maciejowski, Władysław, Polish Organization for Liquid Gas, Warsaw.

Missfeldt, Fanny. Environmental Economist, UNEP Collaborating Center on Energy and Environment. Risoe National Laboratories, Roskilde.

Mizak, Jaczek. Department for International Cooperation and European Integration. Ministry of Environmental Protection, Natural Resources and Forestry, Warsaw.

Pawliotti, Wiesław, Department for Energy, Ministry of the Economy. Warsaw.

Pazdan, Ryszard. Director, ATMOTERM, Opole.

Ponikiewski, Wojciech, Department of UN and Social Affairs, Ministry of Foreign Affairs, Warsaw.

Powroźnik, Maciej. Polish Chamber for Liquid Fuels, Warsaw.

Rabiak, Mr. President. Trade Chamber of the Heat Sector, Warsaw.

Rachobińska, Ms. Head of Environmental Protection Department in the Mazowian Voivodship.

Radwański, Mr. Fundacja Efektywnego Wykorszystania Energii [Foundation for Energy Efficiency], FEWE, Warsaw.

Reklewski, Tadeusz. Joint Implementation Office, National Fund for Environmental Protection and Water Management, Warsaw.

Rey, Bolesław. Director of Foreign Cooperation, Polish Oil and Gas Company, Warsaw.

Róg, Ms. Główny Instytut Górnictwa [Central Mining Institute], Katowice.

Rydzidski, Mr. Director, Office for Housing and Urban Development. Warsaw.

Sadowski, Maciej. Executive Office for Climate Convention. National Fund for Environmental Protection and Water Management, Warsaw.

Skwarczyński, Waldemar. Director of Maintenance and Operation, Polish Oil and Gas Company, Warsaw.

Sobiecki, Marek. Director, Department of Environmental Policy. Ministry of Environmental Protection, Natural Resources and Forestry, Warsaw.

Sobolewski, Miroslaw. Chancellory of Sejm, Bureau of Research. Warsaw.

Stańczak, Paweł. Head of Gas Measurements Office. Polish Oil and Gas Company, Warsaw.

Stiansen, Peer. Advisor. Ministry of the Environment, Oslo, Norway.

Tatarynowicz, Jan. Polish Oil and Gas Company, Regional Subsidiary Zielona Gora

Tausch, Mr. Główny Instytut Górnictwa [Central Mining Institute], Katowice.

Uzbiak, Małgorzata. Department of Foreign Policy, Ministry of Finance, Warsaw.

Wiśniewski, Grzegorz. Director, European Commission Baltic Renewable Energy Centre, Warsaw.

Wojciechowska, Ms. Węglokoks. Katowice.

Zdun, Tomasz. Director of Strategic Studies, Polish Oil and Gas Company, Warsaw.

Żerawski, Zgisław, Head of Environmental Protection Department, Central Statistical Office, Warsaw.

Żylicz, Tomasz. University of Warsaw, Ecological Economics Center. Warsaw.

Annexes

The following materials are included in the annexes:

Annex 1: Questionnaire sent to enterprises in the heat, CHP and power sector. Sample from the four questionnaires sent to industry. [90]

Annex 2: Results of the survey: summary tables listing all responses from heat, CHP and power sector as well as all responding industrial enterprises.[91]

Annex 3: Statistical source table: A complete listing of all professional power plants in Poland and their cumulative CO_2 emissions.

90 As the questionnaires do not differ much, this gives a good idea of all sectors.
91 The results are anonymous as this was assured to the respondents. Documentation for every answer can be provided.

A. Company profile

Name of Company...
Address...
Tel/Fax/Email...
Name of Director/CEO...
Name and contact information of person filling in this questionnaire:
....

A.1 Installed electric capacity in 1998 ….. --- of which:
….% coal-fired ……% gas-fired …… % oil-fired ….. % other fuels

A.2 Installed heat generation capacity in 1998 ……. ---- of which:
….% coal-fired ……% gas-fired …… % oil-fired ….. % other fuels

A.3 Please describe the ownership structure of your enterprise by indicating the percentages:
.......% state-owned
.......% private capital (therein ....% foreign capital share).

A.4 Does your company have a person or office in charge of environmental matters?
❒ No
❒ Yes --- Please supply contact information: ....

B. Awareness, and expectation concerning climate change and mitigation policies.

B.1 How would you describe the level of your knowledge concerning

	well informed	informed	not informed
1. Global warming/ Greenhouse effect in general	❒	❒	❒
2. International efforts in climate protection policy (UN Climate Convention; Kyoto Protocol)	❒	❒	❒
3. Activities Implemented Jointly/ Joint Implementation	❒	❒	❒
4. Emission Certificate Trading	❒	❒	❒
5. Clean Development Mechanism	❒	❒	❒

B.2 Do you think regulation concerning GHG emission reduction is
❒ unnecessary, because ....
❒ necessary, because ....
❒ No opinion

B.3 Are you subject to the following fees?

	No	Yes	--- Can you indicate the order of scale of your annual payment?	Do you think the amount of your payment was			
				low	appropriate	too high	much too high
Fee on CO_2	❒	❒	approx. PLN...............	❒	❒	❒	❒
Fee on CH_4	❒	❒	approx. PLN...............	❒	❒	❒	❒

B.4 Did existing air emission standards and fines on SO_2 and NO_x influence your previous investment decisions?
❒ No
❒ Yes --- In what respect? Did you, for example, buy filters, switch fuels or improve fuel quality? Please describe:...
....
....

B.5 Do you expect any further regulation from your government with the aim of limiting GHG emissions?
❒ No
❒ Yes --- Did this expectation influence recent decisions when buying/ building new technology?
❒ No --- Please indicate the main reason:
❒ technology too expensive
❒ type of regulation unknown
❒ other. Please specify:..
❒ Yes --- In what respect? Please describe: ....
....

B.6 Do you think that the idea to introduce an emissions trading system is in principle:
❒ a good idea ❒ a bad idea ❒ don not know yet

C. Experience with data reporting and capacity to participate in a trading system

C.1 Do you report data to the Voivodships' register of air emissions?
❒ No ❒ Yes ❒ What is that?

C.2 All enterprises in your sector have to report data to the Statistical office and other institutions. Do you think the amount of data you have to report is:
❒ not much ❒ appropriate ❒ too much ❒ far too much

C.3 Emission Certificates are likely to be traded at stock exchanges or through brokers. Does your company have experience with

	No	Not yet, but planning to	Yes, a little	Yes, a lot.	If yes --- is your experience mainly national, international or both?
trading shares or bonds at the stock exchange?	❒	❒	❒	❒	....
using the services of brokers to sell or buy goods?	❒	❒	❒	❒	....

D. Emissions and energy supply

D.1 How do you take account of emissions of the following gases:

	Measurement at point of emissions	Measurements of certain inputs and calculations of expected emissions	Estimates based on knowledge of fuel quality and combustion technology	No emission data available
CO_2	❐	❐	❐	❐
CH_4	❐	❐	❐	❐
N_2O	❐	❐	❐	❐

SO_2	❐	❐	❐	❐
NO_x	❐	❐	❐	❐
Dust	❐	❐	❐	❐

D.2 Considering the planned development of your company over the next four to seven years, do you expect absolute and relative emissions to:

	Emissions in *absolute* terms Tons per year			Emissions in *relative* terms Tons per unit of output		
	Remain constant	Increase	Decrease	Remain constant	Increase	Decrease
CO_2	❐	❐	❐	❐	❐	❐
CH_4	❐	❐	❐	❐	❐	❐
N_2O	❐	❐	❐	❐	❐	❐

D.3 Do you use biomass as a fuel, e.g. in combination with coal combustion?
❐ No
❐ No, but planning to do so in the future
❐ Yes: ❐ woodwastes (incl. sawdust) ❐other, please specify:....................................
If yes: Please indicate biomass share as percentage of your total fuel use: ....%

D.4 In an emissions trading regime, it would be important to know, how much of the carbon contained in the fuel is actually emitted to the atmosphere. How costly would it be for your firm to measure the carbon content of the ashes you dispose of after combustion?
❐ not very costly ❐ costly ❐..very costly

Thank you!
Last question: Are you interested in receiving a copy of the paper for which the answers you provided will be used?
❐ No
❐ Yes --- Please supply name and address to which paper should be send (if different from person who filled out questionnaire)
....

A. Company profile

Name of Company ....
Address ....
Tel/Fax/Email...
Name of Director/CEO ....
Name and contact information of person filling in this questionnaire:
....

