REPUBLIC OF POLAND

FOURTH NATIONAL COMMUNICATION UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

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1. EXECUTIVE SUMMARY

1.1. Introduction

The decision on the ratification by Poland of the United Nations Framework Convention on Climate Change[1)], and later of the Kyoto Protocol[2)] has been driven by its political will to join the international efforts in activities agreed upon jointly under the Convention to slow down climate change and to take both the individual and international responsibility for the processes leading to that change. Poland has signed the Protocol on 15 July 1998 and ratified it on 13 December 2002 (the Kyoto Protocol entered into force on 16 February 2005).

Since 1 May 2004 Poland has become a member of the European Union (EU-25), creating favourable conditions for further opening of the Polish market (including the labour market) and for developing foreign trade supporting the inflow of capital and modern technology as well as for providing access of public institutions and economic entities (including farmers) to the European Union funds supporting the implementation of EU policies that are important for the economy.

Poland is a moderately developed country, but among the poorest countries within the enlarged European Union: with its gross domestic product per capita, in terms of purchasing power parity, about 50% of the EU-25 average, and at the same time with the lowest in the Community level of employment for working age people (53.7%) and the highest unemployment rate (17.6%).

Poland as a Party to the Kyoto Protocol has made a commitment to reduce its greenhouse gas emissions by **6%** selecting **1988** as the base year for commitments under the UNFCCC and the Kyoto Protocol regarding emissions of the three main gases: carbon dioxide, methane and nitrous oxide, and **1995** as the base year for industrial fluorinated gases: HFCs, PFCs and sulphur hexafluoride.

The results of the inventory of greenhouse gas (GHG) emissions and removals for the period of 1988–2004 presented in this report may change following the emissions recalculations carried out during 2006 in accordance with the methodology given in the *Revised 1996 IPCC[3)] Guidelines*, and in *Good Practice Guidance and Uncertainty Management*. Detailed inventory results of GHG emissions and removals by IPCC sectors for the years 1988–2004 that have been obtained so far are presented in Annex 1.

Political and economic transformation that has taken place since 1990, caused the national GHG emissions to drop much below Poland's target under the Kyoto Protocol. **Over the years 1988–2004, GHG emissions (without sector 5. Land-use change and forestry) decreased by as much as 31.7% below the base year.** This target has been achieved by implementing a package of policies and measures primarily leading to the improvement of energy efficiency and restructuring of fuel consumption.

The inventory results for the base year (1988/1995) have been corrected in relation to the Third National Communication in line with the current IPCC inventory methodology and in accordance with the recommendations of the expert team that reviewed the Polish GHG emission inventory in 2005. Also for the first time, the 1989 GHG emission inventory results are presented here. The 1989 GHG inventory is consistent – from the methodological point of view – with the updated 1988 inventory.

Poland as a country undergoing economic modernisation is likely to face an increase of greenhouse gas emissions. The reason for this is mainly the use-structure of fuels (hard coal and lignite), which makes further emission reduction difficult, by switching to gas or to nuclear energy, which does not yet exist in Poland. Modernisation and restructuring processes taking place in enterprises will always be targeted at energy-saving and environmentally friendly measures. Poland wishes to discount the CO_2 emission reductions obtained so far within the framework of the emission trading scheme.

On 4 November 2003 the Council of Ministers has approved *Poland's Climate Policy – the strategies for greenhouse gas emission reductions in Poland until 2020*, whose strategic goal is "for Poland to join the efforts of the international community

1) United Nations Framework Convention on Climate Change (Dz. U. of 1996 No. 53, item 238).
2) Kyoto Protocol to the United Nations Framework Convention on Climate Change (Dz. U. of 2005 No. 203, item 1684).
3) Intergovernmental Panel on Climate Change (IPCC).

for the protection of the global climate through the implementation of the principles of sustainable development, particularly within the scope of the improvement of energy consumption, expansion of the national forest and soil resources, rationalisation of the use of raw materials and industrial products as well as rationalisation of waste disposal in a manner ensuring the achievement of maximum long-term economic, social and political benefits". This goal is consistent with the objectives of the European Union climate policy in which effective climate protection has been given the highest priority in the strategy for sustainable development.

This report has been prepared in line with Part II of Decision UNFCCC/CP/1999/7. The report presents data[4)] for the period between 2000 and 2004 (in relation to 1995); as regards the inventory and projections of greenhouse gas emissions and removals reference was made to the base year (1988/1995).

1.2. National circumstances with respect to greenhouse gas emissions and removals

The Minister of the Environment is the leading body of the state administration responsible for supervising and coordinating work within the Government of the Republic of Poland in the field of environmental protection, including climate change. He performs his duties supported by his executive administration body – the Ministry of the Environment. In principle, the Minister of the Environment is responsible for: the protection of the overall environment-related issues and the use of natural resources, meteorology, environmental control and monitoring, as well as forestry. Furthermore, the Minister of the Environment supervises the National Fund for Environmental Protection and Water Management and the 'State Forests' National Forest Holding. Control powers lie within the Chief Inspectorate for Environmental Protection, which is subordinated to the Minister of the Environment. Financial support for environmental activities is provided by the National Fund for Environmental Protection and Water Management and the voivodship (province), *powia*t (county) and *gmina* (commune) level funds. The funds' income comes from fees for utilising the environment and from fines imposed and executed for exceeding the permissible emission standards or for environmental contamination (environmental fees and fines). These financial resources are in return used for financing environment-friendly activities, including air protection, climate protection, environmental education and other fields.

From the point of view of the most important natural resources for social and economic development, Poland is a country with relatively large forest, biodiversity, landscape and mineral resources (including fossil energy fuels), but with rather poor water resources (its resources are four times smaller than the world's average).

Poland lies within moderate geographical latitudes of Central Europe, at the southern coast of the Baltic Sea. Poland's territory amounts to 312,685 km^2. By the end of 2005 the population of Poland reached 38.2 million. With respect to the population number Poland currently ranks 30th among all the countries in the world and 9th in Europe.

The forest cover index for Poland has a slightly lower level than the European average (totalling app. 31%). However, the relatively large forest area (over 8.8 million ha) is accompanied by qualitative deficiencies – poor composition of tree species over large forestland parts (large areas of Poland covered with coniferous monocultures, especially pine trees), as well as young age and unsatisfactory condition of a significant part of treestands. Zones of weak, moderate and severe damages connected primarily with the impact of air pollutants emitted by the industry cover 58.7% of the total forest area.

The most important usable mineral deposits found in Poland include: hard coal and brown coal (lignite), crude oil and natural gas, copper ores, zinc and lead ores, sulphur, stone salt and rock resources. There are also medical and geothermal groundwater resources. Poland also has considerable accessible renewable energy resources, mainly from biomass and wind power. High variability of climate and weather conditions causes smaller potential possibilities for using solar energy, whilst the deep location of underground geothermal water deposits affects the use of this source of energy. As for waters, their limited resources and small natural land gradients found over the majority of the country do not allow for increasing their use as hydropower.

The latitude parallel configuration of land relief with the growing altitude from the Baltic Sea basin towards the south constitutes an important factor for the development of climate conditions in Poland, allowing for unrestrained parallel exchange of air streams. In effect, the Polish climate has a typical transient nature, affected by both marine and continental climatic features, depending on the current location and activity of atmospheric pressure configurations over Europe. This causes considerable variability of climate conditions in different years, as well as weather variability in shorter periods.

Foreign trade was an important factor of economic development in 2005 – the export growth for the sixth time in turn has markedly overruled the import growth. Following a significant weakening of the dynamics of economic growth between 2001 and 2002, the year 2003 and especially 2004 have brought considerable improvement of the economic situation. In 2004 the GDP growth totalled 5.3% and was highest over the last seven years. In 2005 the economic growth rate has

4) Certain tables and figures may not sum up to 100% due to rounding.

declined to 3.2%. Nevertheless, the GDP per capita level, in terms of purchasing power parity, has reached half the value of EU-25 average.

Despite significant progress in the improvement of energy efficiency in the Polish economy, Poland still has a high potential in this field. Considering an annual growth of GDP by app. 5% and expected energy demand increase by app. 80% in the perspective of 2025, Poland is likely to achieve further reduction of GDP energy intensity to app. 50% of the present level. This would significantly bring Poland closer to the standards of energy intensity achieved in highly developed countries.

Changes in the structure of final energy consumption in major economy sectors reflect the directions of economic development. The restructuring of industry and measures taken by enterprises that are targeted at energy intensity reduction caused a decrease in energy consumption in these sectors. Constant development of road transport and of the services sector causes a continuing growth of those sectors' share in domestic energy consumption. In the household sector due to a system of thermal insulations that was introduced, and an improvement in the efficiency of heating systems the energy use has reduced in 1995–2004, although this sector still remains most energy consuming from among all sectors of the economy.

Year 2005 was the second in turn in which the role of investment as a factor of developing the growth of GDP has increased, however despite increased gross expenditures on fixed assets (by 6.2% as compared to the 2004 level) the investment rate in the national economy has only reached 18.3% in relation to 23.7% in 2000. Companies with foreign capital are becoming a more significant element of the Polish economy. Transfer of foreign capital in the form of direct investment supports the growth of development-favouring activities. The annual inflation rate (from December 2005 to December 2004) totalled 0.7% against 4.4% in 2004.

There are still a number of state-owned enterprises in the Polish economy that have not accomplished their restructuring processes in the mining industry, metallurgy, energy sector, heavy chemical industry or in shipbuilding industry. The private sector is developing rapidly, not only with large private companies that have been privatised from the former state-owned enterprises, but also the ones that are newly developed.

Despite growing labour demand and high labour supply Poland still has a high unemployment rate, although its level has declined as compared to the recent years. At the end of 2005 there were almost 2.8 million unemployed persons and the unemployment rate dropped to 17.6% from 19% at the end of 2004. Nevertheless, it was the highest rate among the EU-25. By the end of 2005 the unemployment rate of young people (under 24 years of age) was 34.6%. People with the lowest qualifications are mostly affected by long-term unemployment and they constitute the largest group of the unemployed persons. A positive phenomenon is a constant rise in the educational level of Poles.

The health condition of the Polish citizens is systematically improving. The number of deaths per thousand people has declined from 10.2 in 1990 to 9.6 in 2005, including infants as much as from 19.3 to 6.4, respectively. In effect, the average expected lifetime duration has increased over the last 15 years by 4.2 years for men, and by 3.7 years for women.

A significant progress has been achieved in environmental protection over the last dozen years or so. The negative pressure of the economy on the environment has declined by reducing the energy intensity and material intensity of production processes, introducing changes in the system of financing environmental activity, and adjusting protective standards to those of the European Union. The state of the environment, currently, does not differ to a significant degree from the one observed in the developed countries. A positive effect is the constant growth of the protected areas in our country – between 1990 and 2004 this area has grown 1.7 times. At the same time, by becoming the EU member, Poland began to develop the European Natura 2000 network of protected areas, which covers a significant part of the area already under protection.

1.3. Information related to greenhouse gas inventory

Each year, Poland submits detailed inventories of GHG emissions and removals to the Climate Convention Secretariat in Bonn. Since 2002, GHG inventory results have been submitted in the form of CRF (Common Reporting Format) – spreadsheet files. National GHG inventories are subject to periodic reviews carried out by expert review teams (ERT) designated by the UNFCCC Secretariat.

Poland being a Party to the Kyoto Protocol made a commitment to reduce its GHG emissions by **6%** and selected year **1988** as the base year for the three main GHG gases: carbon dioxide, methane and nitrous oxide, and the year **1995** for fluorinated gases: HFCs, PFCs and sulphur hexafluoride, for its commitments under UNFCCC and its Kyoto Protocol.

The inventory results of GHG emissions and removals for the period 1988–2004, presented in this report, may be subject of change following emissions recalculations carried out during 2006 in accordance with the methodologies given in the *Revised 1996 IPCC Guidelines* and in *Good Practice Guidance and Uncertainty Management*. Detailed inventory results of GHG emissions and removals by IPCC sectors for the years 1988–2004 that have been obtained so far are presented in Annex 1.

Greenhouse gas inventory results show that over the period 1988–2004 emissions decreased significantly (excluding sector 5. *Land use, land-use change and forestry*) reaching the level as much as 31.7% below the base year. The reduction of

GHG emissions has been caused primarily by the decreases of emissions of: carbon dioxide, methane and nitrous oxide that dropped by 33.6%, 23.7% and 25.7%, respectively. The decreasing trend had continued until the year 2002, after which GHG emissions began to grow by 3.3% in 2003 and by further 1.5% in 2004.

Total GHG emissions in 2004 were dominated by carbon dioxide, which accounted for 81.52% of the total. Methane emissions contributed 10.1% to the total, while the share of nitrous oxide was 7.7% and F-gases accounted for 0.7% of the aggregated 2004 GHG emission total.

The results for the base year (1988/1995) have been corrected in relation to the Third National Communication to follow the current IPCC inventory methodologies and to apply recommendations of the expert team (ERT) that reviewed the Polish GHG emission inventory in 2005. Also for the first time, the 1989 GHG emission inventory results are presented here, which is consistent – from the methodological point of view – with the updated 1988 inventory.

1.4. Policies and measures

The national GHG emission reduction target pursuant to Annex B to the Kyoto Protocol (6% in the period 2008–2012) is going to be met by Poland.

Some of the reduction commitments with respect to CO_2 are allocated – within the emission allowance trading mechanism – among installations in main sectors of the economy according to the National Allocation Plan – NAP (KPRU). The comprehensive GHG emission reduction measures include:

- a system of emission allowance trading,
- the use of the Joint Implementation mechanism,
- the monitoring of emissions and implementation of the Kyoto Protocol (GHG emission monitoring is carried out on a current basis and the results are reported in National Inventory Reports, while implementation of the Kyoto Protocol is presented in National Communications to the Conference of the Parties),
- financial mechanisms that support measures related to GHG emission reduction (financial mechanisms that stimulate emission reduction are introduced by the National Fund for Environmental Protection and Water Management (NFOŚiGW), EkoFund and Global Environment Facility (GEF), to support measures, inter alia connected with energy efficiency improvement).

Poland's energy policy is based upon the following principles: harmonized energy management under social market economy, full integration of the Polish power sector with the European and world energy market, market competitiveness and support to renewable energy sources. This policy formulates priorities and directions of measures such as: monitoring of the level of energy security, cost reductions in power sector and improvement of energy efficiency as well as strengthening the position of self-governing administration towards enterprises in the power sector.

The reserves of GHG emission reductions in the transport sector lie within broadly understood improvement of organisation of passenger and freight transport and related infrastructural measures, and also in increased use of biofuels.

The ultimate goal of the forest policy formulated in the document entitled the *National Forest Policy*, adopted by the Council of Ministers in April 1997, is to specify measures aimed at maintaining sustained multi-functional role of forests, their usefulness and protection and their role in shaping the environment. This goal is to be achieved by increasing the forest cover nationally to 30% in 2020 and 33% in the mid 21st century, reinstatement and rehabilitation of forest ecosystems and regeneration of devastated forest stands in private forests. Implementation of these measures should result in increased removal and capture of carbon dioxide.

The aim of waste management is to prevent waste generation "at source", to recover raw materials, to recycle waste and to ensure environmentally safe final disposal of unused waste. The necessary condition to fulfill the aim is to reduce material and energy intensity of production, and to increase the use of alternative renewable energy sources, and to trace product "life-cycle".

The main measures in individual sectors include:

1. In the energy sector:
   - promotion of renewable energy sources,
   - introduction of financial mechanisms that support energy production from renewable sources,
   - promotion of combined heat and power generation,
   - modernisation of existing technologies in energy production and improvement of energy transformation efficiency.
2. In industry:
   - improvement of technical standards for appliances and equipment,
   - implementation of best available techniques – integrated permits are granted to installations that implement BAT/BEP[5)],
   - reduction of methane emissions from production and distribution of fuels,
   - development of means to support small and medium-sized enterprises, mainly in implementing innovations and for the improvement of effectiveness,

[5)] The requirement to obtain such permits derives from the Polish law and Council Directive 96/61/EC of 24 September 1996 on integrated pollution prevention and control (OJ L 257 of 10.10.1996, p. 26, as amended; OJ Polish special edition, Chapter 15, vol. 3, p. 80).

- promotion of environment-friendly and effective practices and technologies in industrial activity,
- support for the development of environment-friendly, technically feasible and cost-effective methods of GHG emission reductions.

3. In transport:
   - promotion and use of biofuels,
   - promotion of "ecologically clean" vehicles,
   - construction of motorways, ring-roads and express roads,
   - introduction of more stringent emission standards for motor vehicles,
   - promotion of public transport,
   - improvement of the quality of water transport,
   - measures for reducing GHG emissions from air transport.
4. In construction and housing:
   - implementation of energy standards in the construction sector,
   - thermo-modernisation of buildings,
   - increasing awareness of building owners and users with respect to energy saving.
5. In agriculture:
   - rational use of fertilizers, including nitrogenous fertilisers,
   - efficient use of energy in agriculture, including energy production from biomass waste, slurry and manure,
   - support for the use of other renewable energy sources in production processes,
   - reduction of the demand for solid fuels, coal, coke,
   - technical modernisation of farms,
   - improvement of animal breeding systems, methane reduction from animal manure, the use of techniques to capture methane from litter-free rearing of cattle and other ruminants,
   - preferences to plant production with a high CO_2 removal factor,
   - development of new cultivation and harvesting techniques for plant biomass intended for use as renewable energy source and input material for the industry.
6. In forestry:
   - counteracting land use change,
   - improvement of forest management,
   - incentives for and measures supporting afforestation,
   - protection of environmental stability of forests,
   - use of wood for energy purposes.
7. In waste management:
   - recovery and recycling of waste, waste segregation prior to disposal at landfills,
   - modernisation of solid waste disposal at landfills,
   - minimization of waste generation,
   - waste reduction at source,
   - use of landfill gas and biogas for energy generation,
   - implementation of wastewater biological treatment processes based on BAT.

1.5. Projections of greenhouse gas emissions and the overall effects of policies and measures

Following the guidelines of the Climate Convention, two national projection scenarios were developed for GHG emissions: "with measures" scenario and "without measures" scenario for the years: 2005, 2010, 2015 and 2020. The key scenario is the "with measures" scenario in which currently implemented policies and measures were accounted for. Both scenarios were elaborated in accordance with the requirements for national GHG inventories in line with the methodologies presented in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, and in *Good Practice Guidance and Uncertainty Management*.

Macroeconomic assumptions used in the "with measures" scenario expect the annual averaged GDP growth to be 5.1% during 2005–2010, 5.2% in 2011–2015 and 4.8% during 2016–2020. According to demographic projections, Poland's population will continue to decline in the projected period. In 2005–2020, according to energy forecasts, we may expect steady improvement of the energy efficiency in all sectors of economy, and also a significant increase in the use of natural gas and renewables for electric energy production. The demand for electric energy is expected to grow steadily.

The report includes detailed data on greenhouse gas emissions in the base year and years covered by the projections. In both scenarios GHG emissions are expected to grow in 2005–2020, whereas the growth is to be higher in the case of the "without measures" scenario. However, the projected emission for 2020 for both scenarios does not exceed the base year level. The projected emission increase would mainly be caused by the increasing demand for energy resulting in emission growth in sector 1. *Energy.*

Emissions of GHG have reduced in Poland due to the implementation of policies that are described in the report. The most effective policies and measures include: increased share of biomass in fuel balances, fuel conversion, increased share of cogeneration, use of biogas from landfills and processing of sewage sludge and implementation of best available techniques as well as energy-saving and material-efficient technologies.

The national GHG emission reduction target is going to be met by Poland in the first commitment period of 2008–2012 without applying additional measures. Therefore, it is not justified to adopt and implement such measures both from the economic point of view and from the point of view of meeting the Kyoto Protocol targets.

A flexible mechanism in the form of emission allowance trading scheme, pursuant to Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Directive 96/61/WE[6] has been transposed into Polish law in Act of 22 December 2004 on emission allowance trading for greenhouse gases and other substances[7]. Pursuant to the decision of the European Commission of 8 March 2005, after introducing appropriate changes to the *National Allocation Plan for CO_2 Emission Allowances for the Years 2005–2007* (KPRU I), Poland has been incorporated in the Community emission trading scheme. Pursuant to the provisions of Directive 2003/87/EC, by 30 June 2006 each Member State should have submitted to the European Commission for acceptance its *National Allocation Plan for CO_2 Emission Allowances for 2008–2012*. Such a plan (KPRU II) has been submitted by Poland to the European Commission on 30 June 2006. The Polish NAP (KPRU II) was prepared on the basis of sectoral development strategies elaborated by industry associations representing economic entities covered by the system.

Poland does not take part in the implementation of the Clean Development Mechanism (CDM), but participates actively in the implementation of Joint Implementation (JI) mechanism by undertaking – on the Polish territory – jointly with other countries from Annex I to the United Nations Framework Convention on Climate Change, measures that reduce emissions of greenhouse gases. The common will to jointly undertake activities targeted at the Convention's goal through the mechanism of Joint Implementation was expressed by signing agreements and MoU (Memorandum of Understanding) by the Governments of Finland, Canada, Denmark, the Baltic States and the International Bank for Reconstruction and Development (Prototype Carbon Fund). Poland also participates actively in international programmes and funds dealing with the realisation of Joint Implementation projects, like e.g. the Dutch ERUPT programme. Several projects have been described in this report that were carried out during the pilot phase of the mechanism of the Kyoto Protocol (under its Art. 6) – Activities Implemented Jointly (AIJ), as well as under the mechanism of Joint Implementation. Moreover, there are a number of potential Joint Implementation projects in various stages of preparation, beginning with those in initial phase, and ending with those in advanced phase, which are awaiting final approval. A new act is being drafted which will regulate matters concerning Joint Implementation projects in Poland, providing the legal basis for project approvals and for project implementation by the entities.