A.1 Data which indicate the size of your firm: Number of employees in 1998: ....
(estimates sufficient)
Gross turnover in 1998: ....
(estimates sufficient)

A.2 Please describe the ownership structure of your enterprise by indicating the percentages:
.......% state-owned
.......% private capital (therein ....% foreign capital share).

A.3 Does your company have a person or office in charge of environmental matters?
❒ No
❒ Yes --- Please supply contact information: ....

B. Awareness and expectation concerning climate change and mitigation policies.

B.1 How would you describe the level of your knowledge concerning

	well informed	informed	not informed
1. Global warming/ Greenhouse effect in general	❒	❒	❒
2. International efforts in climate protection policy (UN Climate Convention; Kyoto Protocol)	❒	❒	❒
3. Emissions Trading	❒	❒	❒
4. Joint Implementation	❒	❒	❒
5. Clean Development Mechanism	❒	❒	❒

B.2 Do you think regulation concerning GHG emission reduction is
❒ unnecessary, because ....
❒ necessary, because ....
❒ No opinion

B.3 Are you subject to the following fees?

	No	Yes	--- Can you indicate how much you approx. paid in 1998?	Do you think the amount of your payment is			
				low	appropriate	too high	much too high
Fee on CO_2	❒	❒	approx. PLN................	❒	❒	❒	❒
Fee on CH_4	❒	❒	approx. PLN................	❒	❒	❒	❒

B.4 Do you expect any further regulation from your government with the aim of limiting GHG emissions?

❒ No

❒ Yes --- Did this expectation influence recent decisions when installing new technology?

❒ No --- Please indicate the main reason:

❒ technology too expensive

❒ uncertainty about type of regulation

❒ other. Please specify:.......................................

❒ Yes --- In what respect? Please describe:..

....

B.5 Do you think that the idea to introduce an emissions trading system is in principle:

❒ a good idea ❒ a bad idea ❒ do not know yet

C. Experience with data reporting and capacity to participate in a trading system

C.1 Do you report data to the Voivodships' register of air emissions?

❒ No ❒ Yes ❒ What is that?

C.2 Do you think the amount of data you have to report is:

❒ not much ❒ appropriate ❒ too much ❒ far too much?

C.3 Emission Certificates are likely to be traded at stock exchanges or through brokers. Does your company have experience with

	No	Not yet, planning to	Yes, a little	Yes, a lot.	If yes --- is your experience mainly national, international or both?
trading shares or bonds at the stock exchange?	❒	❒	❒	❒	....
using the services of brokers to sell or buy goods?	❒	❒	❒	❒	....

C.4 Do you use services from an Energy Service Company? (ESCO, a firm which optimizes fuel consumption)

❒ No

❒ Not yet, but planned

❒ Yes

D. Products, emissions and energy supply

D.1 Which of the following products does your company produce?

❒..Ammonia	❒..Nitric acid	❒..Smoke black	❒..None of these, please indicate others: ....
❒..Carbides	❒..Adipic acid	❒..Ethylen	
❒..Caprolactam	❒..Urea		

D.2 How do you take account of emissions of the following gases:

	Measurement at point of emissions	Measurements of input and calculations of expected emissions	Estimates based on knowledge of fuel quality and combustion technology	No emission data available
SO_2	❒	❒	❒	❒
NO_x	❒	❒	❒	❒
Dust	❒	❒	❒	❒

CO_2	❒	❒	❒	❒
CH_4	❒	❒	❒	❒
N_2O	❒	❒	❒	❒

HFCs	❒	❒	❒	❒
PFCs	❒	❒	❒	❒

D.3 Considering the planned development of your company over the next four to seven years, do you expect absolute and relative emissions to:

	Emissions in absolute terms (in tons per year)			Emissions in relative terms (in tons per unit of output)		
	increase	remain constant	decrease	increase	remain constant	decrease
CO_2	❒	❒	❒	❒	❒	❒
CH_4	❒	❒	❒	❒	❒	❒
N_2O	❒	❒	❒	❒	❒	❒
HFCs	❒	❒	❒	❒	❒	❒
PFCs	❒	❒	❒	❒	❒	❒

D.4 Does your company import fuels or electricity for its own usage from other countries?

❒ No

❒ Not yet, but planned

❒ Yes, fuels --- Please indicate which fuels and their shares in your total consumption:
....% ....% ....%

❒ Yes, electricity --- Please indicate approximate share in your total consumption: ....%

D.5 Some types of emissions trading systems in discussion are expected to have an impact on the price of energy on the market. How strongly do such price developments affect your profits?

	a little	moderately	considerably	strongly	very strongly
price of electricity & heat	❐	❐	❐	❐	❐
price of oil, gas and coal	❐	❐	❐	❐	❐

If your company produces energy for its own purposes or for sale, please answer questions D.6 - D.8. If not, then please proceed to the last question.

D.6 Please indicate which type of energy you produce:

	Share of self-produced electricity/ heat in total usage	Utilized fuel (please state approximate share of each fuel).				
		hard coal	gas	oil	biomass (which?)	other (which?)
❐ electricity	......%	❐ .....%	❐ .....%	❐ .....%	❐ ....%	❐............ ...%
❐ heat	......%	❐ .....%	❐ .....%	❐ .....%	❐ ....; ....%	❐........... .....%

D.7 How much of the electricity or heat you produce is sold? ......% of electricity ...... % of heat.

D.8 Did existing air emission standards and fines on SO_2 and NO_x influence your previous investment decisions?

❐ No

❐ Yes --- In what respect? Did you, for example, buy filters, switch fuels or improve fuel quality? Please describe: ....

....

Thank you!

Last question: Are you interested in receiving a copy of the paper for which the answers you provided will be used?

❐ No

❐ Yes --- Please supply name and address to which paper should be send (if different from person who filled out questionnaire)

....

Annex 2: Results. Professional power and CHP plants, page 1

	A.1		A.2		A.3		A.4	B.1					B.2	
Questionnaire No	El. Capacity (MW)	Fuels	Heat Capacity (MW)	Fuels	Owner	Percentage	Yes/no	General	UNFCCC	Emission Trading	JI	CDM	Necessary/ unnecessary	Reason
1	>1000	BC	100-1000	BC	State-owned enterprise	100	Yes	Informed	Informed	well informed	Informed	Informed	Necessary	To reach climate stability
2	100-1000	HC	100-1000	HC	State Treasury	100	Yes	Informed	Informed	Informed	Uninformed	Uninformed	Necessary	General need
3	100-1000	HC	<100	HC	State Treasury	100	Yes	Informed	Informed	Informed	Informed	Informed	Necessary	Longterm thinking necessary
4	>1000	HC	100-1000	HC	State Treasury	100	Yes	Informed	Informed	Informed	Informed	Uninformed	Necessary	Concern for future generations
5	>1000	HC	100-1000	HC	State Treasury	100	Yes	Well informed	Informed	Informed	Informed	Uninformed	Necessary	Sustainable development
6	100-1000	HC, biomass	100-1000	HC, biomass	State Treasury	100	Yes	Informed	Uninformed	Informed	Uninformed	Uninformed	Necessary	No reason
7	100-1000	HC	0.00	HC	State Treasury	100	Yes	Informed	Uninformed	Informed	Uninformed	Uninformed	Necessary	Maintain standard of living
8	100-1000	HC	>1000	HC, mazut (7,7%)	State Treasury	100	Yes	Well informed	Informed	Informed	Uninformed	Uninformed	Necessary	No reason
9	100-1000	HC	100-1000	HC, oil (4%)	State Treasury	100	Yes	Informed	Informed	Informed	Uninformed	Informed	Necessary	Concern for future generations
10	<100	HC	100-1000	HC	State Treasury and private capital	85%/15%	Yes	Informed	Informed	Informed	Uninformed	Informed	Necessary	Effects of climate change become visible already
11	<100	HC, mazut(0,3%)	100-1000	HC, mazut(0,3%)	State Treasury and private capital	86,7%/13,3%	Yes	Informed	Informed	Informed	Informed	Informed	Necessary	Climate change is happening
12	>1000	HC	0		State Treasury	100	Yes	Informed	Informed	Informed	Informed	Informed	Necessary	Visible negative effects
13	100-1000	HC	100-1000	HC	State Treasury	100	Yes	Well informed	Informed	Informed	Informed	Informed	Necessary	No reason
14	<100	HC	100-1000	HC, gas(0,5%)	State Treasury	100	Yes	Well informed	Uninformed	Uninformed	Uninformed	Uninformed	Necessary	No reason
15	>1000	HC	0		State Treasury	100	Yes	Informed	Informed	Informed	Informed	Informed	Necessary	No reason
16	<100	HC	100-1000	HC	State Treasury	100	Yes	Informed	Uninformed	Informed	Informed	Informed	Necessary	No reason
17	>1000	HC	<100	HC	State Treasury	100	Yes	Informed	Uninformed	Informed	Uninformed	Uninformed	Necessary	Protection of life on earth
18	<100	HC	100-1000	HC	State Treasury	100	Yes	Informed	Informed	Informed	Informed	Uninformed	Necessary	No reason
19	100-1000	HC	100-1000	HC	State Treasury	100	Yes	Well informed	Informed	Informed	Uninformed	Uninformed	Necessary	Lead to emission reduction
20	<100	HC	100-1000	HC	State Treasury	100	Yes	Well informed	Well informed	Informed	Uninformed	Informed	Necessary	Protection of life on earth
21	100-1000	HC	100-1000	HC	State Treasury	100	Yes	Informed	Uninformed	Informed	Uninformed	Uninformed	Necessary	Future generations
22	100-1000	HC and gas(50%)	100-1000	HC and gas(50%)	State Treasury and private capital	10,2%, private capital 0,1%???	Yes	Informed	Uninformed	Uninformed	Uninformed	Uninformed	Necessary	Greenhouse effect needs to be addressed
23	100-1000	HC	>1000	HC	State Treasury	100	Yes	Informed	Informed	Informed	Informed	Informed	Necessary	CO2 emissions lead to Greenhouse effect
24	100-1000	HC (99%) oil	>1000	HC (98%) oil	State Treasury	100	Yes	Well informed	Informed	Informed	Uninformed	Well informed	Necessary	Negative effects of climate change
25	<100	HC	100-1000	HC	State Treasury	100	Yes	Well informed	Informed	Informed	Informed	Informed	Necessary	Dangerous effects of rapid climate change
26	100-1000	HC (99.3%) Oil	1500 MJ!	HC (91%) Oil	State Treasury	100	Yes	Well informed	informed	informed	Uninformed	informed	necessary	Climate is an important element of nature
27	>1000	HC	100-1000	HC	State Treasury	100	Zes	Well informed	Well informed	informed	NA	Well informed	Necessarz	Concern for future of the earth
28	>1000	BC			State Treasurz	100	Yes	Well informed	Well informed	informed	informed	informed	Necessary	Greenhouse Effect
SUM	20371		14429.5											

Annex 2: Results. Heat plants and municipal heat distribution companies

	A.1		A.2		A.3		A.4	B.1					B.2	
Questionnaire No	El. Capacity (MW)	Fuels	Heat Capacity (MW)	Fuels	Owner	Percentage	Yes/no	General	UNFCCC	Emission Trading	JI	CDM	Necessary/ unnecessary	Reason
1	0		406,7	HC(96,3), gas, oil, coke	Town	100	Yes	Informed	Inormed	Informed	Informed	Well informed	Necessary	Global warming
2	0		124	NA	State Treasury	100	No	Informed	informed	informed	Uninformed	Uninformed	Necessary	No reason
3	0		160	HC	State Treasury and private capital	49%/51%	No	NA	NA	NA	NA	NA	Necessary	Reduce the social cost of the protection of health
4	0		210,4	HC(97,9), gas(1.6), oil(0,5)	Town and private capital	90%/10%	Yes	Uninformed	informed	informed	Uninformed	informed	Necessary	Global Problem
5	13,82	HC	441	HC(97,4), gas, oil	State Treasury	100	Yes	Informed	Uninformed	Informed	Uninformed	Uninformed	Necessary	To reduce environmental degradation
6	0		290,9	HC	Town	100	Yes	Informed	Uninformed	Uninformed	Uninformed	Uninformed	Necessary	They lead to a stabilization of the climate
7	0		251,13	HC(99,4), gas, coke	Town	100	Yes	Well informed	Inormed	Informed	Uninformed	Uninformed	Necessary	Climate change will affect us
8	0		203,9	HC(99,8), gas	Town	100	Yes	Well informed	Inormed	Informed	Uninformed	Informed	Necessary	Climate change will affect us
9	0		196	NA	State Treasury	100	Yes	Informed	Inormed	Uninformed	Uninformed	Uninformed	Necessary	Leads to environmental degradation
10	0		396	HC	State Treasury	100	Yes	Informed	Inormed	Informed	Uninformed	Uninformed	Necessary	otherwise irreversible damage to the earth ecosystem will occur
11	0		159,8	HC(88.8) gas(9.7) oil, coke	Town	100	Yes	Informed	Informed	Informed	Uninformed	Uninformed	Necessary	Assures sustainable development

12	6		159,9	NA	State Treasury	100	Yes	Informed	Uninformed	Informed	Uninformed	Uninformed	Necessary	Good for people

Annex 2: Results. Professional power and CHP plants, page 2

B.3				B.4		B.5			B.6	C.1	C.2	C.3		D.1
CO2	opinion	MH4	opinion	Yes/No	How	Yes/No	Influence on investment yes/no	Yes - how?; No - why?	Opinion	yes no ?	Opinion	Stock market	Broker services	Measurement at source
9461201	Adequate	0		Yes	Change of filters, dry de-sulfurization equipment, new boilers	Yes	No	Unclear	Good idea	Yes	Too much	No	Some	SO2, NOX, Dust
298999	Too high	0		Yes	Change of fuel modernisation of boiler installation of filters	Yes	No	Too expensive	Good idea	Yes	Too much	No	Not yet	
119300	Adequate	0		Yes	Fuel improvement, boiler modernisation	Yes	No	Too expensive	Don't know	Yes	Appropriate	No	No	SO2, NOX, Dust, CO2
679350	Adequate	0		Yes	Fuel improvement, filter installations	No			Don't know	Yes	Appropriate	Not yet	No	
80300	Low	0		Yes	Wet de-sulfurization equipment, new fluid-cycle boilers	Yes	No	Unclear	Good idea	Yes	Appropriate	Yes, national	No	SO2
Yes	NA	0		Yes	Fuel improvement, change in combustion technology	Yes	No	Too expensive	Good idea	Yes	Too much	No	No	
95000	Adequate	0		Yes	Boiler modernisation, installations of filters	Yes	No	Uncertain	Don't know	Yes	Appropriate	No	No	SO2, NOX, Dust, CO2
Yes	NA	0		Yes	Change in fuel use, modernisation of boilers	No			Good idea	Yes	Appropriate	No	No	SO2, NOX, Dust, CO2
170000	Adequate	0		Yes	Fuel improvement, new boiler	Yes	No	?	Don't know	Yes	Appropriate	No	Some, national	SO2, NOX, Dust
29420	Adequate	0		Yes	Fuel improvement, de-sulfurization installation	No	No		Good idea	Yes	Too much	No	No	SO2, NOX, Dust, CO2
74430	Adequate	0		Yes	Filter modernisation, fuel improvement	No	No	Too expensive	Good idea	yes	Appropriate	Some national	No	SO2, NOX, Dust
900000	Too high	0		Yes	Filters, boiler modernisation, fuel improvement	Yes	Yes	Same as above	Don't know	Yes	Too much	Not yet	Some	NOX
320000	Too high	0		Yes	De-sulfurization, de-nitrification installations	Yes	No	Restructuring of company will lead to technical overhaul	Good idea	Yes	Appropriate	No	No	SO2, NOX, Dust
20660	Too high	0		Yes	Fuel improvement, filter modernisation	Yes	No	Too expensive	Good idea	Yes	Appropriate	No	No	SO2, NOX, Dust, CO2
Yes	NA	0		Yes	Wet de-sulfuralization	Yes	Yes	?	Good idea	Yes	Appropriate	Some national	Some national	SO2, NOX, Dust
Yes	Adequate	0		Yes	Change of fuel quality, improvement of combustion	Not available			Don't know	Yes	Appropriate	Some national	No	SO2, NOX, Dust, CO2
900000	Adequate	0		Yes	Improvements of boiler effeciency, installation of filters, de-sulfurization	Yes	Yes	Improvement of production effeciency	Don't know	Yes	Appropriate	No	Some national	SO2, NOX, Dust, CO2, N2O
36290	Low	0	Low	Yes	Planned gas turbines	Yes	Yes	See above	Good idea	No	Appropriate	No	Some national	SO2, NOX, Dust, CO2, N2O
44500	Adequate	0		Yes	Fuel improvement , increasing boiler efficiency	Yes	Yes	?	Don't know	Yes	Appropriate	No	No	SO2, NOX, Dust, CO2
28000	Low	0		Yes	Fuel improvement	No			Good idea	Yes	Appropriate	No	No	
207035	Adequate	0		Yes	Improvement of combustion and fuel	Yes	No	Uncertain	Don't know	Yes	Appropriate	No	No	SO2, NOX, CO2
2000	Adequate	0		Yes	Switch from cool too gas	No	No	Too expensive	Don't know	Yes	Appropriate	No	No	SO2, NOX, Dust
314000	Adequate	0	Adequate	Yes	Fuel Improvement, change of filters, modernisation of boilers	Yes	Yes	Planned increase of cogeneration	Good idea	Yes	Appropriate	Not yet	Not yet	SO2, NOX, Dust
209000	Too high	0		Yes	Improvement fo fuel	Yes	Yes	Low Nox boilers	Good idea	Yes	Too much	No	Not yet	SO2, NOX, Dust
57774	Adequate	0		Yes	Modernization of existing boilers to meet NOX standards	No			Don't know	Yes	Appropriate	No	No	SO2, NOX, Dust
33000	adequate	0		Yes	Improvement of fuel, modernisation of boilers	Yes	No	unclear	Good idea	Yes	Not much	No	No	SO2, NOX, Dust
1076238	adequate	0		Yes	De-sulfurization, low/Nox boilers	Yes	No	Too expensive	Good idea	Yes	Appropriate	Not yet	not yet	SO2, Nox
Yes	too high	0		Yes	De-sufurization	Yes	Yes	modernization of turbines	Good idea	Yes	too much	NA	NA	SO2, NOX, Dust, CO2