The major obstacles in the implementation of *Poland's Climate Policy* include:
- coal-based use structure of primary fuels, conditioned historically through availability of domestic resources and accompanying social circumstances,
- still relatively low energy efficiency of the economy,
- dynamic development of road transport.

1.6. Financial assistance and technology transfer under Art. 4.3, 4.4 and 4.5 of the Climate Convention

Poland as a Party not listed in Annex II to the Convention does not have a duty to fulfil the obligations under Articles 4.3, 4.4 and 4.5 of the Climate Convention. However, by understanding the need for supporting sustainable development in the developing countries and in those with economies in transition, provides such assistance to the extent possible.

The Polish development assistance undergoes constant increase, for instance, in 2004 Poland provided 137.3 million USD to support the development of the developing countries and of those in transition (mainly the developing countries). Additionally, over 20 million USD were transferred primarily to countries in transition. Poland also provides funds for promoting technology development.

1.7. Research and systematic observation

Polish scientific research studies in the field of climatology cover a wide range of topics among which the following can be distinguished:
- physical climatology,
- topoclimatology (climatology of urban areas, in particular),
- dynamic climatology,
- regional climatology, applied climatology and climate change survey.

The following major issues may be identified in climate change research:
- historical research on climate change, modelling of climatic processes, and the development of scenarios for predicted climate change,
- climate change impacts on the natural environment, on the economy and the public,
- impact of human activity on climate,

and
- social and political aspects of climate change.

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[6] OJ L 275 of 25.10.2003, p. 32; OJ EU Polish special edition, Chapter.15, vol. 7, p.631.
[7] Dz.U. of 2004 No. 281, item 2784.

The *National Framework Programme* in which the environment is among one of its priorities in scientific research has been adopted in 2005. A research theme entitled *The economy as a climate change factor* has been launched under this Programme. Its aim is to define the ways of reducing greenhouse gas emissions in Poland and to increase their capture, reduce the use of non-renewable energy sources in favour of the renewables, as well as to combat the negative consequences of emissions of these gases to the economy and nature.

Around 80 research projects on climate change and on the process of global warming have been carried out between 1994 and 2004. They included both projects of European importance and those considered important at national and local levels, e.g.:

– assessment of climate changes in the 20th century,
– adaptation of living organisms and crops to climate change,
– applied research on the impacts of climate conditions on economic and technical activity,
– extreme meteorological and hydrological events in Poland.

Furthermore, scientists from various Polish research centres participated in numerous projects on climate changes and their specific consequences, which were funded with the use of foreign resources, mainly from the European Union.

1.8. Education, training and public awareness

Environmental education raises public awareness and awakens public interest in cross-cutting environmental, economic, social and political issues. It allows for every man to obtain knowledge and capabilities essential for environmental improvement, and creates new behavioral patterns, develops proper attitudes, approaches, values and opinions of the individuals and of social groups taking account of the concern for environmental quality. Environmental education covers the entire public, all age and occupational groups, as well as high-level governmental administration at central and local levels in the process carried out by both the institutional entities specially designated for that purpose and also by non-governmental environmental organisations and the media.

Environmental education in Poland is conducted by a number of institutions, among which is the Ministry of National Education. The Ministry of the Environment is involved in environmental awareness raising of the Poles by organising various competitions, exhibitions, conferences, as well as other information and educational events.

A significant role in the process of developing environmental attitudes is played by mass media. The Minister of the Environment is cooperating with them to disseminate updated and reliable information on environmental protection and water management. The Minister also organises press conferences on climate change as well as seminars for journalists dedicated to this issue. This theme is also present in radio broadcasts commissioned by the Minister of the Environment and financed by the National Fund for Environmental Protection and Water Management.

The Ministry of the Environment publishes an information bulletin on *Climate change*, which contains a broad package of information, inter alia, on greenhouse gas emission trends, research projects, undertakings for preventing and adapting to future climate change, and on domestic and international measures that are taken.

2. NATIONAL CIRCUMSTANCES WITH RESPECT TO GREENHOUSE GAS EMISSIONS AND REMOVALS

2.1. Institutional arrangements

The Republic of Poland is a constitutional republic ruled upon a mixed parliamentary and presidential system of power and with a classical power system broken into three subsystems (encompassing legislative, executive and judicial powers).

Legislative power is exercised by a two-chambered Parliament composed of the Sejm (Chamber of Deputies) and the Senate (Chamber of Senators). Both Chambers of Parliament sitting in joint session act as the National Assembly. The Deputies, the Senate, the President and the Council of Ministers, as well as citizen groups of at least 100 thousand persons having the right to vote, are entitled to legislative initiative.

The executive power belongs to the President of the Republic of Poland and to the Council of Ministers.

The Government performs its duties through government administration organs and units:

- at the national level – the ministries and central offices, as well as foreign services;
- at the regional level:
  - the voivodes (representatives of the Government in 16 voivodships); the voivodship offices subordinated to voivodes, and territorial units of governmental combined administration (inter alia, police and fire services, inspectorates for environmental protection and for plant protection), territorial units of governmental non-combined administration subordinated to ministers and heads of central offices (inter alia, duty offices, statistical offices etc.).

Judicial power is exercised in Poland by courts and tribunals:

- the Supreme Court, the Constitutional Tribunal and the Tribunal of State;
- the common courts (district, voivodship and appeal courts);
- the administrative courts (voivodship administrative courts, the Chief Administrative Court);
- the military courts (garrison courts and regional courts).

The Supreme Court exercises supervision over both common courts and the administrative and military courts regarding judgements.

The Constitutional Tribunal is a fully independent judicial body enacted to settle disputes concerning constitutional compliance of activities undertaken by public authorities.

The Tribunal of State is a judicial body, which settles disputes concerning constitutional responsibilities of individuals exercising supreme state duties, i.e. the President of the Republic of Poland, members of the Government, the President of the Supreme Chamber of Control, the President of the National Bank of Poland, the chiefs of central administration bodies and state senior officials.

Poland has a three-level territorial division, which consists of self-governmental units – communes (*gminas*) and counties (*poviats*), and governmental and self-governmental units – voivodships (provinces). By the end of 2004 there were 16 voivodships, 314 *poviats* and 65 cities with *poviat* status and 2,478 *gminas* in Poland.

The major burden related to the implementation of, inter alia, the Climate Convention and the Kyoto Protocol lies within the Minister of the Environment (issuing regulations concerning emissions trading and coordination of measures related to the protection of the environment, including climate protection are among his tasks).

A number of ministerial research and development institutes are engaged by the Minister of the Environment for undertaking tasks related to the implementation of the Convention and the Kyoto Protocol by Poland. The following are among the main ones:

- the Institute of Environmental Protection (IOŚ) – with its Secretariat for administrative and technical tasks in the field of the Climate Convention and the Kyoto Protocol, as well as the National Administrator of Emission Trading Scheme (playing a role of the national coordinator for the Community GHG emissions trading scheme), including the National Emission Centre, NEC (KCIE),
- the Institute for Forestry Research (IBL) – involved in issues connected with carbon dioxide removal in the field of land use, land-use change and forestry (LULUCF),
- the Institute of Meteorology and Water Management (IMGW) – inter alia, responsible for climate change systematic observation. The National Focal Point for the Intergovernmental Panel on Climate Change is operating within the structure of IMGW.

The Minister of the Environment has supervisory powers over the Chief Inspectorate for Environmental Protection. The regional level Voivodship Inspectorates for Environmental Protection are subordinated to voivodes (voivodeship heads) within the governmental combined administration. The Chief Inspector for Environmental Protection coordinates the activity of the national and regional networks of the State Environmental Monitoring (PMŚ) system to monitor the state of the environment, which includes a measurement and observation network of the Institute of Meteorology and Water Management, and measurement networks of the Institute of Environmental Protection, of the Institute for Forestry Research and of the Polish Geological Institute as well as the voivodship laboratories of the National Inspection for Environmental Protection and inspectors.

Activities leading to the implementation of the Climate Convention are carried out not only by the Minister of the Environment, but also by other leading central bodies of governmental administration (responsible for energy, transport, agriculture, industry, construction and forestry). The central level competences regarding the Climate Convention are within the following Ministers: the Minister of Economy – responsible for the energy and industry sectors, for preparing the energy policy, energy legislation, regulations concerning energy efficiency etc., for the policy for industry restructuring, including hard coal sector, for incorporating appropriate elements of the sustainable development strategy, the state environmental policy and Poland's climate policy into the sectoral policy; the Minister of Transport – responsible for the development of the transport sector, including the transport policy and the implementation of elements of the state environmental and climate policies; the Minister of Construction – responsible for the development of the construction sector; the Minister of Agriculture and Rural Development – responsible for the implementation of the governmental policy in the field of agriculture, including sustainable agricultural development and the implementation of elements of the state environmental and climate policies.

The Central Statistical Office (GUS) maintains, collects and provides access to survey results gathered under public statistics. Data on environmental protection have been disseminated since 1972 in the form of statistical yearbooks published annually under the GUS *Environmental protection* series. The state statistics include aggregated data on emissions of greenhouse gases and other air pollutants, the statistics on energy, fuel production and consumption, and many other statistical data relevant to the Climate Convention, as well as data on production, import and export of ozone layer depleting substances.

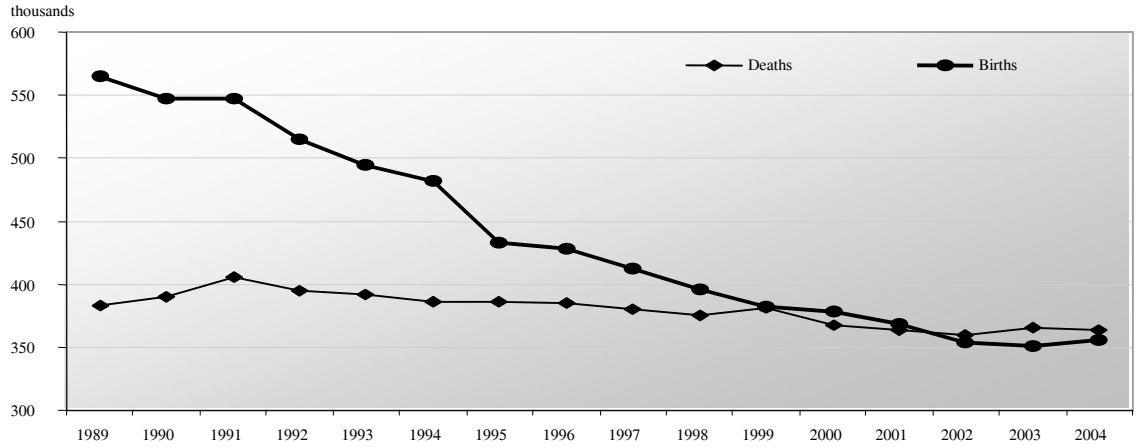
Financial support for environmental activities is provided by the National Fund for Environmental Protection and Water Management – NFOŚiGW (supervised by the Minister of the Environment) and the voivodship, *povia*t and *gmina*- level funds. The funds' income comes from fees for utilising the environment and from fines imposed and executed for exceeding the permissible emission standards or for environmental contamination (environmental fees and fines). These financial resources are in return used for financing environmentally friendly activities, including air protection, climate protection, environmental education and other fields.

2.2. Population profile

After the post-war demographic explosion, since the mid 1980s the population growth rate has been successively declining in Poland, mainly due to dramatic fall of the birth rate and as a result of emigration.

A significant fall in the number of births, together with a rather stable number of deaths are the most important causes for the reduction of Polish population (38.2 million by the end of 2005). The long-term demographic prognosis for Poland until 2030 predicts that the present trends in the changes of population numbers are to be further observed, mainly due to the declining fertility rate, which has been continuing for more than a decade now.

Figure 1. The vital statistics of the population of Poland in 1989–2004



Source: Central Statistical Office (GUS).

Table 1. Average life expectancy in Poland for people born in 1995–2004

Year	1995	2000	2001	2002	2003	2004
Average life expectancy (in years)	72.1	73.8	74.2	74.6	74.7	74.9

Source: GUS.

In effect, despite projected further decline in the death rate and systematic increase of the average life duration (which in 2030 should amount to 77.6 years for men and 80 for women) the population of Poland should decrease by two and a half million people by 2030, finally reaching the number of 35,600 thousand. Population losses would mainly take place in urban areas, mainly due to lower fertility rates than in the rural areas, but also due to a new phenomenon – the lately observed migration of part of the urban population to rural areas at the outskirts of towns.

Since the 1990s the share of the urban population in the total number of people in Poland has been quite stable (over 61.5%). The most urbanised areas are: the Silesian Voivodship (79.6%) and the Lower-Silesian Voivodship (71,6%). In 2004 there were 886 towns and cities in Poland, including 18 cities with over 200 thousand inhabitants each. Warsaw – the capital and the largest city of Poland – is inhabited by 1.691 million people.

The average population density is 122 persons per 1 km^2, but in the most densely inhabited area of the Silesian Voivodship it reaches 381 persons per 1 km^2, whereas in the most sparsely populated north-eastern voivodships (Warmińsko-Mazurskie and Podlaskie) it amounts to 59–61 persons per 1 km^2.

Some summarising data showing trends in the changes of population figures in Poland are presented in Table 2.

Table 2. Selected demographic indices for Poland for 1950–2004

Years	Population		Natural growth rate of population [%]	Population in urban areas [%]
	Total [thousand]	Persons per km^2		
1950	25035	80	19.1	36.9
1960	29795	95	15.0	48.3
1970	32658	104	8.5	52.3
1980	35735	114	9.6	58.7
1988	37885	121	5.7	61.2
1990	38183	122	4.1	61.8
1995	38620	124	4.7	61.1
2000	38256	122	0.3	61.9
2001	38242	122	0.1	61.8
2002	38218	122	-0.1	61.7
2003	38191	122	-0.4	61.6
2004	38174	122	-0.2	61.5

Source: GUS.

2.3. Geographic profile

Poland is situated in Central Europe under moderate geographical latitudes of the Northern Hemisphere (49º00'–54º50' N) and covers an area spreading from the southern coastline of the Baltic Sea – in the north, to the mountain chains of the Sudety Mountains and North Western Carpathians - in the south.

The Polish Baltic Sea coastline is fairly even. The very coastline zone is mainly flat accumulation-type land (sand-bars, coastal lakes, beaches). The dominant sea landscapes include: lowland delta-type, marshy-lake-like type and moraine plains. From place to place the sand-bars with sand dune ridges separate some dozen shallow coastal lakes from the sea. There are only a few places with sea steeps and retreating cliffs, reaching the height from a few to around 20 metres (or even more) above the sea level. The greatest curve of the coastline is formed by the Pomorska Bay with the Szczeciński Bay, in the west, and the Gdańska Bay with the Vistula River Bay, in the east. The Vistula River with its well-shaped delta, the so-called Żuławy Wiślane (Vistula Marshland), with its lowest land level of 1.8 metres below sea level, flows into the Gdańska Bay. This area constitutes one of the most vulnerable places to changes of the sea level in Poland. The country's maritime boundary amounts to 528 km. The area of the territory of Poland, with the internal marine waters covering the Vistula River Bay and the Szczeciński Bay as well as ports, amounts to 312,685 km^2.

The terrain shows a latitude parallel configuration: starting from the coastal lowlands spreading in the north of Poland along the southern coastline of the Baltic Sea, through the hilly lake district, a wide belt of central lowlands, up to the highlands and mountains located in the south (the Sudety and Carpathian Mountains form the southern boundary of Poland).

Lowlands are the dominating type of landscape – 54% of the country's area lies below 150 metres above sea level and almost 37% at the altitude of 150–300 metres. Highland and mountain areas (above 300 metres above sea level) occupy almost 8% of the national territory, including only 0.1% covered by high mountains. Two major Polish rivers crossing the country originate from the mountain areas in the south: the Vistula River (1,047 km) originating from the Carpathians and the Odra River (854 km) running from the Sudety Mountains.

The land relief contributes to the economic use of the territory of Poland (Table 3) – the percentage of wasteland including also natural wasteland, such as seashore sand dunes and naked rocks in the higher parts of the mountains, is very low (1.6%).

Agricultural land and forests are the most dominating forms of land use in Poland, accounting for almost 61% and close to 30% of the country's area, respectively. Arable land predominates among agricultural land (covering almost 45% of the national territory) as well as permanent grasslands (app. 13%) consisting of meadows and permanent pastures. The area of agricultural land is systematically declining, mainly being substituted by forests, wooded land and residential areas.

Table 3. Total area of Poland by type of land-use in 2000–2004 and in 1990 (documented geodetic data)

Type of land-use	Area in different years											
	1990		2000		2001		2002*		2003*		2004*	
	[1000 ha]	[%]	[1000 ha]	[%]	[1000 ha]	[%]	[1000 ha]	[%]	[1000 ha]	[%]	[1000 ha]	[%]
Agricultural land	18784	60.1	18537	59.3	18504	59.2	19162	61.3	19241	61.5	19207	61.4
Forests and tree-land[1)]	8884	28.4	9094	29.1	9122	29.2	9147	29.3	9214	29.5	9264	29.7
Waters	826	2.6	833	2.7	834	2.7	640	2.0	647	2.0	646	2.1
Mineral deposits (mining)	42	0.1	38	0.1	38	0.1	37	0.1	36	0.1	35	0.1
Transport areas	989	3.2	959	3.1	954	3.0	939	3.0	933	3.0	915	2.9
Residential areas[2)]	952	3.1	1050	3.3	1061	3.4	547	1.7	489	1.6	508	1.6
Wasteland	504	1.6	499	1.6	499	1.6	495	1.6	489	1.6	499	1.6
Others	288	0.9	259	0.8	257	0.8	302	1.0	220	0.7	195	0.6

1) Forest land, woodland, scrubland.

2) Housing and industrial areas, and other built-up areas, urbanised non-built-up areas, recreational and leisure areas.

* Significant alterations, which took place in 2002, 2003 and 2004 in the area of agricultural land as well as waters and residential areas, resulting, inter alia, in "statistical" reversing the trends in area changes so far in place, are connected with the new rules, that are mandatory since 2002, for record-keeping and with the updated ground and building records, as well as with amendments to the Act on agricultural taxes and the Act on local charges and taxes, which have been in force since 2003.

Source: Head Office of Geodesy and Cartography (GUGiK).

Large forestland areas and the predominance of agricultural land in the land-use structure linked with a prevalence of moderately intensive management practices in agriculture, are all in favour of a high level of biological and landscape diversity in Poland. Besides wildlife species, also the old, local species of crops and farm animals that are still present in Poland, contribute to this high level of biodiversity.

Mineral deposits that are found in Poland include hard coal and brown coal (lignite), crude oil and natural gas, copper ores, zinc and lead ores, sulphur, stone salt and rock resources. Poland also has medical and geothermal groundwater deposits. Balance stocks of the major minerals have been estimated as follows (as of 31 December 2004[8)]):

- hard coal – app. 43 billion tonnes (of which app. 16 billion tonnes - in managed deposits),
- lignite – app. 14 billion tonnes (of which app. 2 billion tonnes - in managed deposits),
- natural gas – app. 154 billion m^3 (of which app. 128 billion m^3 - in managed deposits),
- crude oil – app. 20 million tonnes (of which app. 18 million tonnes - in managed deposits),
- copper ore – app. 2 billion tonnes (of which app. 1.4 billion tonnes - in managed deposits),
- zinc and lead ores – app. 174 million tonnes (of which app. 35 million tonnes - in managed deposits),
- sulphur – app. 469 million tonnes (of which app. 38 million tonnes - in managed deposits),
- rock salt – app. 80 billion tonnes (of which app. 11 billion tonnes - in managed deposits),
- rock resources – app. 53 billion tonnes (of which app. 16 billion tonnes - in managed deposits).

Poland has also considerable, technically and economically accessible, renewable energy resources, mainly from biomass and wind power. High variability of climate and weather conditions causes smaller potential possibilities for using solar energy, while the deep location of underground geothermal water deposits limits their use as energy source. As for waters, their limited resources and small natural land gradients found in the majority of the country do not allow for increasing their use as hydropower. The total annual technical potential of renewable energy resources from all available sources is estimated in Poland at 1,750 PJ, which constitutes almost half of the total domestic demand for energy and fuel, at its present level.

Water resources in Poland belong to the poorest in Europe – their level reflects the figure of around 1,600 m^3 per capita annually, which is almost three times less than the European average and over four times less than the world's average. This situation is worsened by high seasonal variability and considerable spatial differentiation of water resources – in effect, many regions of the country are threatened with either periodical shortage or surplus of water. The capacity of retention reservoirs is rather small, allowing to retain only as much as 6% of the annual run-off. The reservoirs do not provide adequate protection against drought or flood. Over 83% of water used is abstracted from surface water resources, 15% from groundwater resources, whereas mining waters (from the dewatering of mines) constitute 2% of the water used.