Annex 2: Results. Heat plants and municipal heat distribution companies

B.3				B.4		B.5			B.6	C.1	C.2	C.3		D.1
CO2	opinion	MH4	opinion	Yes/No	How	Yes/No	Influence on investment yes/no	Yes - how?; No - why?	Opinion	yes no ?	Opinion	Stock market	Broker services	Measurement at source
50102	Too high	0		Yes	Fuel switch from coke to gas or oil, filter modernisation	Yes	No	Unclear	Good idea	Yes	Too much	No	No	SO2, NOX, Dust, CO2, N2O
0	NA	0	NA	Yes	Preperation of boiler modernisation and insulation	Yes	Yes	See above	Don't know	Yes	Too much	No	No	
24000	Too high	0	NA	Yes	Improvement or combustion process and fuel quality	Yes	No	Uncertain	Don't Know	Yes	Appropriate	No	No	
30703	Adequate	0		Yes	Elimination of old boilers, expansion of the network, fuelswitch coal to gas	No	No	Too expensive	Don't know	Yes	Appropriate	No	No	
100000	Too high	0		Yes	Fuel switch fromcoal to gas or oil,improvement of fuel quality	Yes	No	too expensive	don't know	Yes	Appropriate	No	No	
22000	NA	0		Yes	Improvement of fuel quality	Yes	Yes	Compuerized combustion process	Don't know	Yes	Too much	No	No	
31135	adequat	0		Yes	Fuel improvement	Yes	No	Too expensive	Don't know	Yes	appropriate	No	Some	SO2, NOX, Dust, CO2
28000	NA	0		Yes	Improvement of fuel quality	Yes	Yes	Will implement combustion optimilization, improvement of network, gas as fuel.	Don"t know	Yes	Appropriate	No	No	SO2, NOX, Dust
36564	NA	0		No		Yes	No	Unclear, too expensive	Good idea	Yes	Appropriate	No	some, national	SO2, NOX, Dust
36295	Too high	0		Yes	Monitoring system installed, improvemnet of fuel, new boilers	No			Good idea	Yes	Appropriate	No	No	SO2, NOX, Dust, CO2
26995	Adequate	0		Yes	Fuel improvement, switch to gas, elimination of small boilers enlargement of network	Yes	Yes	modernization, new boilers	Good idea	Yes	Appropriate	No	No	
32000	Too high	0		Yes	Improvement of fuel quality, boiler modernization, fuel switch to gas or oil	Yes	Yes	Modernization, increasing efficiency	Don't know	Yes	Appropriate	NA	NA	SO2, NOX, Dust

Annex 2: Results. Professional power and CHP plants, page 3

			D.2						D.3		D.4	Interest in results
Consumption based calculations	*Comsumption-based estimates*	*No data on emissions*	*CO2 absolute*	*CO2 relative*	*CH4 absolute*	*CH4 relative*	*N2O absolute*	*N2O relative*	*Yes/No/planned*	*if yes: which*	*Cost of carbon measument in ashes*	
	SO2, NOX, Dust, CO2	CH4, N2O	Growth	Reduction	NA	NA	NA	NA	No		Very expensive	Yes
SO2, NOX, Dust, CO2, N2O	SO2, NOX, Dust, CO2, N2O	CH4	Stable	Reduction	NA	NA	Stable	Reduction	No		Expensive	Yes
SO2, NOX, Dust, CO2		CH4, N2O	Growth	Stable	Na	Na	Na	Na	No		Not very expensive (already happening)	Yes
SO2, NOX, Dust, CO2		CH4, N2O	Reduction	Reduction	NA	NA	NA	NA	No		Not very expensive	Yes
NOX, Dust, CO2		CH4, N2O	Stable/reduction	Reduction	NA	NA	NA	NA	No		Not very expensive	Yes
	SO2, NOX, Dust, CO2	CH4, N2O	Reduction	Stable	Reduction	Stable	Reduction	Stable	Yes	Woodwaste (1% of total fuel use)	Not very expensive	Yes
	SO2, NOX, Dust, CO2	CH4, N2O	Satble	Stable	NA	NA	NA	NA	No		NA	Yes
		CH4, N2O	Stable	Stable	Na	Na	Na	Na	No		Not very expensive (already happening)	Yes
SO2, NOX, Dust, CO2		CH4, N2O	Reduction	Stable	Na	Na	Na	Na	No		Expensive	Yes
			Stable	Satble	NA	NA	NA	NA	No		Not very expensive	Yes
	SO2, NOX, Dust, CO2	CH4, N2O	Stable	Stable	Na	NA	NA	NA	No		Expensive (done at one boiler)	Yes
SO2, Dust, CO2			Stable	NA	NA	NA	NA	NA	No		Expensive	Yes
CO2		CH4, N2O	Stable	Reduction	NA	NA	NA	NA	No		Not very expensive	Yes
		CH4, N2o	Growth	Growth	NA	NA	NA	NA	No		Expensive	Yes
CO2		CH4, N2O	Stable	Stable	Stable	Stable	Stable	Stable	No		Not very expensive	Yes
		CH4, N2o	Reduction	Reduction	NA	NA	NA	NA	No		NA	Yes
			Stable	Reduction	NA	NA	Reduction	Reduction	No		Not very expensive	Yes
		CH4	Growth	Reduction	NA	NA	Growth	Reduction	No		Expensive	Yes
SO2, NOX, Dust, CO2			NA	Reduction	NA	NA	NA	Reduction	No		Expensive	Yes
SO2, NOX, Dust, CO2, N2O			Reduction	Reduction	NA	NA	Reduction	Stable	No		Not very expensive	Yes
	SO2, NOX, Dust, CO2	CH4, N2O	NA	Stable	NA	NA	NA	NA	No		Expensive	Yes
CO2			Stable	Stable	NA	NA	NA	NA	No		Expensive	Yes
	CO2	N2O, CH4	Reduction	Reduction	Reduction	Reduction	Stable	Stable	No		Not very expensive	Yes
SO2, NOX, Dust, CO2	SO2	CH4, N2O	Growth	Stable	NA	NA	Reduction	Reduction	No		NA (stated that combustible parts are measured)	Yes
SO2, NOX, Dust, CO2	SO2, NOX, Dust	CH4, N2O	Stable	Reduction	NA	NA	NA	NA	No		Expensive	Yes
CO2			NA	Stable	NA	NA	NA	NA	No		Not very expensive	Yes
SO2, Dust, Nox	SO2, CO2		growth	Stable	NA	NA	NA	NA	No		Not very expensive	Yes
			Stable	Stable	Stable		Reduction	Reduction	No		Expensive	Yes