8) Resources' balance of mineral deposits and groundwaters in Poland as of 31 December 2004 – Polish Geological Institute, Warsaw 2005.

Table 4. Water abstraction in Poland intended for the national economy and for the public in 1980–2004

Years	Production purposes (uptake from own abstraction points) [hm^3]	Irrigation in agriculture and forestry as well as filling and refilling of fish ponds [hm^3]	Feeding of the water supply network [hm^3]	Total [hm^3]
1980	10137.6	1323.4	2722.6	14183.6
1988	10116.6	1622.7	3066.1	14805.4
1990	9549.4	1693.7	3004.6	14247.7
1995	8431.6	1176.8	2457.1	12065.5
2000	7637.9	1060.6	2350.1	11048.5
2001	7432.8	1033.3	2217.5	10683.5
2002	7554.8	1108.2	2170.5	10833.5
2003	7875.7	1014.8	2179.4	11069.9
2004	7817.0	1071.5	2101.5	10990.0

Source: GUS.

2.4. Climate

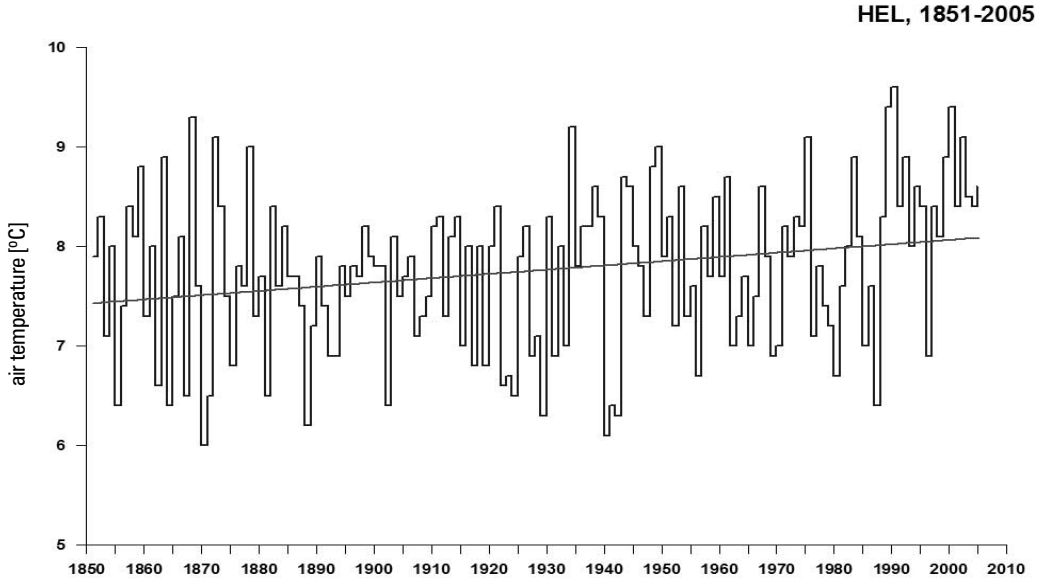
The warming observed in the 20th century in many regions of the world is also confirmed by positive temperature trends (measurements taken over the last 90 years) of annual average air temperatures calculated for the Polish stations located both in the zone of limited anthropogenic impacts and in urban areas. For instance, in the mountain areas, on the Śnieżka Mountain, the temperature rose by 0.6 °C/100 years. At the same time at certain Polish stations located in the south of the country, in the vicinity of towns, the temperature calculated for over a 100-year period grew by: 0.2 °C in Wrocław, 0.4 °C in Cracow, and 0.6 °C in Zakopane. Stations located at the Baltic coast also demonstrated temperature growth in 1901–1990 by 0.5 °C/100 years in Gdańsk-Wrzeszcz and in Hel (Figure 2) and by 0.7 °C/100 years in Koszalin.

Analysis that was performed for the 18 Polish stations, but for a shorter observation period (1954–2000), also shows that it is getting warmer in Poland. An analysis of annual average air temperatures for subsequent decades proved that the 1991–2000 decade showed higher values than the 1981–1990 decade, and this one in turn demonstrated higher levels than in 1971–1980.

Furthermore, 4 out of 10 warmest years had taken place in the last decade, three during the 1980s, and one in each of the decades: the 1970s, 1960s, and 1950s (the latter decade was incomplete). Whereas, among the ten coldest years only one occurred during the 1990 decade, two in each of the decades: the 1980s, 1970s and 1950s, and four in the 1960s. Thus, in the 1990s warm summers occurred more often, whereas the colder ones – rarely.

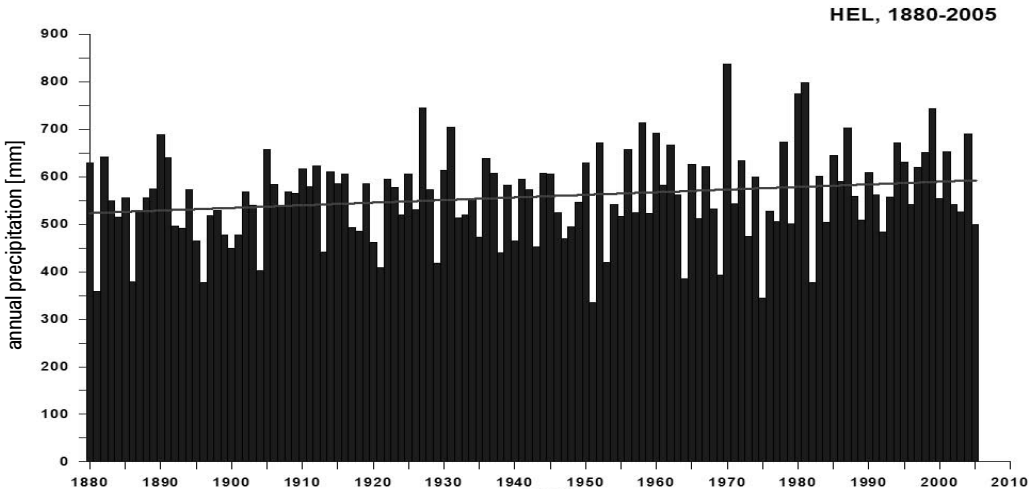
The mean annual air temperature in Poland in the period of 1951–1980 was 7.4°C, whereas over the next ten

Figure 2. Average annual air temperatures at station Hel in 1851–2005



Source: Institute of Meteorology and Water Management (IMGW).

Figure 3. Average annual precipitation sums at station Hel in 1880–2005



Source: IMGW.

years in 1981–1990 its level increased to 7.9°C and in the years 1991–2000 to 8.1°C[9]. In 2002 the mean atmospheric temperature was 9.0°C, and in 2003 and 2004 it was 8.2°C. The maximum temperatures in Poland in 1971–2004 oscillated between 23.6°C and 38.0°C, whilst the minimum temperatures varied from -18.2°C to -35.4°C. The amplitude of the extreme temperatures in this period amounted to 51.9°C at the coast and 70.9°C at the eastern parts of the country.

July is the warmest month with its mean temperatures (for the years 1951–1980) rising towards the south, showing from 16.3°C at the coast to 18.1°C in the south-western low-lands, whilst in the highest mountain parts the average temperature in July does not exceed 9°C. January is usually the coldest month of the year, with its mean monthly temperature dropping towards the east – from -0.1°C at the western coast to -4.2°C at the eastern edges of the country.

The average annual precipitation throughout the country is app. 600 mm with the lowest levels observed in the low-lands of Central Poland (app. 500 mm) and the highest in high mountain areas (app. 1,500 mm), whereas summer precipitation prevails over winter precipitation. Apart from significant geographical variation precipitation in Poland shows considerable fluctuation year after year. The average annual total precipitation sums in the period of 1951–1980 (excluding the mountain stations) amounted to 611 mm. In 2004 the average annual precipitation sum was 639 mm.

Long-term mean annual precipitation sums for the period of 1880–2005 at station Hel are presented in Figure 3.

2.5. Socio-economic development level and economy status

2.5.1. Brief overview

Dynamics of the major development trends

The process of deep socio-economic changes that began in Poland in 1989 has been targeted at an in-depth ownership transformation, the implementation of effective policy against monopoly, liberalisation of prices and adaptation of their structure to the system operating on international markets, the opening of the economy worldwide, making the capital market operational and allowing for foreign investments in the country. All these objectives have been achieved to a different extent and activities targeted at the aforementioned fields are being continued. There are four specific periods that can be distinguished in the development of the Polish economy after 1989:

- 1990–1993, a period of the most intensive introduction of changes adjusting the Polish economy to the requirements of a market economy,
- 1994–1997, during which rapid development of the economy was observed, the gross domestic product (GDP) increased by 6.9% (in 1995), and the situation in the labour market improved successively,
- 1998–2002, during which economic development slowed down (the annual GDP growth dropped from app. 6% to app. 1%), and the unemployment rate grew once again (the number of unemployed exceeded 3 million people and the unemployment rate increased to 18%),
- a period starting from 2003 until now, in which the growth dynamics of GDP exceeded the level of 3% (5.3% in 2004), but the high level of unemployment (19.9% in 2003) and

[9] Data from 30 representative meteorological stations throughout the country (excluding high mountain stations).

the difficult situation of public finances (high budget deficit and public dept) are still maintained.

Gross Domestic Product

The value of the gross domestic product per capita, which has been successively rising at different rates since 1990, is still significantly lower in Poland than in highly developed countries. In 1990 it totalled 4,466 USD, based on purchasing power parity (PPP), in 1995 – 7,442 USD, and in 2004 – 11,524 USD.

The service sector has become increasingly prominent in the generation of GDP. Its share increased from 49% in 1995 to almost 57% in 2004. The second place in the formation structure of GDP belongs to the industry, but its contribution has been slowly declining from 25.8% in 1995 to 22.5% in 2004. A trend of positive changes has been fixed in the industry sector, which is reflected by an increasing role of the processing industry in the generation of GDP and a decrease in the share of capital- and energy-consuming resources sector. The contribution of agriculture and forestry to the generation of GDP has also declined from app. 6% in 1995 to app. 4.5% in 2004. Data of major significance concerning the level, dynamics and structure of GDP in Poland in the period of 2000–2004 and in 1995 are included in Table 5.

Foreign exchange of goods

Since the 1990s the role of export of the electric and machinery industry products, transport sector products, rubber and plastics industry products has been gradually growing, whilst in the case of metallurgy and chemical industry products, mineral products and agricultural products and foodstuffs – it has been showing a declining trend.

Mineral fuels (crude oil and oil-derivatives, and natural gas), passenger cars and car spare parts and accessories, combustion engines, chemicals, plastics, synthetics and rubber products, rolled products, aluminium and aluminium products, telecommunication equipment, pharmaceuticals, as well as computers and computer hardware are among the most important imported products. In foreign trade of goods a surplus of over a dozen or so per cent in the import over export is maintained since 2000, but it is gradually becoming smaller. Selected information on the levels of export and import of goods and services in the period of 2000–2004 and in 1995 is given in Table 6.

Table 5. GDP in Poland in 2000–2004 and in 1995

Specification	1995	2000	2001	2002	2003	2004
GDP [million PLN, current prices]	337222	744622	779205	807859	842120	922157
GDP per capita [PLN, current prices]	8739	19464	20371	21130	22048	24153
GDP dynamics [constant prices, previous year = 100]	105.0	104.2	101.1	101.4	103.8	105.3
GDP structure [%, current prices]						
Total GDP	100.0	100.0	100.0	100.0	100.0	100.0
Taxes from products discounted by donations to products	12.9	12.5	12.3	12.6	13.0	11.5
Gross value added	87.1	87.5	87.7	87.4	87.0	88.5
Agriculture, hunting and forestry	5.6	3.0	3.2	2.7	2.6	4.5
Fishing and fisheries	0.0	0.0	0.0	0.0	0.0	0.0
Industry	25.8	22.1	20.8	21.0	21.3	22.5
Construction	6.2	7.1	6.2	5.8	5.3	4.9
Services	49.5	55.3	57.5	57.9	57.8	56.6

Source: GUS.

Table 6. Export and import of goods and services in Poland in 2000–2004 and in 1995

Specification	1995	2000	2001	2002	2003	2004
Export of goods and services [million PLN, current prices]	78234	201908	210919	231535	280888	346631
Import of goods and services [million PLN, current prices]	70975	249702	239486	259227	302470	364959
Ratio of export value and GDP [%]	23.2	27.1	27.1	28.7	33.4	37.6
Surplus of import over export [%]	-9.3	23.7	13.5	12.0	7.7	5.3

Source: GUS.

Employment and unemployment rate

In the period of 1995–2004 there has been a significant decrease in the number of employed persons in Poland (according to the statistics by almost 3 million people, however a significant part of this drop is connected with the reviewing of data on employment in the agricultural sector on the basis of the results obtained from the National Census for 2002 r.)[10].

Some selected data on employment in Poland in 2000–2004 and in 1995 are presented in Table 7.

Economic transformation caused an increase in the unemployment rate in Poland. In 1995 the average registered unemployment rate (i.e. the ratio of the number of registered unemployed and the number of working age civil population)[11] was 13.1%, while in 2004 it amounted to 19.0%. The unemployment rate is significantly differentiated spatially, which is mainly caused by the uneven level of economic development in different regions and by varied demographic situation. The highest unemployment level is found in the northern and north-eastern regions, which are economically less developed and dominated by agricultural activity. The phasing-out of the state-owned agricultural

Table 7. Employment in Poland in 2000–2004 and in 1995

Specification	1995	2000	2001	2002[1]	2003[1]	2004[1]
Number of employed persons [thousands]	15485.7	15488.8	14995.6	12803.3	12640.7	12720.2
Employed by economy sectors [%]						
Agriculture, hunting and forestry	27.1	27.8	28.6	16.9	16.9	16.8
Fishing	0.0[2]	0.0[2]	0.0[2]	0.0[2]	0.0[2]	0.0[2]
Industry	24.1	20.2	19.8	22.5	22.7	23.0
Construction	5.3	5.3	4.9	5.3	4.9	4.6
Services	43.5	46.7	46.7	55.3	55.5	55.6
Total	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
Specification	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**
Employment rate [%]						
Total	50.7	47.4	45.5	44.1	44.0	44.3
Men	58.5	55.2	52.5	50.7	50.4	51.0
Women	43.7	40.3	39.0	38.1	38.2	38.2
Urban areas	49.3	46.3	44.4	42.7	42.9	43.3
Rural areas	53.1	49.3	47.2	46.4	45.9	46.1

[1] Considerable changes in the number of employed and in the employment structure in 2002, 2003 and 2004 in relation to previous years are connected with the revised number of persons employed in agriculture on the basis of results obtained from the National Census for 2002.

[2] The number of persons employed in fishing is so small that their share is as low as below 0.1% in the total number of employed people.

Source: GUS.

Table 8. Unemployment in Poland in 2000–2004 and in 1995

Specification	1995	2000	2001	2002	2003	2004
Number of unemployed persons [thousands]	2628.8	2702.6	3115.1	3217.0	3175.7	2999.6
Unemployment rate [%]						
Total	13.1	16.0	18.5	19.7	19.6	19.0
Men	12.1	14.2	17.3	19.0	19.0	18.2
Women	14.4	18.1	20.0	20.6	20.4	19.9
Urban areas	13.7	16.9	19.6	21.3	20.8	19.8
Rural areas	12.2	14.3	16.7	17.2	17.8	17.6
Unemployment structure [%]						
Unemployed men	44.9	44.8	47.3	48.8	47.7	52.0
Unemployed women	55.1	55.2	52.7	51.2	52.3	48.0
Unemployed living in urban areas	64.1	66.1	66.0	67.0	65.8	64.7
Unemployed living in rural areas	35.9	33.9	34.0	33.0	34.2	35.3
Unemployed under 24 years of age	34.6	30.5	29.5	27.8	26.0	24.3
Unemployed with education lower than secondary	71.1	70.4	69.2	68.6	67.9	66.2

Source: GUS.

[10] According to data from the 2002 census the number of employed persons in that year, including those working in private farms, was 12 million 803 thousand people, whereas according to the estimates from the 1996 census – 14 million 924 thousand people.

[11] Working age civil population comprises working and unemployed persons not less than 15 years of age excluding those in the army and those employed in the budgetary units of the national defense and public security services.

farms significantly contributed to the generation of unemployment in these areas. The lowest unemployment rate is noted in voivodships with large urban agglomerations of the highest urbanisation level as well as the highest development rate of the industry and services. Problems in the labour market connected with a generally high number of unemployed persons and high average unemployment rate are also accompanied by serious problems deriving from the unemployment structure, such as a high percentage of young people (under 24 years of age) in the total number of unemployed people (24.3% in 2004), a high percentage of unemployed persons constantly without work for longer than a year (35.3% in 2004) and a high share of the unemployed with low educational level (in 2004, 66.2% of the unemployed represented lower than secondary school level education). Selected information on unemployment in Poland in the years 2000–2004 and in 1995 is given in Table 8.

Income level and poverty

The average monthly wages in Poland are increasing following economic restructuring and development, although the relatively high dynamics of this increase, demonstrated in the 1990s, has slowed down recently (Table 9).

Table 9. Average monthly wages in Poland in 2000–2004 (gross values in PLN)

Specification	2000	2001	2002	2003	2004
Wages total	1893.74	2045.11	2097.83	2185.02	2273.44
Public sector wages	2065.62	2233.17	2325.36	2422.57	2553.71
Private sector wages	1760.07	1912.18	1939.91	2023.67	2092.16
Wages in public sector with public ownership	1520.03	1613.80	1623.11	1712.39	1759.32
Wages in private sector with foreign ownership	2728.99	2933.63	3044.46	3079.37	3137.76

Source: "The situation of households in 2003 in terms of household budget results", GUS.

The highest income level was reached by self-employed persons in households (by 53.3% higher compared with the income of the total number of households). The income higher than the average has also been gained by household workers (by 22.1%), by employees working in agricultural farms (by 15.7%) and farmers (by 6.3%). The zone of poverty is enlarging in Poland (Table 10).

Table 10. Poverty zone in Poland in 2000–2004 and in 1995

Poverty limits	1995	2000	2001	2002	2003	2004
	Percentage of persons below the poverty limits					
Relative (50% of average monthly household expenditures)	12.8	17.1	17.0	18.4	20.4	20.3
Statutory	–	13.6	15.0	18.5	18.1	19.2
Minimum of subsistence	–	8.1	9.5	11.1	10.9	11.8

Source: GUS.

Human Development Index (HDI)

The HDI index is a synthetic measure defining the social and economic development level of a given country, which has been developed and used since 1990 under the United Nations Development Programme (UNDP). In 2003 the HDI value for Poland was 0.858. Table 11 shows the HDI values in Poland in the period 1992–2003.

Table 11. HDI values in Poland in 1992–2003

Years	1995	2000	2001	2002	2003
HDI	0.883	0.834	0.840	0.850	0.858

Source: "Human Development Report Poland 2004 – Working out Employment", Warsaw 2004.

The level of HDI higher than 0.81 places Poland among the highly developed countries. In 2003 Poland ranked 36th among the 55 most developed countries. Poland's position in the world development ranking with regard to HDI level is higher than its GDP per capita rating.

2.5.2. Energy sector

The energy sector in Poland encompasses electricity, heat and gaseous fuel supply (liquid fuel supply is included in other sectors, despite the fact that these fuels are taken into account in the total energy balance).

At the end of 2005 the total installed power capacity in power plants was 34.7 thousand MW, which placed Poland at the end of the list of the EU Member States, with regard to the total capacity per 1000 inhabitants. The technical state of the national power transmission network does not pose a risk to the security of electric power supply to the recipients. However, it requires successive modernisation and reconstruction.

The electric power supply sector comprises the following sub-sectors responsible for: energy production (power plants, and combined heat and power – CHP plants), transmission (Polish Power Grid Company – PSE S.A.), and electric power distribution and marketing (14 joint stock companies) and enterprises operating under appropriate authorisation.

As compared with the level in 1999, the installed power has increased thanks to new investments and due to technological modernisation and an increase of turbine power in the existing plants. Modernisation activities carried out in the existing plants also include reduction of coal consumption and adjustment of boilers to enable the use of other types of fuels, as well as measures to install, extend or modernize pollution control systems, inter alia, targeted towards compliance of the Polish power plants and CHP plants with the requirements of the EU Directive on the limitation of emissions of certain pollutants into the air from large combustion plants (Directive 2001/80/EC).

Heat supply covers production as well as distribution and marketing of thermal energy – the heating network (public and autoproducing CHP plants, public and municipal heat plants, and local production and distribution enterprises).

The Polish Oil and Gas Company (PGNiG S.A.) is the largest gas enterprise in Poland, which is involved in gas marketing and storing and in activities connected with the exploration and extraction of natural gas and petroleum oil. The Company remains the owner of the transmission system assets until it is totally sold to OGP Gaz-System Ltd., operating as a sole-shareholder company of the State Treasury. Since July 2005 the OGP Gaz-System Ltd. has been managing the transmission system on the basis of a Transmission Network Leasing Contract concluded with PGNiG S.A. The distribution activity is carried out by six gas companies belonging in 100% to the Capital Group of PGNiG S.A. and by other independent gas enterprises, out of which 6 provide services for more than 100 recipients. The distribution companies gathered in the Capital Group are involved in marketing and distribution, and also serve as operators of the distribution system (OSD). Activities connected with the selling of gas to the marketing companies (intermediates) are carried out mainly by one enterprise – PGNiG S.A. and partly by distribution companies. At present, over 60 enterprises in Poland have concessions for gas marketing. The percentage of dwellings equipped with district supply gas in urban areas accounts for app. 74%, whereas in households in the rural areas it is app. 17.5%.