Annex 2: Results. Heat plants and municipal heat distribution companies

			D.2						D.3		D.4	Interest in results
Consumption based calculations	*Comsumption-based estimates*	*No data on emissions*	*CO2 absolute*	*CO2 relative*	*CH4 absolute*	*CH4 relative*	*N2O absolute*	*N2O relative*	*Yes/No/planned*	*if yes: which*	*Cost of carbon measument in ashes*	
	SO2, NOX, Dust, CO2, N2O	CH4	Stable	Satble	NA	NA	Reduction	Reduction	No		Expensive	No
	SO2, NOX, Dust		NA	NA	NA	NA	NA	NA	No		Expensive	No
	SO2, NOX, Dust, CO2		Reduction	NA	NA	NA	Na	NA	No		Expensive	No
	SO2, NOX, Dust, CO2, N2O		Stable	NA	NA	NA	Stable	NA	No		Not very expensive	Yes
SO2, NOX, Dust, CO2			reduction	NA	NA	NA	NA	NA	No		Not very expensive	Yes
SO2, NOX, Dust, CO2, N2O			Stable	Satble	NA	NA	Stable	Stable	No		Expensive	Yes
			Stable	Satble	NA	NA	NA	NA	No		Expensive	Yes
SO2, NOX, Dust	CO2, N2O	CH4	Stable	Reduction	NA	NA	Stable	Reduction	No		Not very expensive	Yes
	CO2	CH4, N2O	Stable	Satble	NA	NA	NA	NA	No		Not very expensive	Yes
	SO2, NOX, Dust, CO2	CH4, N2O	Growth	Reduction	NA	NA	NA	NA	No		Not very expensive	Yes
SO2, NOX, Dust, CO2		Ch4, N2O	Stable	Stable	Stable	Stable	Stable	Stable	No		Not very expensive	Yes
SO2, NOX, Dust			NA	NA	NA	NA	NA	NA	No		NA	Yes

Metallurgical Industry	A.1		A.2		A.3	B.1					B.2
Questionnaire No	Number of employees	Gross turnover	Owner	Percentage	Yes/no	General	UNFCCC	Emission Trading	JI	CDM	Necessary/ unecessary
Met 1	1000	NA	NA	NA	Yes	Informed	Uninformed	Uninformed	Uninformed	Informed	Necessary
Met 2	4072	742 536 000	State Treasury/Private	11/70.5	Yes	Informed	Informed	Informed	Informed	Informed	Necessary
Met 3	NA	NA	NA	NA	Yes	Well informed	NA	NA	NA	NA	Necessary
Met 4	2500	231 000 000	State Treasury	100	Yes	Informed	Uninformed	Informed	Uninformed	Well informed	Necessary
Met 5	7400	NA	State Treasury	100	Yes	Well informed	Well informed	Informed	Informed	Informed	Necessary
Met 6	NA	NA	State Treasury	100	Yes	Informed	NA	Informed	NA	NA	NA
Met 7	1358	NA	State Treasury/Private	10/70	Yes	Informed	Informed	Uninformed	Uninformed	Uninformed	Necessary
Met 8	NA	NA	State Treasury	100	Yes	Well informed	Uninformed	Informed	Uninformed	Informed	Necessary

Chemical Industry	A.1		A.2		A.3	B.1					B.2
Questionnaire No	Number of employees	Gross turnover	Owner	Percentage	Yes/no	General	UNFCCC	Emission Trading	JI	CDM	Necessary/ unecessary
CH 1	744	137 643 000	Private/State Treasury	75/25	Yes	Informed	Uninformed	Uninformed	Uninformed	Uninformed	Necessary
CH 2	1200	270 000 000	State Treasury	100	Yes	Well informed	Informed	Informed	Informed	Informed	Necessary
CH 3	1242	NA	Private/State Treasury	64.8/35.2	Yes	Informed	Uninformed	Informed	Uninformed	Uninformed	Necessary
CH 4	1600	6 000 000	State Treasury	100	Yes	Informed	Uninformed	Uninformed	Uninformed	Uninformed	Necessary
CH 5	1066	19 043 168	Private/State Treasury	6.5/93.5 of which 64% foreign	Yes	Well informed	Informed	Informed	Uninformed	Well informed	Necessary
CH 6	954	NA	State Treasury/NIF	25/75	Yes	Informed	Informed	Informed	Informed	Informed	Necessary
CH 7	1532	NA	State Treasury/Private	65.14/12.07	Yes	Well informed	Informed	Informed	Uninformed	Well informed	Necessary
CH 8	3300	NA	State Treasury	100	Yes	Informed	Informed	Informed	Informed	Informed	Necessary
CH 9	528	115 940 000	Private	100	Yes	Well informed	Well informed	Informed	Informed	Informed	Necessary

Mineral Industry	A.1		A.2		A.3	B.1					B.2
Questionnaire No	Number of employees	Gross turnover	Owner	Percentage	Yes/no	General	UNFCCC	Emission Trading	JI	CDM	Necessary/ unecessary
Min 1	1000	NA	Private	100	Yes	Well informed	Informed	Uninformed	Uninformed	Informed	Necessary
Min 2	692	NA	State Treasury/ Private	13/87 of which 14% foreign	Yes	Informed	Uninformed	Informed	Uninformed	Uninformed	NA
Min 3	1008	173 000 000	Private	100	Yes	Informed	Uninformed	Informed	Uninformed	Uninformed	Necessary
Min 4	556	NA	State Treasury	100	Yes	Well informed	Well informed	Well informed	Well informed	Well informed	Necessary
Min 5	742	NA	State Treasury/ Private	32/68	Yes	Informed	Uninformed	Uninformed	Uninformed	Uninformed	Necessary
Min 6	604	NA	Private	100 foreign	Yes	Informed	Informed	Informed	Uninformed	Informed	Necessary
Min 7	612	NA	State Treasury/ Private	36.1/63.9	Yes	Informed	Uninformed	Uninformed	Uninformed	Uninformed	Necessary
Min 8	444	49 891 000	Private	4.50%	Yes	Well informed	Informed	Uninformed	Uninformed	Uninformed	Necessary
Min 9	953	48 000 000	State Treasury	100	Yes	Uninformed	Uninformed	Uninformed	Uninformed	Uninformed	No opinion
Min 10	914	222 474 000	State Treasury/ Private	8/92 of which 85% foreign	Yes	Informed	Informed	Informed	Uninformed	Informed	No opinion

ther Industries	A.1		A.2		A.3	B.1					B.2
Questionnaire No	Number of employees	Gross turnover	Owner	Percentage	Yes/no	General	UNFCCC	Emission Trading	JI	CDM	Necessary/ unecessary
O 1	2530	Profit: 5 050 000	State Treasury/Private	5/35 of which 60 foreign	Yes	Well informed	Well informed	Informed	Uninformed	Informed	Necessary
O 2	320	NA	State Treasury	100	Yes	Informed	Uninformed	Uninformed	Uninformed	Uninformed	Necessary
O 3	400	NA	State Treasury	100.00%	Yes	Well informed	Informed	Uninformed	Uninformed	Uninformed	Necessary
O 4	282	45 000 000	State Treasury/Private	49.00%	Yes	Informed	Uninformed	Uninformed	Uninformed	Uninformed	Necessary
O 5	770	Losses	State Treasury/Private	15%/85% of which 100% foreign	Yes	Well informed	Informed	Uninformed	Uninformed	Informed	Necessary
O 6	2373	3 530 000	State Treasury/Private	0.20%	Yes	Informed	Uninformed	Uninformed	Uninformed	Uninformed	No opinion
O 7	366	NA	State Treasury	100.00%	Yes	Well informed	Uninformed	Uninformed	Uninformed	Uninformed	Necessary

Metallurgical Industry	B.3				B.4			B.5	C.1	C.2	C.3
Reason	CO2	Opinion	MH4	Opinion	Yes/No	Influence on investment yes/no	How/Why	Opinion	Yes/no ?	Opinion	Stock market
Common good	3000	Too high	No		Yes	No	Too expensive	Bad idea	Yes	Too much	No
Is a part of the environment	18 500	Too high	No		Yes	Yes	Modernization of heating, low-emission boilers	Good idea	Yes	Appropriate	No
Assures life on earth	8000	Appropriate	NA		NA			Don't know	Yes	Too much	Yes, a lot, national
NA	7000	Appropriate	No		No			Don't know	Yes	Appropriate	Not yet
Ignoring global warming might lead to catastrophy	176000	Too high	No		Yes	Yes	Installation of highly energy efficient steel oven	Good idea	Yes	Appropriate	No
NA	Yes	Too high	No		Yes	Yes	Installation of dust filters, modernization of boilers	Don't know	Yes	Appropriate	No
Because it affects the environment in which we live	4000	Too high	No		Yes	No	Too expensive	Don't know	Yes	Appropriate	No
NA	Yes	Appropriate	Yes	Appropriate	Yes	No	Too expensive	Good idea	Yes	Too much	NA

Chemical Industry	B.3				B.4			B.5	C.1	C.2	C.3
Reason	CO2	Opinion	MH4	Opinion	Yes/No	Influence on investment yes/no	How/Why	Opinion	Yes/no ?	Opinion	Stock market
NA	12527	Too high	No		Yes	Yes	NA	Don't know	Yes	Appropriate	No
Concern for climate and future generations	Yes	Appropriate	No		Yes	Yes	Fuel switch, coal to gas	Good idea	Yes	Appropriate	Yes, some
Future life on earth depends on it	3300	NA	No		Yes	No	Too expensive	Good idea	Yes	Appropriate	Yes, a lot, national
Future of mankind depends on it	3157	Appropriate	No		Yes	Yes	Fuel switch from coal to gas for process heat	Don't know	Yes	Appropriate	No
Affects all countries and people	3033	Too high	No		Yes	Yes	Planned fuel switch coal to gas	Don't know	Yes	Appropriate	Yes, a lot, national
Global warming is dangerous	Yes	Far too high	No		Yes	No	NA	Don't know	Yes	Appropriate	No
NA	12000	Too high	NA		Yes	No	Too expensive	Don't know	Yes	Appropriate	No
Global problem	146 000	Appropriate	16	Appropriate	Yes	No	Uncertain	Good idea	Yes	Appropriate	No
Greenhouse effect leads to disturbance of ecosystems	5437	Too high	No		Yes	No	Too expensive	Good idea	Yes	Too much	Yes, a lot, national

Mineral Industry	B.3				B.4			B.5	C.1	C.2	C.3
Reason	CO2	Opinion	MH4	Opinion	Yes/No	Influence on investment yes/no	How/Why	Opinion	Yes/no ?	Opinion	Stock market
NA	3500	Appropriate	No		No			Don't know	Yes	Appropriate	Yes, a lot, national
NA	No		No		Yes	Yes	Modernization of glass ovens	Don't know	Yes	Appropriate	NA
Part of the environment in which we live	42600	Too high	No		Yes	No	NA	Don't know	Yes	Too much	No
Affects us all	10000	Too high	No		Yes	Yes	De-sulfurization installation	Don't know	No	Appropriate	No
Leads to environmental degradation	254	Appropriate	No		No			Don't know	Yes	Appropriate	Yes, some, international
Provokes extreme weather	100000	Appropriate	No		No			Good idea	Yes	Appropriate	No
Important for the existence of life on earth	5000	Appropriate	No		No			Don't know	Yes	Appropriate	No
We are all responsible for the environment	513182	NA	NA		Yes	Yes	Modernization of ovens and heating system	Good idea	Unknown	Too much	NA
	4749	Appropriate	NA		Yes	Yes	Fuel switch from coal to gas	Don't know	Yes	Appropriate	No
	213872	Too high	No		No	Yes	Installation of dry cement production	Don't know	Yes	Appropriate	No

Other Industries	B.3				B.4			B.5	C.1	C.2	C.3
Reason	CO2	Opinion	MH4	Opinion	Yes/No	Influence on investment yes/no	How/Why	Opinion	Yes/no ?	Opinion	Stock market
NA	140000	Too high	NA		Yes	Yes	Installation of emission monitoring equipment	Good idea	Yes	Appropriate	Yes, a lot, national
Obvious	2161	Appropriate	No		Yes	Yes	NA	Don't know	Unknown	Appropriate	No
Low awareness of the high risks of climate change	8000	Appropriate	No		No		Technology too expensive	Bad idea	Yes	Appropriate	Yes, some, national
Decisive for the long-term development of society	5400	Appropriate	No		Yes	No	Uncertainty	Don't know	Yes	Too much	No
NA	39200	Appropriate	No		Yes	Yes	Fuel switch, coal to gas	Don't know	Yes	Appropriate	No
	2800	Too high	No		Yes	Yes	Gradual introduction of gas-fired machinery	Don't know	Yes	Appropriate	Yes, some, national
Need for a balance in climate	27442	Too high	No		Yes	Yes	Purchase of low-sulfur coal, automatization of boilers	Don't know	Yes	Appropriate	No

Metallurgical Industry	C.4	D.1	D.2	D.3				D.4
Broker services	ESCO?	Products	Coal as reducing agent	Measurement at source	Consumption based calculations	Comsumption-based estimates	No data on emissions	CO2 absolute
No	No	Metal hardening and torsion	No			SO2, NOX, Dust, CO2, N2O	CH4, PFCs, SF6	Stable
No	Yes	Steel	Yes	NOX, Dust		SO2, CO2	CH4, N2O, PFCs, SF6	Reduction
NA	No	Sheet metal	No	SO2, NOX, Dust	CO2	SO2, NOX, Dust, CO2	CH4, N2O, PFCs, SF6	Stable
No	No	Iron casting	No	SO2, NOX, Dust, CO2, N2O	SO2, NOX, Dust, CO2, N2O	SO2, NOX, Dust, CO2, N2O	CH4, PFCs, SF6	Reduction
No	No	Pig iron, steel, coke	Yes	SO2, NOX, Dust, N2O	CO2	SO2, Dust, CO2	CH4, PFCs, SF6	Reduction
No	Not yet	Warm and cold iron casting	No	SO2, NOX, Dust, CO2				Stable
No	Not yet	Ferroalloys	Yes	SO2, NOX, Dust, N2O				NA
NA	NA	Pig iron, steel, coke, sinter	NA	SO2, NOX, Dust, CH4	SO2, NOX, Dust, CO2	SO2, NOX, Dust, CO2	N2O, PFCs, SF6	Reduction

Chemical Industry	C.4	D.1	(Doesn't apply)	D.2				D.3
Broker services	ESCO?	Products		Measurement at source	Consumption based calculations	Comsumption-based estimates	No data on emissions	CO2 absolute
NA	No	Chrome and Phosphor		Dust		SO2, NOX, CO2		Stable
Not yet	No	Pestycides		SO2, NOX, CO2		SO2, NOX, CO2, Dust	CH4, N2O, HFCs, PFCs	Reduction
Yes, some, national	NA	Pharmaceuticals		SO2, NOX, Dust, CO2, N2O	HFCs, PFCs		CH4	Stable
Yes, some, national	No	Plastics		SO2, NOX, Dust, CO2	N2O		CH4, HFCs, PFCs	Reduction
No	No	Pharmaceuticals		SO2, NOX, CO2, N2O	CO2, HFCs			Reduction
NA	No	Chrome and Phosphor		Dust		SO2, NOX, CO2		Stable
No	Not yet	NA			SO2, NOX, Dust, CO2			Stable
No	No	Ammonia, Nitric acid, Urea		SO2, NOX, Dust	SO2, NOX, Dust, CO2, CH4	SO2, NOX, CO2	N2O, HFCs, PFCs	Stable
No	No	Esters, cooling agents		SO2, NOX, Dust	CO2		CH4, N2O, HFCs, PFCs	Stable

Mineral Industry	C.4	D.1	(Doesn't apply)	D.2				D.3
Broker services	ESCO?	Products		Measurement at source	Consumption based calculations	Comsumption-based estimates	No data on emissions	CO2 absolute
No	No	Lime and soda ash usage		SO2, NOX, CO2, Dust				Stable
NA	No	NA		SO2, NOX, CO2				NA
No	No	Lime production		SO2, NOX, Dust		CO2	CH4, N2O	Stable
No	No	Cement and lime usage		SO2, NOX, Dust, CO2, N2O	SO2, NOX, Dust, CO2			Stable
Yes, some, international	No	NA		NOX, Dust	CO2		SO2, CH4, N2O	Stable
No	No	Production and usage of cement. Usage of lime and others		SO2, NOX, Dust	CO2		CH4, N2O	Growth
No	No	Usage of soda ash		NOX, Dust, CO2, N2O	SO2, NOX, Dust, CO2, N2O		CH4	Stable
NA	NA	Usage of cement, lime and others		SO2, NOX, Dust, CO2				Stable
No	No	Usage of cement				SO2, NOX, Dust, CO2	CH4, N2O	Reduction
No	No	Cement production		SO2, NOX, Dust	CO2			Reduction