The tariffs for electric power, heat and gaseous fuels are set by energy distribution enterprises in line with the principles provided by the Act on Energy Law and its executive regulations issued by the Minister of Economy and then approved by the President of the Energy Regulatory Office. The billing system distinguishes the costs of the energy carrier as well as transmission and distribution costs.

The energy balance in Poland is balanced and the structure of the use of energy carriers undergoes successive changes towards reducing the use of hard coal and lignite in favour of other carriers. However, the dominating role of coal as a source of primary energy is still very much in place, it is also an important final energy source, especially in coal-fired individual heating systems. In 2004 the share of hard coal and lignite in the structure of primary energy consumption was 62.4 % (in 1994 – 79.3%, and in 1960 – 94%). Petroleum oil accounted for 19.8% of primary energy consumption, natural gas for 12.8%, and the remaining energy sources (peat, waste fuels and wood, hydro energy and other renewable energy sources) – for 5.0%.

Consumption of hard coal and lignite as a source of primary energy has been showing a decreasing trend since the mid 1990s, also in absolute values. On average, in 1995–2003 hard coal consumption has been decreasing by app. 3% annually and lignite consumption by app. 0.9% annually. Also, the total primary energy use decreased on average by app. 0.8% annually[12], while the use of oil and natural gas demonstrated an increasing trend by 3,5% and 2.3%, respectively, on average annually. Detailed data concerning the level and structure of primary energy consumption in Poland in 1995, 1999, 2003 and 2004 are presented in Table 12, which confirms significant reduction in the share of coal in the consumption structure of primary energy carriers in favour of hydrocarbon fuels. The share of the remaining energy carriers, including renewable energy sources, in the primary energy consumption exceeded 5%.

Table 12. The level and structure of primary energy consumption in Poland in 1995, 1999, 2003 and 2004

Specification	1995	1999	2003	2004
Total primary energy consumption [PJ]	4148.4	3770.1	3939.8	3884.5
Percentage of different energy sources [%]				
Hard coal	60.21	52.39	52.20	48.49
Brown coal (lignite)	12.93	13.83	13.12	13.92
Petroleum oil	13.50	18.85	18.83	19.77
Natural gas	9.16	10.29	12.93	12.80
Other[1)]	4.20	4.64	2.91	5.02

[1)] Wood, peat, waste fuels, hydro energy and other renewable energy carriers.
Source: GUS.

Table 13. The level and structure of final energy consumption in Poland in 1995 and 2002

Specification	1995	2002
Consumption level [Mtoe[1)]]	60	55
Consumption structure [%]		
Hard coal	35	23
Liquid fuels	20	29
Gaseous fuels	10	12
Electric power	13	15
Heat (from network supply)	15	13
Other	7	8
Total	100	100

[1)] Mtoe – million tonnes of oil equivalent.
Source: "Energy efficiency in 1993–2002", GUS.

[12)] Data from the Energy Market Agency (ARE S.A.)

The demand for hydrocarbon fuels is satisfied, mainly through import, which in 2004 covered almost 96% of the total oil demand and app. 60% of natural gas demand. Also, around 30% of petrol and app. 80% of liquified gas is supplied through import. Comparison data regarding the level and structure of final energy consumption in Poland in 1995 and 2002 are included in Table 13.

A declining overall consumption of final energy is primarily affected by the decreasing use of solid fuels, especially coal, which is to a great extent influenced by a general fall in the use of energy for heating purposes. Instead, increased final consumption of liquid fuels, especially oil-derivatives, electric power, natural gas and other final energy sources is observed. An increase in electric power consumption is noted mainly in the services sector and in households, whereas a decrease in the use of this type of energy is observed in industry and agriculture.

The demand for final energy in the form of hard coal, electric power and heat from the supply network is fully covered by domestic production, while import has a dominating role in supplying liquid and gaseous fuels. The level of domestic electricity generation also enables profitable export of this type of energy – a surplus in the export over import has been maintained over the entire period of 1995–2004 in Poland. Data on the national electric power balance as well as on heat production and sales in 2000–2004 and in 1995 are presented in Table 14.

Table 14. Electric power balance, and heat production and sales in Poland in 2000–2004 and in 1995

Specification	1995	2000	2001	2002	2003	2004
Electric power						
Production [TWh]	139.0	145.2	145.6	144.1	151.6	154.2
Import	4.4	3.3	4.3	4.5	5.0	5.3
Domestic consumption	118.1	124.6	124.7	124.2	127.1	130.5
Export	7.2	9.7	11.0	11.5	15.1	14.6
Losses and statistical differences	18.1	14.2	14.2	12.9	14.4	14.3
Heat (in steam and hot water)						
Production [PJ]	674	558	578	564	577	560
Sales [PJ]	420	340	420	352	–	–

Source: GUS and ARE.

A decrease in the primary energy consumption observed in Poland over the recent years resulted from a declining energy intensity index in the national economy. This index, however, is still around twice as high in Poland as the average index for the old EU Member States (EU-15). Detailed data on primary energy consumption in Poland in 2000–2004 and in 1995 in relation to the GDP level and the population number are included in Table 15.

The following features maintained in the energy production and distribution systems in Poland are among the unfavourable ones:

– a significantly lower energy transformation efficiency than in highly-developed West European countries,
– high energy losses in transmission systems, consisting of: losses in electric power transmission of app. 10% of energy generated and app. 11.5% of energy introduced into the power grid system, and losses in heat transmission connected with leakages of pipelines and water losses.

Both these factors together cause that the efficiency of the heat transmission system in Poland is between 50% and 86%, whereas in the EU-15 it ranges between 70% and 91%. The scale of the aforementioned unfavourable phenomena is significantly affected by the advanced age and a high decapitalization rate of the technical machinery and equipment from the energy sector, which is 68% on average.

According to the most recent projections regarding primary energy demand in Poland until 2020 that take account of additional improvement in energy efficiency in electric power generation, transmission, distribution and use, thanks to active domestic policy in this field, successive increase in the final energy consumption is expected. Detailed data on projected primary energy demand in Poland in 2005, 2010, 2015 and 2020 are included in Table 16. They were used to prepare projections of greenhouse gas emissions described in Chapter 5.

Table 16. Projected primary energy demand in Poland until 2020 (in Mtoe)

Specification	2005	2010	2015	2020
Hard coal*	42.2	48.2	52.8	57.7
Brown coal (lignite)	12.8	13.0	13.9	12.8
Petroleum oil*	22.6	24.7	27.9	31.3
Natural gas	12.3	14.5	16.6	18.7
Renewable energy	4.5	7.0	7.8	9.0
Other fuels	0.6	0.7	0.6	0.4
Electric power total	*-0.9*	*-0.9*	*-0.9*	*-0.9*
Primary energy total	**94.0**	**107.2**	**118.7**	**129.0**

* With import-export balance of derivative products.
Source: ARE.

Table 15. Primary energy consumption in Poland in relation to GDP level and population number in 2000–2004 and in 1995

Specification	1995	2000	2001	2002	2003	2004
Primary energy consumption [PJ]	4148.4	3870.3	3917.8	3786.7	3939.8	3884.5
Energy intensity of GDP [PJ/1000 PLN]	12.3	5.2	5.0	4.7	4.7	4.2
Primary energy consumption per capita [PJ/capita]	107.4	101.2	102.4	99.1	103.2	101.8

Source: GUS and MŚ.

2.5.3. Industry

The industry remains the major factor that generates economic and GDP growth, beside the dynamically developing services sector, despite the fact that its share in the GDP total has significantly decreased.

The sold production of industry has been systematically rising, after significant initial fall in the period of economic recession and decrease of GDP in 1990–1991. The highest growth dynamics of the sold industrial production was noted in 1994 (12.2%), and from 1995 to 2004 it was 6.5% annually on average. Data regarding the level and structure of sold industrial production in 2000–2004 and in 1995 are presented in Table 17.

The recent years faced a significant growth of the importance of the private sector in the Polish industry, which has already in 2004 generated 80.9% of the total sold production of industry. The significance of the private sector will keep on rising due to planned continuing ownership transformation in this economy sector. Transition into the market economy also forced transformation in the sectoral structure of the Polish industry, which until the end of the 1980s has been dominated by heavy industry. In the 1990s and after 2000 the situation deeply changed - inter alia, the share of mining and quarrying activity in industrial production has significantly declined in favour of manufacturing, as well as other production fields, such as, e.g. metal production.

A positive phenomenon is observed in the form of more rapid, than in other sectors, growth in industrial production sections and groups considered as the driving-forces of technical progress. A high industrial production growth rate is noted, inter alia, in the field of production of office equipment and computer hardware, production of motor vehicles and transport equipment, manufacture of radio, television and communication equipment and apparatus, as well as publishing and printing activity. It is also worth emphasising that significant improvement in work efficiency (productivity) in the industry sector is observed. The productivity, measured by the value of sold production in constant prices per employee has risen in the period of 1995–2004 by almost 120%. Structural changes in the industry in spatial terms result in a slight reduction of disproportions in the industrialisation level among different regions. However, those disproportions still remain high. Transformations in the industrial ownership structure and in the production branch structure are accompanied by organisational as well as technical and technological changes in production processes, and all these transformations jointly contribute to a decrease in energy intensi-

Table 17. Sold production of industry in Poland in 2000–2004 and in 1995

Specification	1995	2000	2001	2002	2003	2004
Sold production total [million PLN[1)]]	244433	488801	500781	527908	582663	678521
Sold production per capita [PLN[1)]]	6334	12777	12960	13374	14783	17772
Sold production per employed person [PLN[1)]]	65062	151658	161539	174000	194552	231994
Sold production by ownership sectors [%]						
Public sector	53.1	28.7	24.7	23.7	22.0	19.1
Private sector	46.9	71.3	75.3	76.3	78.0	80.9
Dynamics of sold production[2)] [%]	9.7	6.7	0.6	1.1	8.3	12.6
Sold production by activity sections and divisions[1)] [%]						
Mining and quarrying	8.0	x	x	5.0	4.5	4.9
Industrial processing (Manufacturing). including:	82.0	x	x	83.2	84.1	85.0
Manufacture of food products and beverages	19.1	x	x	19.9	18.9	16.7
Manufacture of clothing and furriery	2.6	x	x	1.9	1.6	1.4
Manufacture of wood and wood products	2.8	x	x	3.1	3.0	3.1
Manufacture of coke and oil refinery products	4.1	x	x	4.0	4.2	5.0
Manufacture of chemical products	6.8	x	x	5.9	6.2	6.0
Manufacture of rubber and plastic products	3.2	x	x	4.4	4.8	4.7
Manufacture of metals	6.6	x	x	3.5	3.6	4.8
Manufacture of metal products	3.8	x	x	5.3	5.6	5.8
Manufacture of machinery and equipment	5.6	x	x	4.3	4.6	4.6
Manufacture of motor vehicles and transport equipment	5.9	x	x	7.0	8.1	10.3
Manufacture of furniture and other production activity	3.1	x	x	3.7	4.2	4.1
Electricity, gas and water supply	10.0	x	x	11.8	11.4	10.1

[1)] Current prices.
[2)] Constant prices.
Source: GUS.

ty of industrial production. This decrease particularly takes place in those production fields where the energy consumption is high, as in these production fields the energy prices significantly affect production costs. According to the estimates a decrease of the production energy intensity of the most energy consuming products of the following industries: metallurgy, metal processing, chemical, cement, glass, wood, pulp and paper, and sugar industry, has reached the level of 26% in 1994–2002, and the overall fall of the energy intensity in the entire processing industry amounted to almost 20% in this period. It can be assumed that the rate of favourable changes in this scope will slow down in the future, as further energy saving will require more advanced and costly investment measures directed at modernising production technologies and machinery stock or as a minimum renewal/reconstruction of machinery and equipment with the highest decapitalization rate.

2.5.4. Transport

From the beginning of the 1990s, the transport sector, like the industry sector and many other economy branches, has been undergoing significant structural changes in the ownership and organisational spheres and in the transportation structure.

The share of the sales of transportation and storage services for the public sector has decreased from 50.1% in 1995 to 29.6% in 2004, while the share of the private sector, both with the domestic and foreign ownership involved, increased from 49.9% to 70.4%, respectively. A significant organisational partitioning of the sector has taken place.

The share of railway and water transport in the transportation total has also decreased in favour of road transport. Detailed data on transportation services in 2000–2004 and in 1995 are presented in Table 18.

Table 18. Transport services and the level and structure of passenger and freight transportation in Poland in 2000–2004 and in 1995

Specification	1995	2000	2001	2002	2003	2004
Sales revenue from transport products and services, and stock management [million PLN, current prices]						
Total	27586.9 (100%)	55897.6	63117.1	70477.7	78775.8	81652.3 (100%)
Public sector	13823.4 (50.1%)	22359.3	21475.1	24279.2	25683.7	24194.2 (29.6%)
Private sector	13763.5 (49.9%)	33538.3	41372.0	46198.5	53092.1	57458.1 (70.4%)
Transport of goods [thousand tonnes]						
Total	1380810 (100%)	1271529	1241382	1233209	1238842	1324511 (100%)
Railway transport	225348 (16.3%)	187247	166856	222908	241629	282919 (21.4%)
Road transport	1086762 (78.7%)	1006705	996517	931190	911997	956939 (72.2%)
Pipeline transport	33353 (2.4%)	44342	45301	46132	51782	53378 (4%)
Marine transport	26019 (1.9%)	22774	22426	25222	25435	22499 (1.7%)
Inland water transport[1)]	9306 (0.7%)	10433	10255	7729	7968	8747 (0.7%)
Air transport	22 (0.0%)	28	27	28	31	29 (0.0%)
Transport of passengers [thousand persons]						
Total	1601089 (100%)	1319972	1236583	1124940	1112533	1085509 (100%)
Railway transport	465901 (29.1%)	360687	332218	304025	283359	272162 (25.1%)
Road transport[2)]	1131593 (70.7%)	954515	898710	815041	822875	807281 (74.3%)
Marine transport	540 (0.0%)	625	582	559	526	626 (0.1%)
Inland water transport[1)]	1208 (0.1%)	1265	1637	1648	1795	1396 (0.1%)
Air transport	1847 (0.1%)	2880	3436	3667	3978	4044 (0.4%)

[1)] Including coastal transport.
[2)] Excluding municipal public transport fleet.
Source: GUS.

The recently observed decrease in transportation demand, despite gradual economic development and GDP growth, should be considered as a positive trend in the transport sector. This refers both to the transportation of goods and of passengers, however in the latter case the overall situation picture should be corrected by the rising trend in individual motor transport. Stabilization, observed since 2002, or even a slight increase in railway transportation of goods with a decreasing trend in road transport of goods, is also a positive phenomenon.

Road transport accounts for almost 90% of the total energy consumption in the transport sector. Railway transport accounts for app. 6%, and the remaining 4% is assigned to air and water transport. In 1990–2002 there has been a constant increase by almost 2.5% annually in the total level of fuel consumption in road transport, irrespective of the observed decrease in the unit fuel consumption per vehicle equivalent, from app. 0.61 toe in 1990 to app. 0.52 toe in 2001, as well as irrespective of a decrease by app. 17% of the average fuel consumption per 1000 km of truck (heavy-duty vehicle) transportation in the years 1994–2002. Following modernisation of the aircraft fleet a decrease in the energy intensity of the air transport is observed. However, the average unit fuel consumption in transport is still by app. 20% higher than the EU average. Biofuels have only a very small share in fuel consumption in the transport sector. Detailed data on the number of motor vehicles and tractors in 2000–2004 and in 1995 are included in Table 19.

Despite significant rise in the number of passenger cars in the recent years in Poland, there were still only 314 cars per 1000 inhabitants in 2004, which is significantly less than in highly developed countries. Also, the level of the mean annual passenger car mileage amounting to almost 9.5 thousand km is lower. A high level of import of used cars is typical for Poland. Several year-old or even over ten-year old cars, often demonstrating unsatisfactory technical condition, purchased mainly in Germany and other West European countries are repaired in Poland to serve further users. From the beginning of 2004, 828.3 thousand such cars have been imported to Poland by mid 2005.

Despite the changes that have taken place in the recent 15 years, transport still remains a falling-behind sector, as it insufficiently invested and generally offers low quality services to businessmen and the public.

2.5.5. Construction and housing

Basic data on economic activity in the construction sector in Poland in the period 2000–2004 and in 1995 are presented in Table 20.

Table 19. Registered motor vehicles and tractors in Poland in 2000–2004 and in 1995

Vehicles	1995	2000	2001	2002	2003	2004
	[in thousands]					
Total incl.:	11186	14106	14724	15525	15899	16701
Passenger cars	7517	9991	10 503	11029	11244	11975
Buses	85	82	82	83	83	83
Trucks and road tractors	1354	1879	1979	2163	2313	2392
Ballast and agricultural tractors	1212	1253	1257	1294	1322	1319
Motorcycles	929	803	803	869	845	836

Source: GUS.

Table 20. Sold production of the construction sector in Poland and buildings completed in 2000–2004 and in 1995

Specification	1995	2000	2001	2002	2003	2004
Sold production total [million PLN]	37817.1 (100%)	107177.5	104197.8	99543.5	92315.7	97449.4 (100%)
Public sector	4681.0 (12.4%)	4421.0	3604.4	3226.7	3289.1	3144.0 (3.2%)
Private sector	33136.1 (87.6%)	102756.5	100593.4	96316.8	89026.6	94305.4 (96.8%)
Buildings completed [numbers]	61233	50205	54219	66321	139702	80756
Urban areas	27187	28429	30275	34283	59380	37385
Rural areas	34046	21776	23944	32038	80322	43371
Cubic volume of buildings completed [dam^3]	59590	80795	97275	92877	145856	110144
Urban areas	33716	57812	68119	60888	76349	64355
Rural areas	25874	22983	29156	31989	69507	45789

Source: GUS.

The number of dwellings in Poland reached 12,683 thousand in 2004, of which 8,513 thousand dwellings were found in urban areas (67.1%) and 4,170 thousand (32.9%) – in rural areas.

The total surface area of the existing dwellings amounted to 875,494 thousand m^2 in 2004, of which 59.6% – for dwellings in urban areas and 40.4% – for dwellings in rural areas.

Dwellings owned by natural persons predominate in the ownership structure of the housing stock (in 2004 57.4% of the total number of dwellings and 69.3% of the total usable floor space). Next come the co-operative dwellings (27.4% and 20.0%, respectively), municipal (gmina-owned) dwellings (10.4% and 6.9%) and company-owned dwellings (3.7% and 2.8%). The remaining dwellings are owned by other entities.

Old dwellings with a high decapitalization rate and low usable standard constitute a significant part of the housing stock in Poland. In 2004 the number of persons per dwelling totalled 3.1 on average (2.76 in urban areas and 3.53 in rural areas), and the number of persons per room – 0.82 (0.79 and 0.87, respectively).

Most dwellings are fitted with basic household installations. In 2004 on average 98.4% were fitted with central water supply systems, 94.2% – with a lavatory, 91.9% – with a bathroom, 74.1% – with network supply gas installation and 84% – with central heating. However, these figures as far as the situation in the rural areas is concerned differ significantly from the country's average value, i.e. 88.1% of dwellings are fitted with a water supply system, 73.3% – with a lavatory, 74.7% – with a bathroom, 17.5% – with network gas installation and 63.3% – with central heating.

After a breakdown period in the 1990s, the number of annually completed dwellings, which is presently rising successively, amounted on average to 77.3 thousand in 1996–2000, 87.8 thousand in 2000, 106,0 thousand in 2001, 97.6 thousand in 2002, 162.7 thousand in 2003 and 108.1 thousand in 2004. In 2004, 67.1% of the newly built dwellings were put into use in urban areas and 32.9% – in rural areas. The number of annually completed dwellings still does not satisfy the current housing demand in Poland, which is estimated at 1.5 to 2 million dwellings.

The advanced average age of the existing dwelling stocks (over 40 years) and their worsening technical condition has a negative impact on the energetic parameters of dwellings and on energy consumption in households. It is estimated that in these households, which are the major final energy consumers at country's scale (app. 34% of the total final energy consumption, with a slight rising trend), as much as 77% of the energy consumed is used for heating homes, and almost 11% for producing hot water. Nearly 10% of energy is used for lighting purposes, preparing meals and supplying household appliances with electricity.

2.5.6. Agriculture

Polish agriculture has to a great extent retained its traditional character – multisectoral production type and the use of extensive production methods. Over 40% of private farms (in 2004 private farms accounted for almost 87.6% of the overall agricultural land) carry out mixed production without clearly defined specialisation. Field crop production predominates in almost 30% of farms, whereas animal breeding and raising – in app. 20% of farms. There are also farms assigned to different crop production types classified as special sectors (orchards, vegetable production, greenhouse production, herb production, tree nursery, etc). Production models and the structure of crop production vary in different regions of the country, depending on local natural and economic conditions (e.g., the vicinity of trade markets) and on strong tradition. Maintaining multisectoral and extensive production is favoured by significant farm partitioning, which is typical for Polish agriculture. In 2004 the average area of agricultural land per farm amounted to 7.5 ha, however, the majority of farms (58.2%) had a significantly smaller farmland area (1.01–4.99 ha), while farms exceeding 50 ha accounted only for 1%. The size structure of farms in 2000–2004 and in 1995 is illustrated by data in Table 21.

Table 21. Private farms in Poland in 2000–2004 and in 1995 by size groups

Specification	1995	2000	2001	2002	2003	2004
Number of farms [thousands]	2048	1881	1882	1952	1850	1852
Average agricultural land area per farm [ha]	6.7	7.2	7.1	7.4	7.4	7.5
Percentage of farms by agricultural land area						
• 1.01–1.99 ha	20.9	23.8	22.8	26.5	25.8	26.1
• 2.00–4.99 ha	33.7	32.6	33.8	32.2	33.0	32.1
• 5.00–9.99 ha	26.7	23.8	24.3	21.9	22.1	21.8
• 10.00–14.99 ha	10.7	9.9	9.7	9.3	9.2	9.6
• 15.00–19.99 ha	4.4	4.5	4.4	4.3	4.2	4.3
• 20.00–49.99 ha	3.3	4.7	4.4	4.9	4.7	5.1
• 50.00 ha and more	0.3	0.7	0.6	0.9	1.0	1.0

Source: GUS.

Crop production predominates in the gross output level of agricultural production (53.5% in 2004), whereas in the market output it is animal production (59.6% in 2004). Private farms provide a significant part of the gross production and market output, 89.0% and 86.0%, respectively in 2004. In 2004 the market output accounted for 49.0% of gross output in crop production and 83.2% of gross output in animal production.

Detailed data on the level and structure of gross and market outputs in Polish agriculture in 2000–2004 and in 1995 are presented in Table 22.

Arable land dominates in the structure of agricultural land accounting for 77.7% in 2004. Meadows and pastures cover 20.6% of agricultural land, and orchards – 1.7%.

The following are the main crops that are grown: cereals, potatoes and industrial crops, especially sugar beet and rape. Wheat and rye predominate among cereals that are cultivated, and to a smaller extent – cereal mixtures for feedstuff and barley, triticale and oat, as well as buckwheat and millet, and maize for feed and grain, which are cultivated on even smaller areas. Major agricultural crops constituted almost 88.4% of the total sown area, which amounted to 11,285 thousand ha in 2004.

Animal production output focuses mainly on the breeding and raising of cattle, pigs and poultry. The breeding level for sheep and horses is much smaller. Detailed data regarding animal livestock in Poland in 2000–2004 and in 1995 are included in Table 23.

Extensive production predominates in animal breeding in Poland, covering almost 50% of cattle livestock and nearly 35% of pig livestock. Only 2% of cattle and 16% of pigs are bred under highly intensive production conditions. Animal feeding is mainly based on bulky feed produced in farms and on fodder feed produced from own cereal mixtures. A litter rearing system and grazing on pastures are commonly used for animal raising.

Table 22. Gross and market agricultural outputs in Poland in 2000–2004 and in 1995 (current prices)

Specification	1995	2000	2001	2002	2003	2004
Global production						
Total [million PLN] of which:	43347.4	55985.4	60319.5	55706.0	56263.6	66985.4
Crop production [%]	58.6	53.2	52.4	52.8	52.8	53.5
Animal production [%]	41.4	46.8	47.6	47.2	47.2	46.5
incl. private farms [%]	89.1	90.0	90.1	90.1	89.6	89.0
Market output						
Total [million PLN] of which:	21711.2	33491.4	35933.8	34739.3	36542.9	43465.0
Crop production [%]	39.4	37.4	36.8	38.7	40.0	40.4
Animal production [%]	60.6	62.6	63.2	61.3	60.0	59.6
incl. private farms [%]	84.7	86.4	86.9	87.1	86.3	86.0
Share of market output in gross output [%]						
Total	50.1	59.8	59.6	62.4	64.9	64.9
Crop production	33.7	42.1	41.9	45.8	49.2	49.0
Animal production	73.2	80.0	79.0	80.9	82.6	83.2
Production output per 1 ha of agricultural land [PLN]						
Gross output	2417	x	x	3296	3480	4103
Market output	1211	x	x	2056	2260	2662

Source: GUS.

Table 23. Animal livestock of cattle, pigs, sheep, horses and poultry in Poland in 2000–2004 and in 1995

Specification	1995	2000	2001	2002[1)]	2003	2004
Cattle [in thousands]	7306	6083	5734	5533	5489	5353
Pigs [in thousands]	20418	17122	17105	18629	18605	16988
Sheep [in thousands]	713	362	343	345	338	318
Horses [in thousands]	636	550	546	330	333	321
Cattle + pigs + sheep + horses [in terms of large heads in thousands]	9600	8013	7726	7578	7542	7177
Poultry (hens + geese + turkeys + ducks) [in thousands]	51740	53261	55582	198783	146321	130289

[1)] From 2002 data revised on the basis of the results of the Agricultural Census.
Source: GUS.

Table 24. Consumption of mineral and lime fertilisers in Poland in 2000–2004 and in 1995 (in kg of pure ingredient per 1 ha of agricultural land)

Specification	1994/1995	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004
Mineral or chemical fertilisers total, incl.:	79.7	85.8	90.8	93.2	93.6	99.3
Nitrogenous fertilisers	46.6	48.4	50.3	51.0	51.5	54.8
Phosphatic fertilisers	15.5	16.7	17.9	18.9	18.7	19.7
Potassic fertilisers	17.6	20.7	22.6	23.3	23.4	24.8
Lime fertilisers	131.9	95.1	94.2	94.1	94.6	93.5

Source: GUS.

The use of mineral fertilisers has been considerably reduced in Poland after 1990. The current consumption of mineral and lime fertilisers in Polish agriculture to a great extent does not satisfy the justified needs resulting from agricultural production carried out on agricultural land with the majority of light soils, which are poor in nutrient elements and significantly acidified. Assessment results indicating that the level of mineral and lime fertilisation should and may be higher have, inter alia, taken account of the fact that under Polish soil and climatic conditions the process of forming and releasing nitrous oxide is less intensive and thus losses/releases of nitrogen from mineral fertilisers are also smaller. An increase in the use of lime fertilisers is essential due to progressive soil acidification resulting from soil-forming processes and deposition of nitrogen and sulphur compounds that are emitted into the air from the energy sector, industry and transport (strong acid pH or acid pH is presently found over app. 55% of agricultural land area). The actual level of lime fertilisation does not counterbalance the progress of this phenomenon. Detailed data on the consumption of mineral and lime fertilisers in Poland in 2000–2004 and in 1995 are included in Table 24.

2.5.7. Forestry

In 2004 forests in Poland covered an area of 8,973 thousand ha, accounting for 28.7% of the total country's area (recorded forests and wooded land, including forest, wooded and shrub land, covered an area of 9,264 thousand ha in that year).

The forest cover index is differentiated regionally – ranging from 20.6% in the Łódzkie Voivodship (Central Poland) to 48.7% in the Lubuskie Voivodship (Western Poland). In Poland the forestland area per capita is almost 0.23 hectares.

The forest structure is dominated by public forests (82.5%, of which 81.6% are owned by the State Treasury and 0.9% by gminas), 95% of which are managed by the 'State Forests' National Forest Holding (LP). Private forests – owned by natural persons or land communities – account for the remaining 17.5% of the total forest area in Poland.

The habitat structure of forests is dominated by coniferous species covering around 60% of the total forest area; the remaining 40% are covered by broadleaved tree species. There is little differentiation in the species composition of tree stands. The dominating coniferous tree stands account for almost 76.7% of the total forest area, of which 69% is covered by pine trees. However, the species structure of forests, due to targeted appropriate afforestation measures and cultivation activities, undergoes gradual changes. During the recent 50 years the share of broadleaved trees in the total forest area increased from app. 13% in 1945 to app. 23% at present. Also, the average age of tree stands in forests shows a growing trend reaching 60 years of age in 2004.

A high level of spatial fragmentation is an unfavourable feature of forests in Poland. The Regional Directorates of the State Forests have 28 thousand forest complexes under their management, of which over 6 thousand do not exceed the area of 5 ha each.

Due to undertaken afforestation activities and introduced limitations in tree felling the total treestand stocks are increasing in the Polish forests. In forests managed by the State Forests the growing stock of standing wood amounted to 1,555.4 million m^3 in 2003 (1,322.6 million m^3 in 1995). The average annual removals of wood are maintained at around 1.5% of the growing stock of standing wood and have never exceeded the level of the current increase of treestand wood thickness. Detailed data on forestland area and treestand species, their age structure and stocks in Poland in 2000–2004 and in 1995 are presented in Table 25.

Since many years insects, fungi, adverse climatic phenomena, fires and air pollution have been constantly endangering the condition of Polish forests. Observations that are carried out within the framework of the international biological monitoring of forests show that since 1995 the forest condition has improved (in particular, the percentage of severely damaged forests has declined), but the treestands are still significantly endangered. Detailed data on treestand damage in Poland in 2000–2004 and in 1995 are presented in Table 26.

Table 25. Forestland area and forest treestands in Poland in 2000–2004 and in 1995

Specification	1995	2000	2001	2002	2003	2004
Forestland area [thousand ha][1)]						
Total	8756	8865	8894	8918	8942	8973
Public forests, incl.:	7262	7341	7349	7363	7379	7400
Forests managed by the State Forests	6868	6953	6968	6987	7006	7030
Private forests	1494	1524	1545	1555	1563	1573
Forest cover index [%]	28	28.4	28.4	28.5	28.6	28.7
Forest area by treestand species [thousand ha, forests managed by the State Forests][2)]						
Coniferous trees, incl.:	x	x	x	5364	5366	5371
pine and larch	x	x	x	4842	4844	4850
Broadleaved trees	x	x	x	1604	1621	1635
Growing stock of standing wood [hm^3, forests managed by the State Forests]						
Total	1323	1466	1480	1500	1523	1555
Coniferous trees	x	x	x	1181	1199	1227
Broadleaved trees	x	x	x	319	324	328
Timber removal [dam^3]						
Total	20651	26025	25017	27137	28737	30427
Coniferous removals	15365	19540	18047	19828	20838	22348
Broadleaved removals	5286	6485	6970	7309	7899	8079
Total removals in forests managed by the State Forests	18774	24097	23471	25595	27134	28699

1) Status as of the end of a year.
2) Status as of the beginning of a year.
Source: GUS.

Table 26. Treestand damages in forests in Poland in 2000–2004 and in 1995 (%)

Specification	1995	2000	2001	2002	2003	2004
Undamaged trees	5.7	10.4	9.9	8.8	8.1	8.3
Slightly damaged trees	41.6	57.7	59.4	58.5	57.1	57.1
Moderately damaged trees	49.5	29.9	28.7	30.7	32.6	32.4
Severely damaged trees	3.0	1.6	1.6	1.6	1.6	1.7

Source: GUS.

Almost 8% of forestland is threatened by infectious fungi diseases. Insect pests attack smaller areas, but almost 4.1% of the forest area is endangered by leaf-eating pine tree pests, including nun moths, which pose a threat to 1.6% of forestland area.

The age structure of treestands and the predominant share of coniferous habitats causes a great risk of fires, especially in early spring and in the summer season during long-term periods of drought, creating favourable conditions for both the generation of fires and their rapid spreading. In 2000–2004 around 51.1 thousand forest fires have taken place in Poland, which covered an area of app. 40.9 thousand hectares.

Apart from forests representing mainly a productive function, vast forest areas (37.2% in 2004) are occupied by protective forests (water-protective, soil-protective, spa areas, public recreation zones, etc.), which are subject to protection due to other roles they play. Forest management in these areas is targeted at those other specific environmental and social functions fulfilled by forests in a given area.

The size of the forestland area in Poland is on one hand affected by forestland exclusions for non-forest purposes, and on the other by forest renewal (after felling, fires, etc.) and afforestation of new areas. Data on the levels of exclusions, as well as renewal and afforestation in 2000–2004 and in 1995 are presented in Table 27.

Table 27. Forestland exclusions for other purposes and the level of renewals and afforestations in Poland in 2000–2004 and in 1995

Specification	1995	2000	2001	2002	2003	2004
Exclusions [thousand ha]	0.4	0.7	0.5	0.4	0.7	0.7
Renewals and afforestations [thousand ha]	77.8	68.9	65.4	56.8	66.1	61.7

Source: GUS.

2.5.8. Waste management

The industry and the municipal sector are the major producers of waste in Poland. In 2004, 124 million tonnes of industrial waste were generated due to industrial activity. Almost 64% of waste was produced in the mining and metallurgy industries (metal ore smelting), and around 18% in the energy sector.

The majority of industrial waste is utilized in a variety of ways, and only partly deposited on landfills (almost 14% in 2004). Also industrial waste that has been already deposited on landfills is processed and used in the economy. Therefore, the amount of industrial waste accumulated in the recent years on landfills is systematically declining. In 2000 it amounted to 2,011 million tonnes and in the proceeding years until 2004: 1,977.9 million tonnes, 1,813.3 million tonnes, 1,779.9 million tonnes, and 1,745.3 million tonnes, respectively. The dominating method of treatment for industrial waste is its use for energy recovery purposes, for producing construction materials and for levelling and hardening land surface. These waste management options account for almost 73% of all waste that is utilised in the economy.

Municipal waste is mainly waste from households, service facilities for the public and from open areas, such as roads and parks. Average municipal waste amount generated annually per capita is 256 kg and keeps rising gradually. In 2004 the municipal waste management enterprises collected 9,759 thousand tonnes of municipal waste, of which as much as 9,194 thousand tonnes (94.2%) were deposited on 1,049 operational landfills occupying an area of 3,385 ha. Only as little as below 3% of municipal waste is recovered from waste paper, glass, plastics and metals, and around 2.4% is composted.

The total amount of waste generated includes also sludge from industrial and municipal wastewater treatment plants, which in 2004 amounted to 1,087.2 thousand tonnes (in dry matter). Out of this quantity 453.3 thousand tonnes were deposited in landfills. By the end of 2004 the amount of sewage sludge accumulated at the sites of all treatment plants totalled to 10,150.6 thousand tonnes.

Detailed data on the amounts and management methods for industrial and municipal waste in 2000–2004 are presented in Table 28.

Table 28. Generation and management of industrial and municipal waste in Poland in 2000–2004

Specification	2000	2001	2002	2003	2004
Industrial waste [thousand tonnes]					
Generated	125500	123800	117900	120600	124030
Utilised in the economy	96500	96800	93200	95400	97415
Deposited on landfills	22300	20500	17100	16100	17133
Accumulated on landfills	2011000	1977900	1813300	1779800	174347
Municipal waste [thousand tonnes]*					
Collected by municipal enterprises	12226	11109	10509	9925	9759
Collected selectively (separated during collection)	13	147	116	145	243
Treated (incineration and composting plants)	248	323	251	171	322
Deposited on landfills	11965	10638	10142	9609	9194
Sewage sludge from wastewater treatment plants [thousand tonnes of dry matter]					
Generated	1063.1	x	1083.7	1008.7	1087.2
Thermally transformed	34.1	x	31.5	47.0	39.9
Landfilled	474.5	x	469.5	453.1	453.3
Accumulated at the premises of wastewater treatment plants	x	x	10714.2	10364.6	10150.6

* Information on municipal waste that has been collected not generated.
Source: GUS.

2.5.9. The state of the environment

Consequently enforced provisions of the environmental policy, and implementation of restructuring and modernisation processes in the economy contributed to the reduction of environmental pressures. Air emissions of major pollutants – SO_2, NO_x and particulates - have declined by around 55%, 38% and 76%, respectively, compared with the level of the early 1990s. Over 95% of industrial wastewaters and app. 88% of wastewaters from the municipal sector are treated in conformity with the law. These achievements enabled radical improvement of air quality in industrialised areas, and an improvement in the quality of the majority of watercourses, although to an insufficient extent. Considerable progress has also been obtained in the management of industrial and municipal waste. Annual expenditures on environmental protection reached 1.6% of GDP in the recent decade. At the same time new sources of hazards have occurred, such as an increasing number of on-road vehicles or an increasing individual consumption (electricity, household chemical agents, packaging). The significance of other traditional sources of pressure – municipal economy sector and agriculture – has also grown. More stringent legal requirements, including Poland's international commitments, enforce implementation of new solutions. Further improvement of environmental conditions requires further investments in the industry, especially in the energy sector, including measures for fuel diversification (increased gas consumption). The present challenge is to further reduce the adverse impact of released pollutants on the environment and human health.

2.6. Special circumstances for fulfilling obligations by Poland

Pursuant to Article 4.6 of the United Nations Framework Convention on Climate Change and paragraphs 4a and 7 of Decision 9 of the Second Conference of the Parties to this Convention, Poland recognises justification for a flexible approach to fulfilling its commitments resulting from the Convention as regards the following issues:

- Poland has adopted 1988 as the base year for the assessment of its commitments,
- the 1990 emission level may only be used for the assessment of the state of global emissions, but it cannot be used as a basis for reviewing Poland's compliance with the obligations of the Convention,
- this Communication was drawn up in conformity with the reporting guidelines as adopted by the Fifth Conference of the Parties to the United Nations Framework Convention on Climate Change, and meets the required scope of information and way of presentation to the maximum extent possible.

The reason for Poland to decide on changing the base year from 1990 to 1988 was that the year 1990 was the first year in Poland after major political and economic transformation, which significantly affected the stability of the Polish economy[13)]. It was in 1999 that the transitional breakdown of the economy took place. Therefore the level of greenhouse gas emissions in 1990 neither corresponds with the normal emission level, which results from the country's development needs, nor with the actual economic potential of Poland. Choosing 1990 as the base year would not be reliable for evaluating the potential and condition of the Polish economy.

[13)] Detailed justification for selecting 1988 as the base year has been presented in the First National Communication to the Conference of the Parties to the Climate Convention (1994).

3. INFORMATION ON GREENHOUSE GAS INVENTORY AND REMOVALS

3.1. Inventory

Each year, Poland submits detailed inventories of GHG emissions and removals to the UNFCCC Secretariat in Bonn. Since 2002, GHG inventory results have been submitted in the form of CRF (Common Reporting Format) tables – spreadsheet files that cover the 2000–2004 period. National GHG inventories are subject to periodic reviews carried out by expert review teams (ERT) designated by the Secretariat for the Climate Convention.

For the needs of the UNFCCC Convention and the Kyoto Protocol, Poland selected year **1988** as the base year for the main greenhouse gases: carbon dioxide, methane, nitrous oxide, and year **1995** for fluorinated industrial gases (F-gases): HFCs, PFCs and sulphur hexafluoride.

The results of the inventory of greenhouse gas (GHG) emissions and removals for the period of 1988–2004 presented in this report may change following the emissions recalculations carried out during 2006 in accordance with the methodology given in the *Revised 1996 IPCC Guidelines*, and in *Good Practice Guidance and Uncertainty Management*. Detailed inventory results of GHG emissions and removals by IPCC sectors for the years 1988–2004 that have been obtained so far are presented in Annex 1.

The results for the base year (1988/1995) have been corrected in relation to the Third National Communication to follow the current IPCC inventory methodologies and to apply recommendations of the expert team (ERT) that reviewed the Polish GHG emission inventory in 2005. Also for the first time, the 1989 GHG emission inventory results are presented here, which are consistent – from the methodological point of view – with the updated 1988 inventory.

Poland committed itself to 6% GHG emission reduction in the 2008–2012 period compared to the base year 1988[14)]. The inventory results show that over the period 1988–2004 GHG emissions decreased significantly (excluding sector 5. *Land use, land-use change and forestry*) reaching the level as much as 31.7% below the base year. The GHG emissions decrease has been caused primarily by decreases of emissions of carbon dioxide, methane and nitrous oxide that dropped by 33.6%, 23.7% and 25.7%, respectively. The decreasing trend had continued until the year 2002, after which GHG emissions began to grow by 3.3% in 2003 and by further 1.5% in 2004 (Table 29).

Table 29. Emission changes of carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride in 1988–2004 expressed in carbon dioxide equivalent (Gg CO_2 eq.)

GHG	Years																
	Base year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
CO_2 – with sector 5	440973	422698	340737	324003	334738	323209	331430	307935	331514	320725	298107	291011	278212	277990	275359	290871	290541
CO_2 – without sector 5	477004	459734	380697	366959	371591	363133	371588	348172	372530	361626	337448	329697	314812	317844	308277	319082	316700
CH_4	51151	50676	58819	54362	51952	51061	51805	51598	47296	47845	49041	47252	45848	38816	37787	37684	39025
N_2O	40384	41877	19428	16126	15562	15426	15574	16734	16715	16743	15984	23284	23895	23946	22633	23936	30004
HFCs*	26	0	0	0	0	0	0	26	97	154	167	206	595	1073	1523	1825	2436
PFCs*	250	0	0	0	0	0	0	250	236	249	251	240	224	270	287	278	285
SF_6*	13	0	0	0	0	0	0	13	8	9	12	14	16	18	21	20	23
Total emission**	**568829**	**552287**	**458944**	**437447**	**439105**	**429619**	**438968**	**416794**	**436881**	**426626**	**402903**	**400694**	**385390**	**381968**	**370529**	**382825**	**388473**

* 1995 is the base year for: HFCs, PFCs and SF_6.