Other Industries	C.4	D.1	(Doesn't apply)	D.2				D.3
Broker services	ESCO?	Products		Measurement at source	Consumption based calculations	Comsumption-based estimates	No data on emissions	CO2 absolute
No	No	Pulp, cardbord		SO2, NOX, Dust, CO2				Reduction
No	Not yet	Toilet paper				SO2, NOX, Dust, CO2	CH4, N2O	Reduction
No	No	Cotton fabrics		SO2, NOX, Dust, CO2			CH4, N2O	Reduction
No	No	Sugar and others				SO2, NOX, Dust, CO2, N2O	CH4	Stable
No	No	Paper				SO2, NOX, Dust, CO2, CH4, N2O		Reduction
No	No	Cotton fabrics		SO2, NOX, Dust, CO2	SO2, NOX, Dust, CO2	SO2, NOX, Dust, CO2	CH4, N2O	Reduction
No	No	Sugar		SO2, NOX, Dust, CO2, N2O		SO2, Dust, CO2, N2O		Reduction

Metallurgical Industry							D.5		D.6		D.7
CO2 relative	CH4 absolute	CH4 relative	N2O absolute	N2O relative	Others absolute	Others relative	Yes/No/planned	if yes: which?	Electricity and heat	Oil/gas/coal	Kind of energy
Reduction	NA	NA	Stable	Reduction	NA	NA	No		Significantly	Significantly	Heat
Reduction	NA	NA	NA	NA	NA	NA	No		Significantly	Significantly	Heat
Reduction	NA	NA	NA	NA	NA	NA	No		Significantly	Strongly	Heat
Reduction	NA	NA	Stable	Reduction	NA	NA	No		Little	Little	Heat
Reduction	NA	NA	Reduction	Reduction	NA	NA	No		Little	Little	Electricity and heat
Stable	NA	NA	NA	NA	NA	NA	No		Significantly	Significantly	Electricity and heat
Stable	NA	NA	NA	NA	NA	NA	No		Very strongly	Strongly	
Stable	Reduction	Stable	NA	NA	NA	NA	No		NA	NA	NA

Chemical Industry							D.4		D.5		D.6
CO2 relative	CH4 absolute	CH4 relative	N2O absolute	N2O relative	Others absolute	Others relative	Yes/No/planned	if yes: which?	Electricity and heat	Oil/gas/coal	Kind of energy
Stable	NA	NA	Stable	Stable	NA	NA	No		Significantly	Significantly	Electricity and heat
Reduction	NA	NA	NA	NA	NA	NA	No		Significantly	To some degree	Electricity and heat
Stable	NA	NA	Reduction	Reduction	HFCs and PFCs Reduction	HFCs and PFCs Reduction	No		NA	NA	Heat
Reduction	NA	NA	Reduction	Reduction	NA	NA	No		Significantly	Significantly	Heat
Reduction	NA	NA	Reduction	Reduction	HFCs: Growth	HFCs: Growth	No		NA	NA	Heat
Stable	NA	NA	Stable	Stable	NA	NA	No		Significantly	Significantly	Electricity and heat
Reduction	NA	NA	NA	NA	NA	NA	No		NA	NA	Electricity and heat
Stable	Stable	Stable	NA	NA	NA	NA	No		NA	NA	Electricity and heat
Stable	NA	NA	NA	NA	NA	NA	No		To some degree	To some degree	Heat

Mineral Industry							D.4		D.5		D.6
CO2 relative	CH4 absolute	CH4 relative	N2O absolute	N2O relative	(Doesn't apply)	(Doesn't apply)	Yes/No/planned	if yes: which?	Electricity and heat	Oil/gas/coal	Kind of energy
Stable	NA	NA	Stable	Stable			No		NA	NA	No
NA	NA	NA	NA	NA			No		Strongly	Strongly	Heat
Stable	NA	NA	NA	NA			No		Strongly	Strongly	No
NA	NA	NA	NA	NA			No		Little	Very strongly	Heat
Reduction	NA	NA	Stable	Reduction			No		Strongly	Very strongly	None
Stable	Growth	Stable	Growth	Stable			Yes	HC	Significantly	Significantly	Heat
Stable	Stable	Stable	Stable	Stable			No		Significantly	Very strongly	No
Reduction	NA	NA	NA	NA			NA		Significantly	Very strongly	Heat
Reduction	NA	NA	NA	NA			No		Significantly	Significantly	Heat
Reduction	NA	NA	NA	NA			Yes	coke 15% of energy usage	NA	NA	NA

Other Industries							D.4		D.5		D.6
CO2 relative	CH4 absolute	CH4 relative	N2O absolute	N2O relative	Others absolute	Others relative	Yes/No/planned	if yes: which?	Electricity and heat	Oil/gas/coal	Kind of energy
NA	NA	NA	NA	NA	NA	NA	Yes	42% of coal	NA	NA	NA
Reduction	NA	NA	NA	NA	NA	NA	No		Strongly	Stronlgy	Heat
Reduction	NA	NA	NA	NA	NA	NA	No		Little	Significantly	Electricity and heat
Stable	NA	NA	Reduction	Reduction	NA	NA	Not yet		Little	To some degree	NA
Reduction	Reduction	Reduction	Reduction	Reduction	NA	NA	No		NA	NA	Electricity and heat
Reduction	NA	NA	NA	NA	NA	NA	No		Significantly	Significantly	Electricity and heat
Reduction	NA	NA	Reduction	Reduction	NA	NA	No?		Significantly	Significantly	Electricity and heat

Metallurgical Industry		D.8	D.9		Interest in results
Share	Fuel	Share of sold energy	Yes/no	How?	
1	HC	NA	Yes	Improvement of fuel quality	Yes
15	Recovered process heat	100	Yes	Change in heating technology, fuel switch from heavy fuel oil to gas	Yes
1	HC(50%), gas (50%)	4% of heat	Yes	Modernization of filters and boilers, improvement of coal quality	Yes
100	HC(90%), gas (10%)	3% of heat	Yes	Fuel switch from coal and town gas to natural gas	Yes
2/120	HC(20%), gas (30%), oil (50%)	20% of heat	Yes	Efficiency improvements, fuel improvements and fuel switching	Yes
21/100	HC	NA	Yes	Boiler modernization, purchase of higher quality coal	Yes
			No		No
NA	NA	NA	Yes	Fuel improvements, installation of gas de-sulfurization equipment and fluid bed combustion boilers	Yes

Chemical Industry		D.7	D.8		Interest in results
Share	Fuel	Share of sold energy	Yes/no	How?	
47/100	HC	1.3% of electricity	Yes	Fuel improvement, CO reduction	Yes
20/100	HC	NA	Yes	Installation of gas turbine	Yes
100	HC	5% of heat	Yes	De-sulfurization installation	Yes
100	HC(65%), gas(30%), oil(5%)	NA	Yes	Fuel switch from coal to gas and oil	Yes
100	HC	13% of heat	Yes	Fuel improvement, planned fuel switch	Yes
47/100	HC	1.3% of electricity	Yes	Fuel improvement, CO reduction	Yes
NA	HC	NA	Yes	Improvement of fuel quality	Yes
20/100	HC	7% of heat	Yes	Fuel improvement, energy efficiency investment in production	Yes
100	HC	10% of heat	Yes	Fuel improvement	Yes

Mineral Industry		D.7	D.8		Interest in results
Share	Fuel	Share of sold energy	Yes/no	How?	
					Yes
100	gas	None	Yes	Modernization of ovens	Yes
					Yes
1	HC	35% of electricity 70% of heat	Yes	New filters and improvements of coal quality	Yes
			Yes	Modernization of gas oven for NOX reduction	Yes
1	HC	10% of heat	No		Yes
					Yes
1	HC(37%) recoverd process heat (63%)	NA	Yes	Fuel switch from town (or coking?) gas to natural gas	No
0.84	HC(99.7%) gas (0.3%)	4.4% of heat	Yes	Fuel switch from coal to gas	Yes
NA	NA	NA	No		Yes

Other Industries		D.7	D.8		Interest in results
Share	Fuel	Share of sold energy	Yes/no	How?	
NA	NA	NA	NA	NA	NA
100	HC (37%) gas (63%)	No	Yes	Fade out of coal use, switch to gas	Yes
90/100	HC	6 % of electricity 6 % of heat	Yes	Installation of filters, purchase of low-sulfur and low dust coal	Yes
NA	NA	NA	NA	NA	NA
30/115	HC	15% of heat	No	But planned installation of gas-fired boilers	No
24.2/100%	HC	0.02% of electricity 0.8% of heat	Yes	Installation of De-sulfurization equipment, gradual introduction of gas-fired tachnology	Yes
100	HC	26% of electricity 49% of heat	Yes	Purchase of low-sulfur coal, automatization of boilers	Yes