** CH_4, N_2O and total GHG emissions excluding sector 5. *Land use, land-use change and forestry*.

Source: Ministry of the Environment (MŚ).

[14)] The base year emissions include: emissions of carbon dioxide, methane and nitrous oxide in 1988, and emissions of HFCs, PFCs and sulphur hexafluoride in 1995.

Total GHG emissions in 2004 are dominated by carbon dioxide emissions that contribute 81.52% to the total. Methane emissions contribute 10.05% to the total, while the share of nitrous oxide is 7.72%. The shares of individual greenhouse gases in 2004 changed slightly compared to those in 1988. Carbon dioxide share decreased by 2.3% and was compensated by increases of methane (by 1.6%) and nitrous oxide (increase by 0.6%). F-gases account for 0.71% of the aggregated 2004 GHG emission total.

3.2. Trends in emission changes by gases

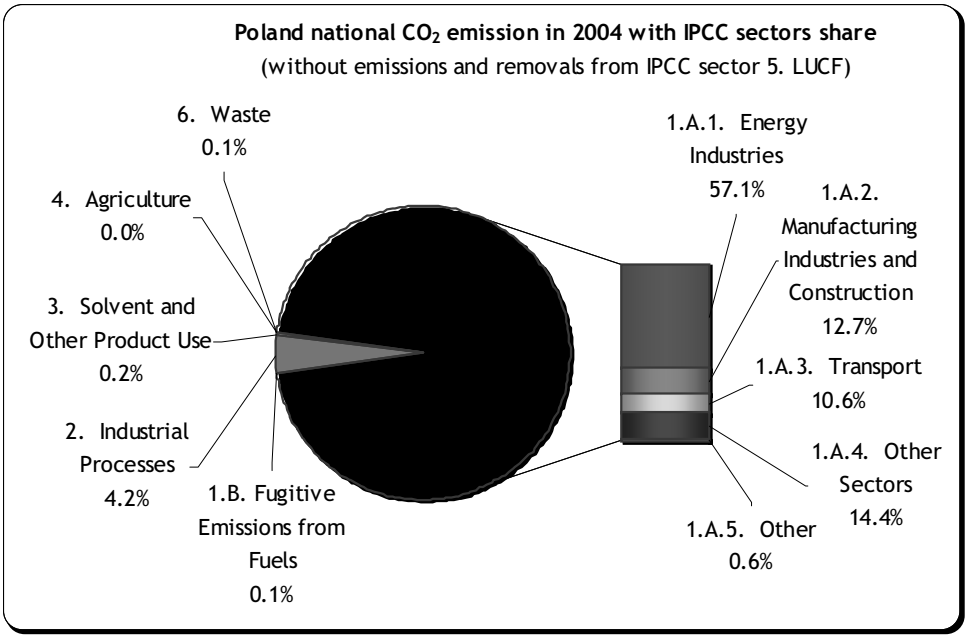
Carbon dioxide

The basic source of carbon dioxide emissions in 2004 was combustion of fuels in sector 1. *Energy*, that makes up almost 96% of CO_2 emissions, including: Energy Industries – 57.1%, Manufacturing Industries and Construction – 12.7%, Transport – 10.6%, Other sectors – 14.4% (Figure 4). Since 1988 the shares of individual emission sources have changed insignificantly.

Over the period: 1988–2004 carbon dioxide emissions decreased by as much as 33.6% (with 34.1% accounting for CO_2 removals). The largest decrease app. by 20% occurred during 1988–1990 period. At the same time, the fuel structure had changed so that the share of liquid fuels increased from 12.5% in 1988 to 20.4% in 2004, the share of gaseous fuels dropped from 7.5% in 1988 to 6.4% in 2004 and the share of hydrocarbon fuels increased from 20.0% to 26.8%, respectively. In 2003 emissions were higher than in 2002 by 3.5% following increasing economic growth, which resulted in increasing energy demand. However, 2004 emissions were lower than in the previous year by 0.7%.

Removal of carbon dioxide by forests in 2004 was estimated at 26,159 Gg, i.e. 8.3% of total emissions of that gas (see Annex 1) and was by 27.4% lower than in 1988. Until 2001, CO_2 removal had been higher than in the base year and in 1991 it was higher by as much as 19.2%. Since 2002 the amount of removals has dropped below the 1988 level and has continued to fall in the following years. The drop of removal is caused by increasing commercial harvesting accompanied by fairly constant biomass growth in forests and decreasing trend in afforestation. The latter is caused by increasing trend of using land for other than afforestation purposes related to socio-economic development of Poland.

Figure 4. Carbon dioxide emission share in 2004*

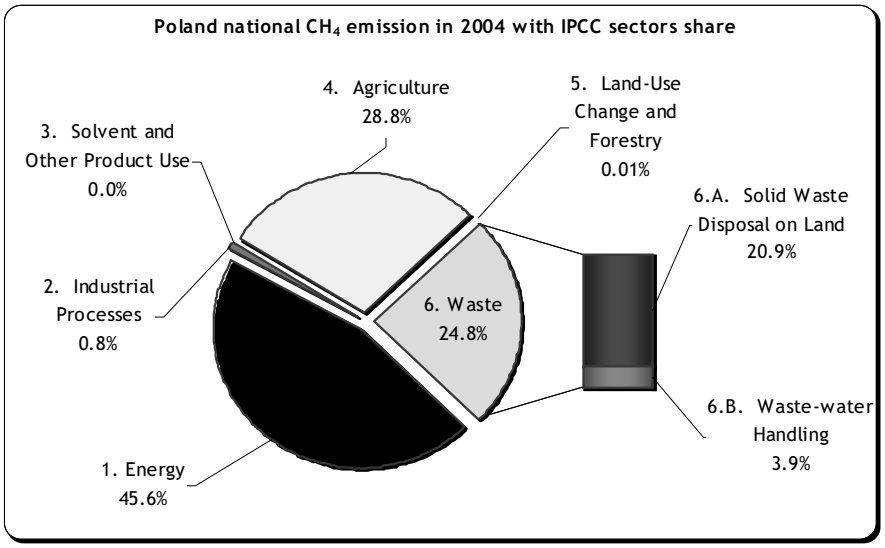


* Sectors names and numbering according to IPCC classification used in national inventories of sources and removals of greenhouse gases; in sector 4. *Agriculture* CO_2 emissions do not occur.
Source: MŚ.

Methane

The largest source of methane is sector 1. *Energy*, whose share in total CH_4 emissions in 2004 was 45.6%. Here, the largest contribution came from fugitive emissions resulting mainly in extraction of hard coal (app. 30% of the national total). Another important source of methane is the *Waste* sector 24.8% of the total. Within the *Waste* sector, largest contribution came from solid waste disposal on sites (20.9% of the total). Sector 4. *Agriculture* contributed 28.8% of the

Figure 5. Methane emission share in 2004*



* Sectors names and numbering according to IPCC classification used in national inventories of sources and removals of greenhouse gases; in sector 3. *Solvent and Other Product Use* CH_4 emission do not occur.
Source: MŚ.

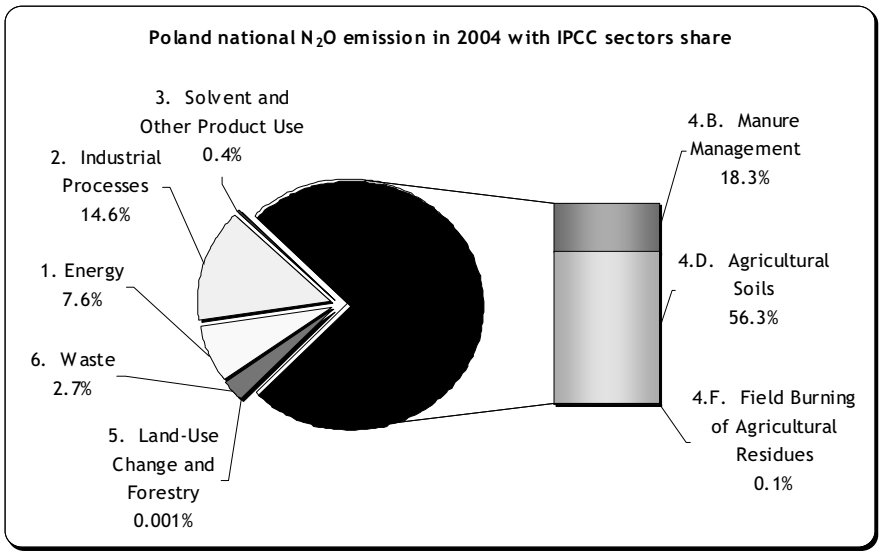
total. The dominating subsector here was the enteric fermentation, 20.7% of emission total (Figure 5).

Compared to 1988 methane emissions in 2004 were lower by 23.7%. Significant decrease occurred in sectors: 1. *Energy* (23.7%) and 4. *Agriculture* (44.2%). In the former sector the decrease was caused by decreasing fugitive emissions from hard coal mines (47%), due to sector restructuring and decreasing coal extraction. In agriculture, the emissions decreased following systematic decrease of livestock population, resulting in decreasing emissions from enteric fermentation (by 50.6%). Significant effect on methane emissions had the increase in sector 6. *Waste*, by 31.5%. The large difference in CH_4 emission estimates from waste between 1988 and 2004 is related to the application of new emission estimation methodology for years 1988–1989. The same methodology is going to be applied for the entire time series.

Nitrous oxide

The largest source category of nitrous oxide was agriculture, which made up 74.7% of the national total. Emissions from agricultural soils contributed 56.3%, and emissions from animal manure 18.3% of the total. The second largest source category was chemical industry (almost 15%). The other two sectors 1. *Energy* and 6. *Waste* (waste-water handling) contributed 7.6% and 2.7% respectively (Figure 6). Emissions in 2004 were

Figure 6. Nitrous oxide emission share in 2004*



* Sectors names and numbering according to IPCC classification used in national inventories of sources and removals of greenhouse gases.
Source: MŚ.

lower than in the base year 1988 by 25.7% due to significantly lower livestock population. N_2O emissions in 2004 grew by 25.3% compared to 2003. This increase was caused by adding to the 2004 estimates indirect N_2O agricultural emissions from soils, which were not accounted for in previous national inventories.

Industrial F-gases

Since 1995 – the base year for F-gases – until 2004, F-gas emissions grew from 289 Gg to 2,744 Gg of CO_2 eq., but the changes were different for various groups of F-gases. There is a clear increasing emission trend of hydrofluorocarbons (HFCs). HFC emissions grew from 26 Gg to 2,436 Gg CO_2 eq. mainly due to increased emissions from increasing number of refrigeration and air-conditioning equipment both stationary and mobile and general trend of substituting CFC gases by HFCs. On the other hand, emissions of perfluorocarbons (PFCs) changed insignificantly in the 1995–2004 period, following the trend of aluminium production – the main source of PFC emissions. Slight PFC emissions increase was also caused by increased use o perfluorobuthane (C_4F_{10}) in fire extinguishers. The increase of sulphur hexafluoride (SF_6) emissions from 13 to 23 Gg CO_2 eq. was caused by the increased use of that gas in electrical appliances. During 2006, the entire time series 1995–2004 of F-gas emissions was recalculated (Annex 1).

3.3. Uncertainty evaluation of GHG emission data and key source analysis

Uncertainty analysis of GHG emission estimates was carried out in accordance with international guidelines[15)]. The analysis was made by applying recommendations made by the Expert Review Team designated by UNFCCC Secretariat, which made the in-depth review of Polish GHG inventory in 2005.

The uncertainty analysis for the year 2004 brought the following total uncertainties for individual greenhouse gases and their groups:

CO_2 – 7.4%	CH_4 – 20.9%	N_2O – 47.7%
HFC – 42.0%	PFC – 40.0%	SF_6 – 100.0%

These results are in line with corresponding values obtained in GHG national inventories in other countries. The ranges of uncertainty estimates in other countries vary within the following intervals: for CO_2 0.2–10%, CH_4 5–50% and N_2O between 5 and 300%.

Relatively low uncertainty values for total CO_2 emissions (7.4%) are caused by the fact that most of CO_2 emissions are generated in sector 1.A in which activity data are relatively precise (2–5%) as well as CO_2 emission factors (0.2–2%). Higher uncertainty estimate for methane (20.9%) is due to the fact that significant parts of CH_4 emissions come from agriculture (from enteric fermentation of livestock and animal manure) where emission factors are quite uncertain (app. 50%). Like in other countries, large uncertainty of total emissions was estimated in case of N_2O (47.7%). The main cause is large uncertainty of the respective emission factors in dominating source categories including animal manure management (150%).

Large uncertainties of emission factors are caused by inter alia uncertainties of measurement and chemical analyses based on which emission factors were determined. Also insufficient knowledge of processes leading to emissions is another reason for large uncertainties. Uncertainties of activity data are often caused by the lack of suitable analyses and due to inherent uncertainty of selected statistical analysis used in public statistics and energy balances. Uncertainty levels in GHG inventories can be lowered by studying the uncertainties of the key sources especially those where uncertainty ranges are highest.

In 2004, 14 key emission sources were identified in Poland's GHG emission inventory. The most important ones are: stationary combustion of fuels (solid, liquid and gaseous) and road transport. CO_2 emissions from those sources made up over 77% of the national GHG emission total expressed in CO_2 eq. Emissions from solid fuel combustion in stationary sources contributed app. 56% to total GHG emissions in Poland.

Detailed results of uncertainty analysis and key source analysis are given in the National Inventory Reports (NIR) of sources and removals of GHG that are submitted annually to the UNFCCC Secretariat.

[15)] IPCC Tier 1 level.

4. POLICIES AND MEASURES

Poland's Climate Policy. Strategies for greenhouse gas emission reductions in Poland until 2020[16] is the key governmental document formulating the national climate policy, which contains the basic objectives, priorities and tasks for economic sectors responsible for the major part of the national greenhouse gas emissions. Reduction of greenhouse gas emissions depends on the energy, industrial and forest policies as well as preferences used for the development of renewable energy sources.

Work is underway to incorporate the Climate Convention and the Kyoto Protocol into the *State Environmental Policy for 2007–2010, considering perspectives for 2011–2014*. This document is to be approved by the Parliament (Sejm) of the Republic of Poland by the end of 2006.

4.1. Instruments

Since the beginning of 1990s the Polish economy has been functioning and developing in line with the principles of a free market economy and now it is becoming more and more affected by globalisation processes. Poland is successfully making use of certain instruments to stimulate desired behaviour of the users of the environment assuming that "environmental goods" have a certain value, which should be taken into account in the economic cost-benefit evaluation. The concept based on the fundamental "polluter pays" principle is implemented by using a number of new instruments of a fiscal nature or by enforcing certain requirements or technical standards, which stimulate the desired behaviour of environmental end-users. They include:

- promotion of production and services less-burdening to the environment and therefore aiming at more sustainable consumption,
- stimulation of multiple-use of goods, recycling and recovery of secondary resources,
- development of equipment and facilities that serve environmental protection,
- use of the principle of preventing pollution "at source" and promotion of implementing best available techniques/best available practices (BAT/BEP),
- securing and developing work places that are less burdening to the environment and serving the environment, the so-called "green work places",
- strengthening and enlarging the export offer of Polish economic entities involved in environmental protection, especially the export to the markets of Central and Eastern Europe and of the developing countries,
- capacity-building in advisory services serving sustainable development,
- involvement of financial institutions to support market-based undertakings in environmental protection and sustainable development.

Among these instruments are also the following ones:

- emission standards for installations – permissible emission levels,
- an obligation to measure emissions of pollutants,
- environmental quality standards (qualitative requirements that have to be met in a specified period of time by the environment as a whole or by its natural components),
- air protection programmes prepared by the voivodship head (voivode), with the aim to meet the permissible levels of substances in the atmosphere,
- a system for air quality assessment (the assessment of the quality of air is performed under the State Environmental Monitoring system, by using specified measurement or modelling methods),
- an obligation to measure the levels of substances in the air (air monitoring within the State Environmental Monitoring system (PMŚ) includes measurement and assessment of air pollution with a view to the observation of continental-nature phenomena and research in global-nature phenomena observation),
- permits for utilising the environment (environmental permits),
- environmental management systems – voluntary commitments of organisations (manufacturing enterprises and service companies, financial, educational, health protection institutions, public administration bodies, etc.) to take

[16] Document approved by the Council of Ministers in November 2003.

measures aimed at systematic reduction of environmental impacts connected with the type of activity involved,
- fees for releasing gases or dusts (particulates) – income from those fees forms the funds for environmental protection and water management,
- administrative fines (imposed for those exceeding the amounts or types of substances specified in permits as permitted to be released into the air),
- "green certificates" ,(certificates of origin for electric power produced from renewable energy sources).

4.2. Major legislative acts and strategic documents

Legal acts that comply with the European Union legislation as well as other strategic documents that are approved by the Council of Ministers and the Parliament (Sejm) of the Republic of Poland are of great significance to climate protection. Table 30 presents selected legislative acts and strategic documents that are most relevant to climate change.

Table 30. Legal acts and strategic documents

Item no.	Title of document	Information
	I. MULTI-SECTORAL ISSUES	
1	*Poland's Climate Policy. Strategies for greenhouse gas emission reductions in Poland until 2020* (adopted by the Council of Ministers on 4 November 2003)	The strategic goal of the climate policy is "for Poland to join the efforts of the international community for the protection of the global climate through the implementation of the principles of sustainable development, particularly in the scope of the improvement of energy consumption, the expansion of the national forest and soil resources, the rationalisation of the use of raw materials and industrial products as well as the rationalisation of waste disposal in a manner ensuring the achievement of the maximum long-term economic, social and political benefits". This goal is consistent with the objectives of the European Union climate policy.
2	*The Second State Environmental Policy* (adopted by the Council of Ministers on 13 June 2000 and by the Parliament on 23 August 2001)	This document as one of its major goals sets out directions of actions to reduce the energy intensity of the economy and lays down priorities in using renewable energy sources.
3	Resolution of the Parliament (Sejm) of the Republic of Poland of 8 May 2003 on the adoption of the "State Environmental Policy for 2003–2006, considering perspectives for 2007–2010" (M.P. No. 33, item 433)	The state environmental policy is implemented through changes in production and consumption patterns, the reduction of material intensity, water intensity and energy intensity of the economy, and by the use of best available techniques and good management practices.
4	*Poland 2025: Long-term Strategy for Sustainable Development* (adopted by the Council of Ministers on 26 July 2000)	The Strategy assigns high priority to environmental problems and considers international co-responsibility of Poland for environmental threats, including risks connected with climate change. This document indicates, inter alia, the need to reduce the energy consumption in the economy in connection with the activity leading to the fulfillment of commitments of the Kyoto Protocol.
5	*The National Reform Programme for 2005–2008 for the Implementation of the Lisbon Strategy* (adopted by the Council of Ministers on 27 December 2005)	The Programme points out a number of essential activities, such as: to facilitate the use of eco-technologies, to support energy efficiency and co-generation, to promote the development and modernisation of energy infrastructure, to provide assistance in developing renewable energy sources.
6	Act of 27 April 2001 – Environmental Protection Law (Dz.U. of 2006 No. 129, item 902)	The Act contains regulations concerning air protection so as to ensure possibly the best air quality.
7	Act of 20 April 2004 on substances that deplete the ozone layer (Dz.U. No. 121, item 1263, as amended)	The Act sets out mainly the provisions for using and marketing ozone depleting substances and products, equipment and installations containing these substances.
8	Act of 20 July 1991 on the Inspection for Environmental Protection (Dz.U. of 2002 No. 112, item 982, as amended)	This Act establishes the State Environmental Monitoring system and lays down the rights and duties of the State in the field of environmental control and execution of environmental legislation in all its elements (e.g., air, forests, waste control).
9	Act of 27 March 2003 on spatial planning and management (Dz.U. No. 80, item 717, as amended)	Spatial management plans constitute an instrument for sustainable development and spatial order. The Act lays down the principles of sustainable development.
10	Act of 20 March 2002 on financial support for investments (Dz.U. No. 41, item 363, as amended)	The Act lays down the principles and forms of providing financial support for businessmen undertaking new investments or for those creating new work places associated with these investments.
11	Act of 22 December 2004 on emission allowance trading of greenhouse gases and other substances (Dz.U. No. 281, item 2784)	A flexible mechanism in the form of an emission allowance trading scheme, pursuant to Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, has been transposed into the Polish law by the Act of 22 December 2004 on emission allowance trading of greenhouse gases and other substances.
12	Regulation of the Council of Ministers of 22 June 2004 on the adoption of the National Development Plan 2004–2006 (Dz.U. No. 149, item 1567, as amended)	The National Development Plan sets out a short-term national socio-economic strategy; it is an overriding national socio-economic plan, which takes account of the regional development strategies – major sectoral strategies (for agriculture, energy, housing, communication/transport) and horizontal strategies (education, innovation). Work on a document entitled the *National Development Strategy for 2007–2013* is currently underway.
13	*Water Management Strategy*, elaborated by the Minister of the Environment in 2005	Measures laid down in the *Water Management Strategy* favour the adaptation of water management to changed climatic conditions. They mainly include measures to enhance the efficiency of protection against floods and effects of droughts, inter alia, by improving retention in river valleys, stimulating activities that capture water in soils by modernising irrigation or building and modernising flood control facilities (reservoirs, falls, flood control embankment, polders).

Item no.	Title of document	Information
14	*Strategy for changing the production and consumption patterns to those favouring implementation of the principles of sustainable development* (adopted by the Council of Ministers on 14 October 2003)	One of the Strategy's goal is to "eliminate, successively, economic activities that harmful to the environment and human health, to promote environment-friendly management systems, to change production and consumption models, and to revitalise the natural environmental status in all those places where the natural equilibrium has been disturbed".
15	*National Strategy for biodiversity preservation and reasonable use with an action programme*[17)]	The ultimate goal of the Strategy is to preserve all natural environmental values and ensure sustainability in the development at all organizational levels. Biodiversity preservation must apply to the entire nature of Poland, irrespective of the form of its use or the degree of its transformation or damage. The *National Strategy for biodiversity preservation and reasonable use with an action programme* is taken account of in undertaking all activities connected with the protection and management of natural resources in Poland.
II. ENERGY SECTOR		
16	Act of 10 April 1997 – Energy Law (Dz.U. of 2006 No. 89, item 625, as amended)	The Act lays down the principles for energy management and for saving energy resources, as well as supports the use of renewable energy sources. Of great significance is the requirement to develop consistent development plans for enterprises and communes (gminas), which, inter alia, need to include undertakings related to the use of renewable energy sources.
17	*Energy Policy of Poland until 2025* (adopted by the Council of Ministers on 4 January 2005)	The document defines measures that need to be taken to ensure national energy security, competitiveness of the economy and its energy efficiency as well as environment protection.
18	*Strategy for renewable energy development* (adopted by the Council of Ministers on 5 September 2000 and by the Parliament (Sejm) on 23 August 2001)	The Strategy assumes an increase of the share of renewable sources in the national fuel and energy balance by 7.5% in 2010 and by 14% in 2020 in the structure of primary energy carrier consumption. An increase in the use of renewable energy sources (RES) will, above all, facilitate reaching the targets set in environmental policy related to emission reduction of pollutants that are responsible for climate change, and acidifying substances.
19	Act of 18 December 1998 on supporting thermo-modernisation projects (Dz.U. No. 162, item 1121, as amended)	The Act is targeted at the reduction of energy used for heating buildings and for supplying hot water; at the reduction of energy losses in local heating networks and local heating sources, as well as at shifting from conventional to renewable energy sources.
III. INDUSTRY		
20	See item no. 12.	Sectoral strategies for different industrial branches are incorporated into the National Development Plan. At present the preparation of a document entitled the *State Development Strategy for the years 2007–2015* is underway.
IV. TRANSPORT		
21	*State Transport Policy for the years 2006–2025* (adopted by the Council of Ministers on 29 June 2005)	The Policy's aim is to achieve a transportation system that would be technically, spatially, economically, socially and environmentally sustainable under the country's developing market economy taking account of international cooperation, mainly at the European scale.
V. AGRICULTURE		
22	Act of 28 November 2003 on supporting the development of rural areas with financial resources originating from the Guarantee Section of the European Agriculture Guidance and Guarantee Fund (Dz.U. No. 229, item 2273, as amended)	The Act lays down the tasks and properties of organisational units and bodies in supporting the development of rural areas from resources originating from the Guarantee Section of the European Agriculture Guidance and Guarantee Fund, related to the support provided, inter alia, for: agricultural activity on less-favoured areas, for agri-environmental and animal welfare improvement measures, for agricultural land afforestation and adaptation of farms to European Union standards.
23	*Rural Development Plan for the years 2004–2006* (M.P. No. 56, item 958)	The Plan sets out objectives, priorities and principles for supporting sustainable development in the rural areas
VI. FORESTRY		
24	Act of 28 September 1991 on forests (Dz.U. of 2005 No. 45, item 435, as amended)	The Act lays down the principles for preserving, protecting and increasing forest resources, as well as the principles of forest management in conjunction with other elements of the environment and of the national economy.
25	*National Programme for the Augmentation of Forest Cover* (KPZL), adopted by the Council of Ministers in 1995 and updated in 2003	This Programme sets out measures targeted at increasing the national forest cover from 28% to 30% by 2020. It determines the quantitative transfer of land from agriculture to forestry, and presents a complex action plan towards rationalization of the natural land-use structure of the country's natural habitat area. New afforestations are elements of the implementation of the multifunctional and sustainable development of the country.
VII. WASTE		
26	Act of 27 April 2001 on waste (Dz.U. No. 62, item 628, as amended)	The Act sets out the rules for handling waste in a way that ensures the protection of human life and health as well as environmental protection pursuant to the principle of sustainable development, and in particular lays down the rules for waste generation or waste reduction and for the limitation of their adverse effects on the environment, and the rules for waste recovery and treatment.
27	Resolution no. 219 of the Council of Ministers of 29 October 2002 concerning the national waste management plan (M. P. No. 11, item 159)	The Plan includes measures for preventing and minimising waste, for providing recovery, mainly recycling of waste, waste treatment and landfill that would be safe for human health and the environment.
28	Act of 11 May 2001 on packaging and packaging waste (Dz.U. No. 63, item 638, as amended)	The Act lays down the requirements with which packaging must comply with regard to environmental protection, as well as rules for handling packaging and packaging waste that ensure human life and health protection and environmental protection pursuant to the principle of sustainable development.
29	Act of 11 May 2001 on the duties of businessmen in managing certain wastes, and on product fees and deposit charges (Dz.U. No. 63, item 639, as amended)	The Act introduces a new economic instrument targeted at rationalising the management of packaging waste and end-of-use product waste.

[17)] Document approved by the Council of Ministers on 25 February 2003.

4.3. Domestic policies and measures

Progress in the implementation of different measures for reducing greenhouse gas emissions is differentiated and as shown in the analysis below it depends to a significant extent on the compliance of a given measure with the economic priorities of a specific sector.

National emission reduction targets

The national greenhouse gas emission reduction target included in Annex B to the Kyoto Protocol (-6% in relation to the 1988 base year level) remains unchanged and will be achieved by Poland.

Complex measures for reducing emissions of greenhouse gases:

- the scheme for greenhouse gas emission allowance trading,
- the use of the Joint Implementation Mechanism (JI),
- monitoring of emissions and of the implementation of the Kyoto Protocol – monitoring of greenhouse gas emissions is carried out on a current basis and its results are presented in the national inventory reports. Implementation of the provisions of the Kyoto Protocol is subject to periodical evaluations, which are submitted through National Communications to the Conference of the Parties to the Convention,
- financial mechanisms supporting measures for reducing emissions of greenhouse gases – financial mechanisms stimulating emission reduction of these gases are introduced by the National Fund for Environmental Protection and Water Management (NFOŚiGW), EcoFund and GEF in order to support activities related to, inter alia, the improvement of energy efficiency. For example, support provided by the NFOŚiGW has led in 2001–2003 to the achievement of CO_2 emission reduction by 1,135.382 Gg/year in the course of the following undertakings: modernisation of heating systems (403.856 Gg/year), fuel conversion (353.751 Gg/year), renewable energy sources (212.344 Gg/year) and enhancement of energy efficiency (165.431 Gg/year). The co-financing of projects by the EcoFund has in 2000–2004 led to a reduction of emissions of carbon dioxide and methane in the municipal-household sector in the following fields:

	CO_2 [Gg/year]	**CH_4** [Gg/year]
Modernisation of heating systems	235.110	–
Fuel conversion	1690.276	–
Utilisation of heat from waste	274.298	3.133
Renewable energy sources	379.695	–
Total	2579.379	3.133

In general, support provided by these institutions has led to an annual CO_2 emission reduction amounting to 3,714.761 Gg and CH_4 emission reduction reaching 3.313 Gg. The Global Environment Facility (GEF) has provided financial resources for the following projects:

1. In 1995–2004 – a project on the conversion of coal to gas (*Coal-to-Gas Project*). The project has led to the reduction of CO_2 emissions by almost 65% in the course of conversion of small coal-fired boilers to gas boilers, and to the reduction of CO_2 emissions by 28% as a result of energy efficiency growth in the new residential buildings.
2. In 2000–2004 – the *Zakopane/Podhale Geothermal District Heating and Environment Project.* The project was co-financed by: the NFOŚiGW, EcoFund, USAID, EU, Denmark, local sources and commercial banks. In 1995–2004 a CO_2 emission reduction by 2,700 Gg was obtained in the course of project implementation. Also emissions of other air pollutants declined and an improvement of air quality was achieved by replacing local coal- and coke-fired boilers in seven towns: Zakopane, Nowy Targ, Kościelisko, Szaflary, Bańska Niżna, Biały Dunajec and Poronin. The new heating system embraced the following elements: 5 geothermal wells, installation of a new geothermal district heating plant with a capacity of 60–70 MW, installation of two new gas-fired peaking heating plants (42 MW in Zakopane and 12 MW in Nowy Targ) and developing almost 100 km of district heating network, including transmission and distribution heating network and end-user connections.
3. A project named *Rural Environmental Project* realized in 2000–2004 has been co-financed by the World Bank, the Nordic Environmental Finance Corporation, Phare, NFOŚiGW and contributions of the beneficiaries and of the self-governments. The projects's objective was to build facilities for storing animal manure in almost 1,000 private farms. The project covered app. 24 thousand animals and app. 29 thousand ha of agricultural land. Its implementation resulted in a reduction of emissions of nitrogen compounds by 17 kg N/ha. It is expected that as time goes on this effect will improve to 28 kg N/ha, which would make an annual reduction of nitrogen emissions into the environment of almost 800 Mg per year.
4. The *Kraków Energy Efficiency Project* has been implemented since 2004 and its accomplishment is expected in 2007. The project is co-financed by the International Bank for Reconstruction and Development (IBRD). The project's aim is to improve the energy efficiency of the heating systems of Małopolskie Voivodship within the region of Cracow and to remove barriers in transactions in the market economy, as well as to raise awareness regarding energy efficiency in buildings. Replacement of coal-fired boilers

with boilers fired by low-sulphur heating oil or low NO_x emission oil/gas-fired burners will reduce CO_2 emissions, and Polish emission standards for SO_2 and NO_x will be met.

5. *Integrated Approach to Wood Waste Combustion for Heat Production*. This project has been launched in 2001 and should be finalised by September 2006. The project's objective is to strengthen the development of the energy market based on wood-like waste (biomass) as a substitute for fossil fuels by establishing an inter-communal partnership public and private company on the territories of the Jordanów and Bystra-Sidzina communes. The specific project's goals include:
   – increased use of wood waste as fuel for heating homes in Poland,
   – the development of local wood waste purchasing (trade) and management markets for heat production on commercial terms,
   – integration of investments related to boiler replacement with activities of energy consumers targeted at reducing heat consumption,
   – an increase of public approval for utilising wood waste as a modern, economically feasible and widely accessible type of fuel,
   – an increase of economic competitiveness of converting coal to biomass in relation to coal-to-gas, to -oil or to -electricity conversion.
6. *Gdańsk Cycling Infrastructure Project* – its duration has been planned for 2001–2005. The project's objectives were:
   – to reduce CO_2 emissions from road traffic in total by 250 Gg within 10 years starting from the fifth year after accomplishing the investment,
   – proportionate reduction of toxic emissions from traffic,
   – to increase the share of bicycle trips to the level of 5–10% of all trips in Gdańsk,
   – to improve road traffic safety,
   – to increase the mobility of all groups of inhabitants; to create a pattern for a model infrastructure investment linked with an information campaign to be utilized in other towns and countries.
7. The *Polish Energy Efficiency Motors Programme (PEMP)* will be realised in 2004–2009. The project is co-financed by several domestic institutions. The aim of the project is to achieve an increase in the sales of power efficient motors to the level of 30% of the total motors' market by 2010 and to obtain energy savings of 55.7 GWh in 2006, and 231.6 GWh in 2010 by optimising electric motors and drives; as well as a reduction of the national greenhouse gas emissions by 885 Gg CO_2 by 2006 (accumulating during the project life-time) and by 3,700 Gg CO_2 by 2010, including the medium-term impact (accumulating during the investment life-time). According to the estimates, the countrywide use of energy efficient drives would decrease the expenditures of enterprises for electricity by as much as 240 million USD annually.
8. Small (GEF) projects:
   – 3 projects in the scope of biofuel production at a total of 27,742 USD including two installations for producing rape oil with a capacity of 400 litres of oil and an agri-refinery,
   – 15 projects related to the conversion of fuels from coal to biomass in 63 boiler plants amounting to a cost of 43,601 USD with a total capacity of almost 2,800 kW,
   – growing a pilot plantation of 20 ha of basket willow (*Salix viminalis*),
   – 5 projects related to the conversion of coal heating to solar collectors amounting to a sum of 135,653 USD with app. 150 m^2 of collectors installed as an out-come,
   – 1 project on the promotion of renewable energy sources among school children amounting to 11,370 USD (two boilers with a total capacity of 800 kW),

   and
   – 7 projects related to the development of almost 700 km of bicycle routes and trails at a total cost of 232,251 USD.

4.4. Energy sector

The energy sector secures all manufacturing activities and is the major indicator of the country's economic development. The following mineral resources create the basis for the Polish energy sector:

– hard coal – its extraction has been declining over the last years due to the liquidation of the old and economically unprofitable mines, and the use of energy saving technologies and machinery at energy users. Hard coal is found in the Górnośląskie (Upper Silesian), Dolnośląskie (Lower Silesian) and Lubelskie Coal Districts,
– brown coal (lignite) – extracted in open pits (the Konińskie, Turoszowskie and Bełchatowskie Coal Districts),
– crude oil – its extraction in Poland is scarce, Poland imports oil from the Russian Federation, the Arab countries and from the North Sea countries,
– natural gas – the domestic extraction satisfies 40% of the Poland's gas demand, the remaining quantity is imported from the Russian Federation and Ukraine,
– other energy sources, clean hydropower, geothermal energy, wind power – increasing share from year to year.

Renewable energy

Biomass (especially wood and wood waste) and hydro energy, and to a much smaller extent also wind energy and geothermal and solar energy are among the most commonly

currently used sources of renewable energy in Poland, which provide around 5% of the primary energy total. A decrease in the extraction of coal and an increase of its prices, beside promotion connected with the implementation of innovation technology, environmental protection and sustainable development significantly contribute to the increase of the primary energy use.

Solid biomass, mainly fuel wood and wood waste is used mainly in low and medium capacity boilers in app. 110 thousand households, especially in rural areas (the total capacity of these boilers is app. 5,500 MW_{th}), as well as in app. 150 installations in local municipal heating plants (a total of app. 600 MW_{th}), and in several co-incineration installations for biomass and fine coal in autoproducing CHP plants (a total of app. 330 MW_{th})[18]. Straw is used for energy purposes in app. 30 local heating installations (with a total capacity of app. 50 MW_{th}). It is also estimated that app. 150 straw-fired boilers (with a total capacity of app. 45 MW_{th}) are installed in small and medium agricultural farms.

The use of biogas is developing in Poland, mainly landfill gas and gas from wastewater treatment plants for the production of electric power or combined heat and power production. The total capacity of the 28 existing installations using landfill gas is 9 MW_e of electric power and 5 MW_{th} of thermal power, whilst app. 30 installations using gas from wastewater treatment plants amount to a total of 14.5 MW_e and 24.5 MW_{th}, respectively. However, 20 agricultural biogas plants that were built in the 1980s are currently out of operation. The biogas production level in Poland is estimated at app. 62 ktoe[19] (in 2002) and is similar to the production level in Denmark. However, the biogas production scale in Poland per 1000 inhabitants is much smaller than in Denmark, and also smaller than the average of the old European Union Member States (EU-15) and reaches 1.6 toe (13 toe in Denmark, 7.4 toe on average in the EU-15).

Bioethanol and fatty acid methyl esters are the main biocomponents that are produced and used in fuels in Poland. According to data for 2004 the production capacity of the Polish biorefineries for these biocomponents was around 80 million litres of bioethanol and 120 thousand tonnes of esters annually. The share of petrol with 5% of bioethanol added, in the total amount of petrol produced by the largest Polish refineries in 2005 ranged from 35% to 60%. This kind of petrol is to be one of the major types of petrol produced by these refineries in future. The second half of 2006 should see an introduction into the common use of the Diesel oil with up to 5% of additive of the methyl esters, and of a biofuel – Diesel oil with 20% of ester additives.

Wind energy is used in Poland by public wind plants connected to the power grid network, and various small power plants operating for their own purposes of individual farms and households. In 2004 the total installed capacity of wind plants amounted to 65 MW, and electricity production totalled 142 GWh. The largest existing wind farms are situated at the Baltic Sea coast – in Zagórze near Wolin (30 MW_e) and in Cisowo near Darłowo (18 MW_e). The interest in wind power is increasing. Construction of further wind farms is planned at the coast of the Baltic Sea, at sea (near Słupsk), as well as in other regions of Poland, particularly in the north and north-east and south-east. It has been estimated that investments under construction will potentially account for a total capacity exceeding 1,000 MW_e.

Hydro energy is used in Poland for electricity generation. The total capacity of operating hydropower plants is almost 870 MW_e. The majority of this capacity originates from around a dozen of large power plants. The installed capacity of over 600 small power plants of below 5 MW_e, amounts to around 178 MW_e. It has been estimated that app. 650 existing dams (after their appropriate modernisation,) and app. 400 that are planned could be potentially used for putting into operation small hydro plants. The total capacity of these power plants could be close to 200 MW_e.

Geothermal energy, whose share in the structure of primary energy use has been estimated at 0.06%, is mainly used in central heating systems and for water heating in the housing sector and in public buildings, and also in balneology, fish breeding and in greenhouse and drying room heating systems. The existing geothermal plants with the total capacity of app. 34 MW_{th} generate heat mainly for housing purposes. The level of geothermal energy used in balneology, fish breeding and in greenhouse and drying room-heating systems is estimated at 20 MW_{th}. An increase in the utilization of heat pumps has also been observed in Poland since several years. Instead of using heat from water with elevated temperatures, the energy it is used from the ground and shallow groundwaters. There are almost 1,000 installations of this kind with the total capacity of app. 12 MW_{th}. Geothermal plants are located in Bańska Niżna (Podhale), Pyrzyce, Mszczonów, Uniejów, Słomniki and Stargard Szczeciński.

The level of solar energy use in Poland is insignificant. It is assumed that app. 60 solar air energy-collecting systems with the surface of almost 6,000 m^2 are used for drying agricultural crops. There are also a few thousand water heating solar systems for heating in-door air and providing hot water, mainly for the housing sector (in single and multi-dwelling

[18] Installations for biomass and fine coal co-incineration in autoproducing CHP plants (330 MW in total) include 3 installations in pulp and paper industry and in furniture manufacturing – data from a raport of the Energy Market Agency entitled *Long-term prognosis for the development of fuel and energy management until 2025*.

[19] 1 ktoe = 1 kilotonne of oil equivalent.

buildings), summer houses and for sport, leisure and tourist facilities (their total surface is estimated at app. 33,000 m^2). The overall surface of solar energy collectors that are installed in Poland amounts to app. 39,000 m^2, which gives around 1 m^2 per 1,000 inhabitants (the EU average is 34 m^2).

4.4.1. Policy

The *Energy Policy of Poland until 2025*[20], which was adopted by the Council of Ministers on 4 January 2005, is a principle document formulating the basis for energy management in Poland. It lays down measures to ensure energy security, competitiveness of the economy and its energy efficiency as well as environment protection.

The Polish energy policy is based on the following principles:

- harmonious energy management under social market economy,
- full integration of the Polish energy sector with the European and global energy sectors,
- market competitiveness and support for renewable energy sources.

This Policy creates priorities and lays down measures, such as: monitoring of the level of energy security, reduction of energy costs and improvement of energy efficiency, as well as strengthening the role of self-governmental level administration towards energy enterprises.

4.4.2. Measures

Legislative, financial and organizational measures:

- **Promotion of renewable energy sources. Introduction of financial mechanisms supporting energy production from renewable sources** – the share of energy produced from renewable sources in the total energy production is systematically rising and in 2004 it accounted for 5.49%. Promotion of renewable energy sources includes:
  - introduction of financial mechanisms in 2002 supporting energy production from renewable sources in the form of exemptions from excise tax on the sales of electricity from RES,
  - introduction of a supporting mechanism, under the Energy Law, in the form of an obligation, imposed on energy enterprises involved in energy selling to the end-users, to obtain a specified number of certificates of origin for electricity produced from RES and to submit them to the President of the Energy Regulatory Office for cancellation or to pay a substitute fee, as well as to enable the marketing of property rights from these certificates. This mechanism is supplemented by an obligation for energy enterprises, acting as officially authorised sellers, to purchase all electricity generated from renewable sources within the territorial activity of the authorized seller, as well as by a system of fines imposed on energy enterprises for incompliance with the aforementioned duty. Financial resources obtained from the substitute fees and from fines feed the budget of the National Fund for Environmental Protection and Water Management and are exclusively intended for providing financial support for investments connected with renewable energy sources. An additional support is an exemption from excise tax on the sales of electricity from renewable energy sources (RES). In 2004 the level of CO_2 emissions that was avoided due to the substitution of conventional power plants with renewable energy sources totalled 2,893 Gg,
  - issuance of certificates of origin for electricity produced from renewable energy sources,
  - An increase in the production and use of renewable energy in 2002–2004 results from the following measures that have been taken:
    - introduction of an obligation to purchase energy from renewable sources, which caused an increase of energy purchased from these sources by 318,622 MWh in 2004 in relation to the level of 2001. The duty to purchase such energy allows for avoiding 288.353 Gg of CO_2 emissions per year,
    - introduction of financial mechanisms in 2002 supporting energy production from renewable sources in the form of exemptions from excise tax on the sales of electricity from RES,
    - granting certificates of origin for electricity produced from these energy sources. This mechanism is strengthened by a system of fines imposed on energy enterprises for incompliance with the duty to obtain a specified number of certificates. Moreover, it is possible to decrease by 50% the costs related to the connection to the network of renewable electric power sources and to take advantage of other discounts for producing this type of energy.
- **Promotion of combined heat and power production** – as shown in Table 31, the level of combined heat and power production and process efficiency are systematically increasing. As a result, the average CO_2 emission in 2000–2004 has decreased by 33,534.158 Gg per year. At the same time the process of fuel conversion to more environmentally sound fuels, including those reducing greenhouse gas emissions, is underway in power plants and in combined heat and power plants,

[20] M.P. of 2005 No. 42, item 562.