Name of the enterprise	Electric capacity (MWe)	Thermal capacity (MWt)	CO2 Emissions 1998 (metric tons)	Individual share in total emissions	Cumulative share in emissions
ELEKTROWNIA BEŁCHATÓW	4320.0	376.0	33513707	23.2	23.2
ELEKTROWNIA "KOZIENICE"	2749.0	266.0	7175321	5.0	28.2
ZESPÓŁ ELEKTROWNI PĄTNÓW-ADAMÓW-KONIN S.A.	2688.0	583	15554596	10.8	39.0
ZESPÓŁ ELEKTROWNI DOLNA ODRA S.A.	1708.0	67.0	7407815	5.1	44.1
ELEKTROWNIA "RYBNIK" S. A.	1695.0	59	7489513	5.2	49.3
ELEKTROWNIA TURÓW W BOGATYNI	1673.0	111.5	9461201	6.6	55.9
ELEKTROWNIA IM. TADEUSZA KOŚCIUSZKI S.A.	1600.0	0.0	6165596	4.3	60.1
ELEKTROWNIA JAWORZNO III S.A.	1565.0	383.0	6500643	4.5	64.6
ELEKTROWNIA OPOLE S.A.	1450.0	0.0	5411385	3.8	68.4
ELEKTROWNIA "ŁAZISKA" S.A.	1100.0	196.0	4529013	3.1	71.5
ELEKTROCIEPŁOWNIE WARSZAWSKIE S.A.	934.0	5597.0	6117946	4.2	75.8
"ELEKTROWNIA SIERSZA" S.A.	731.0	37	2448298	1.7	77.5
ELEKTROWNIA "ŁAGISZA" S.A.	700.0	380	3551960	2.5	79.9
ZESPÓŁ ELEKTROWNI OSTROŁĘKA S.A	672.0	309.0	2912810	2.0	81.9
ELEKTROWNIA SKAWINA S.A.	590.0	575.0	1993324	1.4	83.3
"ZESPÓŁ ELEKTROCIEPŁOWNI W ŁODZI" S.A.	499.5	2803	3277277	2.3	85.6
ELEKTROCIEPŁOWNIA "KRAKÓW" S.A.	446.0	1457	2121988	1.5	87.1
ELEKTROWNIA STALOWA WOLA S.A.	385.0	422.0	1380231	1.0	88.0
ZESPÓŁ ELEKTROCIEPŁOWNI WROCŁAW S.A.	360.0	1415.0	2094769	1.5	89.5
ZESPÓŁ ELEKTROCIEPŁOWNI WYBRZEŻE S.A.	353.0	1500	2200629	1.5	91.0
ZESPOŁ ELEKTROCIEPŁOWNI S.A. BYDGOSZCZ	204.4	1007.0	1395090	1.0	92.0
ELEKTROWNIA BLACHOWNIA S.A.	204.0	184	928339	0.6	92.6
ELEKTROWNIA "HALEMBA" S.A.	200.0	58.0	795278	0.6	93.2
ZESPÓŁ ELEKTROCIEPŁOWNI POZNAŃSKICH S.A.	166.0	941	1259907	0.9	94.0
ZESPÓŁ ELEKTROCIEPŁOWNI BIELSKO-BIAŁA S.A	157.0	898.0	1107007	0.8	94.8
ELEKTROCIEPŁOWNIA "BIAŁYSTOK" S.A.	155.0	557.0	976512	0.7	95.5
ZESPÓŁ ELEKTROCIEPŁOWNI BYTOM S.A.	125.0	322	633330	0.4	95.9
ELEKTROCIEPŁOWNIA "VICTORIA" Sp. Z O.O	113.1	366.0	261611	0.2	96.1
"ELEKTROCIEPŁOWNIA ZABRZE" S.A.	106.0	595.0	722657	0.5	96.6
SPÓŁKA ENERGETYCZNA "JASTRZĘBIE" S.A.	93.0	603	800188	0.6	97.2
"ELEKTROWNIA CHORZÓW" S.A.	74.5	490	469188	0.3	97.5
ELEKTROCIEPŁOWNIA "GORZÓW" S.A.	68.0	350	658395	0.5	97.9
ELEKTROCIEPŁOWNIA "BĘDZIN" S.A.	55.0	496.0	496203	0.3	98.3
"ELEKTROCIEPŁOWNIA ELBLĄG" SP. Z O. O.	37.0	398.0	395708	0.3	98.6
BORUTA	36.3	305	115583	0.1	98.6
PRZEDSIĘBIORSTWO ENERGETYCZNE "MEGAWAT" SPÓŁKA Z O.O.	29.0	275	370119	0.3	98.9
"ELEKTROCIEPŁOWNIA ZIELONA GÓRA" S.A.	23.4	274.0	310552	0.2	99.1
"ENERGO-ZACH" Sp. Z O. O.	15.0	62	54783	0.0	99.1
ELEKTROCIEPŁOWNIA "EC-WSK" SP. Z O.O.	12.0	166.0	137733	0.1	99.2
ELEKTROCIEPŁOWNIA "PZL-MIELEC" SPÓŁKA Z O.O.	10.0	234.0	196500	0.1	99.4
"ENERGETYKA KALISKA-ELEKTROCIEPŁOWNIA PIWONICE" SP.Z O.O.	7.0	137	142979	0.1	99.5
"ELEKTROCIEPŁOWNIA ZDUŃSKA WOLA SP. Z O.O."	6.6	132.0	128844	0.1	99.6
ELEKTROCIEPŁOWNIA "ENERGOTOR-TORUŃ" S.A.	6.0	150.0	182868	0.1	99.7
ELEKTROCIEPŁOWNIA "GIGA" SP. Z O.O.	6.0	146	118793	0.1	99.8
"ANDROPOL-ELEKTROCIEPŁOWNIA"SP.Z O. O.	4.7	98	86990	0.1	99.8
ELEKTROCIEPŁOWNIA "TORUŃ" S.A.	2.2	314.0	241951	0.2	100.0
SUM	28134.7		144295130	100.0	

Source: Compiled from ARE (1999b) and questionnaire data

Bibliographic Data Sheet **Risø-R-1203(EN)**

Title and authors

The feasibility of domestic CO_2 emissions trading in Poland

Jochen Hauff

ISBN	ISSN
87 – 550 – 2740 - 7	0106 - 2840

Department or group	Date
System Analysis Department	October 2000

Groups own reg. number(s)	Project/contract No(s)
SYS – 1999 – 132/036 – 1	ENS 1753 / 99-003

Pages	Tables	Illustrations	References
116	16	5	115

Abstract

In early 2000, neither a comprehensive upstream system nor an all-encompassing downstream approach to CO_2 emissions permit trading seems feasible in Poland. However, a pilot emissions trading system in the power and Combined Heat and Power (CHP) sector is thought to be a realistic option in the near future.

A comprehensive upstream approach would require permits for the carbon contained in fossil fuels produced or imported in Poland. It is ruled out due to the perceived difficulties of the inclusion of the coal sector in such a system. While inclusion of the gas sector, and especially of the oil sector, seems possible within a relatively short time, relying on an upstream approach without the coal sector is not advisable. Once the restructuring of the coal sector as well as the privatization of the gas and oil sector is advanced, an upstream approach might become an option again.

A comprehensive downstream approach would regulate CO_2 emissions at their source, that is mostly at point of combustion of fossil fuels. A system which includes industry, households and transport can be assumed to be infeasible. Instead, a "core program" was examined, which would focus on power and heat generation as well as energy intensive industries. Such an approach was found feasible in principle. Currently, however, only the largest emitters could be easily integrated in a reliable system. Drawing the line between those included and those excluded from such a partial system requires careful analysis. Including all enterprises in the relevant sectors would require significant improvements in monitoring and reporting reliability.

A pilot emissions permit trading system could be introduced in the professional power and heat sector. Here, awareness concerning the instrument was found to be high and the system could be based on monitoring requirements already required by law. Gradual inclusion of more relevant sectors and eventual combination with an upstream component to include oil refineries, and with them the growing CO_2 emissions from transport, seem possible.

Such a pilot program would allow firms and the policy maker to gather relevant experiences for the possible future introduction of a comprehensive system and for the emerging international emissions trading system.To determine whether a pilot system is desirable, however, an extensive and comparative analysis of different climate protection policy options is still needed for Poland. It should include a close look at the implications of EU climate protection policies and the effects of the liberalization of international electricity markets on domestic policy options.

Descriptors INIS/EDB

Available on request from Information Service Department, Risø National Laboratory,
(Afdelingen for Informationsservice, Forskningscenter Risø), P.O.Box 49, DK-4000 Roskilde, Denmark.
Telephone +45 4677 4004, Telefax +45 4677 4013