Table 31. Combined heat and power production, and transformation efficiency in 2000–2004

Specification	2000	2001	2002	2003	2004
Fuel energy input [TJ]	1528042	1527571	1514717	1605269	1600696
Electricity production [GWh]	141032	141340	140159	148214	150326
Combined heat production [TJ]	196780	209276	205570	225409	219274
Efficiency [%]	46.10	47.01	46.88	47.28	47.51

Source: IEA STATISTICS – Electricity Information 2005 & 2006.

- **Introduction of "green certificates", certificates of origin for electric power produced from renewable energy sources** – these certificates have been introduced under the Act on Energy Law,
- **Introduction of a system of incentives for enterprises to undertake investments leading to energy saving** – the system of incentives includes:
  - preferential credits granted by a system of Funds for Environmental Protection and Water Management for modernising energy production sources and for thermo-modernisation activities,
  - donations provided by the EcoFund foundation for modernising energy production and for renewable energy sources,
  - donations from the European funds within the framework of the Integrated Operational Programme for Regional Development, launched in 2004,
- **Introduction of a system of incentives for the public sector to undertake investments leading to rational energy consumption** – the system of incentives includes the aforementioned credits and donations, as well as donations of the Global Environment Facility and mechanisms of the Act on supporting thermo-modernisation activities in public buildings (Table 30),
- **Modernisation of existing energy production technologies and enhancement of energy transformation efficiency** – modernisation of technology has been carried out in more than a dozen public energy plants and CHP plants, by, inter alia, putting into operation of fluidised boilers, by introducing biomass co-incineration and adjusting technology to combined energy production. Changes of the average transformation efficiency in the public energy sector in 2001–2004 (Table 32) caused a reduction of CO_2 emissions by almost 2,536.968 Gg/year.

Table 32. Transformation efficiency in the public energy sector in 2001–2004

Year	Efficiency [%]
2000	45.29
2001	45.90
2002	45.97
2003	45.96
2004	46.64

Source: GUS.

- **Introduction of the requirements concerning energy efficiency of new water heating boilers fired with liquid and gaseous fuels**[21)],
- **Introduction of key requirements regarding energy efficiency for cooling equipment (appliances)**[22)],
- **Energy efficiency labels** – since 2001 an obligation has been introduced of the labelling of household appliances, however no market survey has been carried out to enable a quantitative assessment of the effects of this activity. Fragmentary studies prove that e.g. in the case of use of energy-saving refrigerators CO_2 emission may decline by almost 77 Gg/year, and in the case of fluorescent lamps by nearly 1.6 Gg/year,
- **Improvement of the efficiency of electrical household appliances** – measures leading to the improvement of efficiency of such equipment are subject to the GEF project on Polish Energy Efficiency Motors Programme (described in Chapter 4.3),
- **The use of methane from mines for heat generation** – measures connected with de-methanising are taken in hard coal mines and their aim is to utilise this gas for industrial purposes. The level of methane in-take from mines in the given period of time is shown in Table 33. This measure enabled to obtain a total reduction of CO_2 emissions by almost 367.366 Gg.

Table 33. Recovery of high-methane natural gas from hard coal mines

Year	Amount of methane captured	
	[million m^3]	[TJ]
2000	226	7431
2001	330	10890
2002	297	9902
2003	344	11287
2004	368	12092

Source: GUS.

21) Act of 30 August 2002 on compliance assessment (Dz.U. of 2004 No. 204, item 2087, as amended) implementing Council Directive 92/42/EEC of 21 May 1992 on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels (OJ L 167 of 22.06.1992, p. 17).

22) Act of 30 August 2002 on compliance assessment (Dz.U. of 2004 No. 204, item 2087, as amended) implementing Directive 96/57/EC of the European Parliament and of the Council of 3 September 1996 on energy efficiency requirements for household electric refrigerators, freezers and combinations thereof (OJ L 236, 18.09.1996, p. 36; Polish special edition Chapter 12, vol. 1, p. 305).

– **Exemption from an excise tax on electricity production based on methane from hard coal mines** – an exemption from an excise tax on electricity production from methane released and captured during in-depth mining works is used.

4.5. Industry

Hard coal mining

A reduction of the production capacity as well as a declining impact of mines on the environment is observed in the mining sector. Employment reduction in the mining industry was compensated by special funds of the so-called Mining Social Package.

Chemical industry

This industry sector demonstrates constant and slow increase of production and sales. In effect of restructuring measures the property structure of the chemical industry has changed, especially in large enterprises – small and medium-size plants almost entirely belong to the private sector. Production technologies have undergone intensive modernisation. Direct foreign investments play a significant role in modernizing and restructuring the chemical industry. Chemical industry is highly capital consuming and strongly dependent on the sources of the resources. Its typical feature is also a very high production of semi-products, which are later processes by other industry sectors. The chemical industry is composed of the following branches:

1. Great chemical synthesis (WSCH), which includes:
   – petroleum industry – based on crude oil processing,
   – production of mineral fertilisers,
   – soda industry – based on rock salt and limestone,
2. Low-tonnage chemistry – production of pharmaceuticals, cosmetics and auxiliary products,
3. Chemical processing – manufacturing of end-products based on high-tonnage products, which includes:
   – rubber industry,
   – plastics industry,
   – paint and vanish industry,
   – distribution and trade of chemical agents.

Cement industry

The cement industry in Poland encompasses around a dozen of plants producing cement. High season-dependence is a characteristic feature of the domestic cement market, which derives from the climatic conditions in Poland. In the course of privatization the unit heat consumption for burning clinker has decreased by 22% compared with the level achieved in the early 1990s. Thus, the amount of off-gases emitted to the atmosphere per unit product also declined. Introduction of modern management methods and process control, production concentration and assigning high priority to economic effectiveness and environmental protection currently allows to classify the cement industry as the leading industries in Europe – technically and organizationally.

All these measures have led to the minimisation of cement industry's impact on the environment in our country. As compared with the late 1980s carbon dioxide emissions dropped by over 25%. The cement industry in its activity uses large amounts of waste as secondary resources for the production of clinker and cement additives (substitution of non-renewable fuels by waste). Alternative fuels are also used in this industry, saving natural fuel resources.

Iron and steel industry

Iron and steel metallurgy is a basis for supplying materials for the general construction, road, water, energy and municipal industries – it provides basic materials for the electromachinery, ship-building, machinery, transport, metal and extraction industries.

Refrigeration sector

Measures taken in the refrigeration industry are targeted at replacing gases used in cooling equipment that are subject to commitments of the Montreal Protocol as well as at reducing energy consumption in production processes. The refrigeration sector is preparing to introduce Regulation of the European Parliament and of the Council on certain fluorinated greenhouse gases, whose aim is to reduce the emission of certain greenhouse gases containing fluorine[23)] by introducing monitoring of leakage from equipment and restrictions of use for products and equipment containing these gases (regulation also includes placing on the market prohibitions of the products and equipment containing F-gases listed in Annex II). In Poland HFCs are used in the cooling sector and in air conditioning, both as single substances (mainly HFC–134a) and also as mixture components (HFC – 134a, HFC – 143a and HFC – 125). Currently, PFCs are not used in Poland in the refrigeration sector.

[23)] Fluorinated greenhouse gases (the so-called F-gases) means hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). In the majority of cases they are applied as substitutes for the commonly used so far substances that deplete the ozone layer (ODS), chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), which apart from having adverse effect on the ozone layer, also belong to greenhouse gases. Regulation (EC) No. 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases (OJ L 161 of 14.6.2006, pp. 1–11).

4.5.1. Policy

In industry priority has been given to restructuring of the following sectors: hard coal, zinc and lead mining, iron and steel metallurgy, sulphur mining and processing as well as cement and chemical industry. Furthermore, among other priorities addressed to the entire industry there are: privatization and restructuring of economic entities and overall industrial sectors, as well as consolidation of entities to strengthen their economic force, research and development activity, innovation growth and implementation of provisions pursuant to the updated Lisbon Strategy, inflow of direct foreign investments, public assistance and its proper assignment and elimination of barriers in business sector development.

4.5.2. Measures

Legislative and organisational measures:

- **Improvement of technical standards for equipment and facilities** – such measures result in an improvement of the energy effectiveness of industrial production[24] (e.g., in the iron and steel industry it results from the modernisation of natural gas-fired tunnel furnaces),
- **Implementation of best available techniques** – integrated permits are granted to installations and plants implementing BAT/BEP[25]. The use of best available techniques in the iron and steel industry was based on replacing open-hearth furnaces with electric converters, optimisation of the heating capacity of heaters, conversion from blast-furnace gas and coke-oven gas to natural gas, and modernisation of the process of steel smelting. In effect CO_2 emissions decreased by about 240 Gg,
- **Reduction of methane emissions from production processes and fuel distribution** – for this purpose certain regulations on hermetic air-tight sealing of fuel distribution have been enacted[26],
- **Development of a set of measures supporting the activity of small and medium enterprises, mainly in the field of introducing innovation and capacity improvement** – mechanisms supporting the activity used, inter alia, with regard to small and medium enterprises. In 2001–2003 the programme for the development of innovation covered 18.3% of small and 37.1% of medium enterprises. In the majority of cases it applied to manufacturing enterprises in the field of technical equipment and devices, as well as construction,
- **Promotion of environmentally sound and effective practices and technologies in industrial activity. Supporting the development of environmentally friendly and technically profitable (feasible) methods for reducing greenhouse gas emissions** – to promote environmentally friendly technologies a series of folders, which disseminate information on best available techniques for different production areas (for instance, guidebooks for brickyards and titanium white and soda production plants) have been published,
- **Setting of priorities for research and development targeted at sophisticated ecological and material- and energy-saving production technologies and provision of their financing** – many research and development (R&D) projects have been carried out, including a project entitled Approximation of the working conditions in Poland to the standards of the European Union. Furthermore, the following R&D projects have been prepared or undertaken:
  - *Improvement of innovation development systems in production and maintenance processes in 2004–2008*,
  - *Safety of exploitation of the technical infrastructure threatened by corrosion effects*,
  - *The state energy policy and energy security, and the management of natural and energy resources taking account of the European Union standards and of environmental requirements*,
- **Technological modernisation in industrial plants, reduction of CO_2 emissions in iron and steel industry** – technological modernisation in the mineral industry has led to a decrease in CO_2 emissions from 10,573 Gg in 2001 to 7,588 Gg in 2004 as a result of energy efficiency improvement in the production of clinker from 3,732 kJ/kg to 3,692 kJ/kg for the dry method and from 5,795 kJ/kg to 5,432 kJ/kg for the wet method, while maintaining the same production level. In metallurgy measures aimed at energy recovery from waste have led to a reduction of CO_2 emissions by almost 450 Mg/year. These measures were based on fuel conversion from coal to gas in boilers; the reduction of electricity unit consumption in the production of ferrosilicon; modernisation of heating furnaces and furnaces for thermal processing; construction of installations using

[24] Implemented Council Directive 92/42/EEC of 21 May 1992 on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels (OJ L 167 of 22.06.1992, p. 17) and Directive 96/57/EC of the European Parliament and of the Council of 3 September 1996 on energy efficiency requirements for household electric refrigerators, freezers and combinations thereof (OJ L 236, 18.09.1996, p. 36).

[25] The need to obtain such permits results from the Act on Environmental Protection Law, which implements Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (OJ L 257 of 10.10.1996, p. 26, as amended; OJ EU Polish special edition, Chapter 15, vol. 3, p. 80).

[26] Regulation of the Minister of Economy of 21 November 2005 on technical conditions that have to be met by liquid fuel bases and stations, long-range transmission pipelines used for transporting crude oil and petroleum products, and their location (Dz.U. No. 243, item 2063).

waste heat from rotary sinter coolers on sinter belt, purchasing and building of energy-saving ignition furnaces in sinter plants and building of installations for converter gas recovery.

4.6. Transport

The following are the most significant features of transport:

– increased general mobility of the inhabitants of Poland, fast development of individual transportation means and a dropping share of public passenger transport as well as rapid increase of passenger air transport,
– insufficient development and quality of transport infrastructure, which does not allow the infrastructure to keep up with the trends in place regarding the scale and ways of transportation (especially in road and air transport). It also does not keep up with the needs connected with the necessity to influence such trends, which are regarded as negative in order to limit their range and dynamics (overloaded road transport, especially on major national roads and in urban areas; lack of adaptation to the traffic loads and bad condition of road surface; bad technical quality of a significant part of the collective transportation fleet and of railway and tramway tracks; lack of sufficient fitting with sophisticated systems of traffic control).

4.6.1. Policy

The *State Transport Policy for 2006–2025* (alike the previous policy) sets out its major goal to fulfill the rational expectations of the public to modernise the basic transportation system and ensure high quality transport services, taking due account of, inter alia, the need to reduce the negative impact of transport on the environment and the living conditions. This requires parallel action in three directions:

– to optimize traffic and transportation growth rate,
– to have influence on the way passengers or goods are transported to use to a maximum extent those means of transport that are least harmful to the environment,
– to use technical and organisational solutions that reduce unfavourable environmental impacts.

The policy directions that are followed include, in particular, the improvement of the state of all category public roads and development of a network of motorways and express roads, modernisation of railways and improvement of the state of the railway infrastructure; safety improvement in transport; improvement of the quality of public transport in towns, the development of aviation service market and improvement in the operation of the inland water transport. The greenhouse gas reduction reserves in the transportation sector are to be found in the improvement of the organisation of passenger and freight shipment, and with associated infrastructure undertakings, as well as in the use of biofuels.

Preparations are underway to implement Directive of the Council and of the European Parliament on emissions from air conditioning systems in motor vehicles, whose aim is to reduce emissions of fluorinated gases (F-gases)[27)].

4.6.2. Measures

Legislative and financial measures:

– **Promotion and use of biofuels** – on 2 October 2003 the Parliament adopted an Act on biocomponents used in liquid fuels and liquid biofuels[28)]. Currently, work on the amendment of the act on biofuels is under-way; a system of taxes for fuels has been introduced, which promotes alternative fuels, an additional instrument has been used in the form of fees for making use of the environment, which are generally imposed for utilising motor fuels produced from non-renewable resources; excise duty levels for LPG[29)] that have been introduced are much lower than the ones for petrol or Diesel oil, which makes this type of fuel privileged. This has also caused greater interest of users in fitting their cars with LPG installations, which led to the development of service facilities and a distribution network for this fuel,
– **Introduction of a road tax** – work is underway to introduce charges for using road infrastructure, dependant on the distance driven and the ecological category of a vehicle,
– **Energy efficiency changes in road transport** – differentiated fee rates for driving on domestic roads have been introduced depending on the level of exhaust gas emissions from vehicles,
– **Promotion of "environmentally clean" motor vehicles** – a system of fees for making use of the environment has been established, which distinguishes vehicles with lower emissions of pollutants or with lower fuel consumption. Moreover, an information system on fuel consumption and CO_2 emissions in the marketing of new passenger cars has been introduced. Additionally, control of exhaust gas emissions as an obligatory element of the vehicle technical control plays an important role in this area.

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27) Directive 2006/40/EC of the European Parliament and of the Council of 17 May 2006 relating to emissions from air-conditioning systems in motor vehicles and amending Council Directive 70/156/EEC (OJ L 161 of 14.6.2006, pp. 12–18).
28) Dz.U. of 2003 No. 199, item 1934, as amended.
29) Liquid Petroleum Gas.

Technical measures:

- **Construction of motorways, by-pass roads and express roads** – in 2000–2004 the implementation of the programme for building motorways and modernising the road network has been intensified and this resulted in the building of almost: 297 km of motorways, 38 km of express roads, and 38 by-pass roads, which improved road traffic flowability and reduced energy losses resulting from congestion,
- **Improvement of vehicle energy effectiveness, including measures connected with vehicle construction** – as a result of technological progress declared by the producers of passenger cars and decisions of car buyers the consumption of fuels dropped markedly and thus CO_2 emissions decreased. For instance, a unit emission of CO_2 from passenger cars decreased from the level of 165 g/km in 2001 to 154 g/km in 2004. Introduction of noise limitations at airports in air transport is connected with the use of aircrafts with engines with technologically lowest possible fuel consumption,
- **Technical measures connected with vehicle construction** – there is an on-going progress in the improvement of fuel consumption efficiency in new passenger cars, trucks, buses, rail vehicles and aircrafts put into service in Poland,
- **Introduction of restrictions in speed rates in towns** – a legislative obligation has been introduced on speed limits in urban built-up areas during daytime up to 50 km/h (and up to 60 km/h during the hours between 23.00 and 5.00)[30],

Legislative and administrative measures:

- **Improvement of the infrastructure for cyclists and pedestrians** – activities that were undertaken focused on promoting bicycles as a means of transport and on building bicycle routes. Promotion of bicycle transport is favoured by the setting or building of bicycle paths and pedestrian pathways for the every-day local and tourist transport, both in the urbanised areas and beyond them. In 2003 the total area of pavements and bicycle routes in Poland for roads within the administrative limits of towns amounted to 79,910 thousand m^2, and for roads outside the administrative limits of towns 16,399 thousand m^2. Actions of non-governmental organisations promoting bicycle use as a means of transport, as well as attractive bicycle prices, which encourage their purchasing and use play a significant role in the popularisation of bicycles. Furthermore, the idea of multimodal transport (bicycle and collective means of transport) is being implemented by creating bicycle parking places close to places where modes of transport are changed and by providing possibilities for transporting bicycles by collective transportation means,
- **Promotion of public transport** – the structural changes that have been introduced in the Polish State Railways Joint Stock Company (PKP S.A.) should facilitate involvement of railway operators in providing services for collective transport at local and regional levels. Support is also provided for investment undertakings for the development of collective transportation services in towns, such as the co-financing with the state budget resources the building of an underground train in Warsaw,
- **Programme for the development of combined transport** – in 2001–2004 there has been an increase in the share of intermodal railway transportations in the total transportation from 1.2% in 2001 to 1.6% in 2004,
- **Improvement of the quality of water transport** – inland navigation ship-owners may apply for financial resources for undertakings to promote inland water transport as the most ecological branch of transport, and in particular for activities aimed at environmental protection (repairs, replacement of old engines with new ones that meet environmental requirements),
- **Measures to reduce greenhouse gas emissions from air transport** – the aviation space has been divided into two types: A and G, which will enable flights from point to point following the shortest route. The expected fuel-saving effect has been estimated at 6–8%. Implementation of the newest air navigation devices allows to reduce the waiting time of planes to land, and thus to reduce energy consumption.

Educational measure:

- **Information and educational activity related to the need for behavioural changes** – this activity resolved itself into information and educational activities related to economic driving, which is in favour of a significant reduction in fuel consumption and exhaust gas emissions (the so called "eco-driving") – many projects have been accomplished and standards and requirements of the European Aviation Safety Agency (EASA) have been incorporated into the operational procedures at airports and by aviation transporters (carriers) which contributed to more environmentally sound behaviour.

[30] Act of 20 June 1997 – Road Traffic Law (Dz. U. of 2005 No. 108, item 908, as amended).

4.7. Construction and housing

4.7.1. Policy

The housing policy is decentralised and subordinated to the decisions of the local self-governments[31]. The development of the housing sector for the poorest social groups is financially supported by self-governments (gminas), which also provide financial aid for the poor. Also the housing co-operatives take advantage of the country's assistance in paying back housing credits.

4.7.2. Measures

Legislative and organisational measures:

- **Introduction of energy standards in the construction sector** – the technical and construction requirements on effective and rational energy use in buildings have been extended by: thermal protection and heating, ventilation and air-conditioning installations, and hot water supply systems. Work on the energy performance of buildings is underway,
- **The process of thermo-modernisation of buildings** – more stringent requirements were put into effect regarding buildings intended for thermo-modernisation with the use of budgetary sources in the form of heating efficiency improvement bonuses. A new energy standard has been elaborated for buildings by introducing a new regulation[32]. In the case of existing buildings the energy demand drops by 50% on average after thermo-modernisation. For example, modernisation of public buildings caused a CO_2 emission reduction by 70.772 Gg in 2004 in relation to the level in 2001,
- **Raising awareness of the users and owners of buildings in energy saving** – an educational and information programme has been implemented, which is addressed to investors of new buildings, as well as managers and owners of the existing buildings. Its role is to motivate to improve the technical standard of construction resources (building stock), including the energy standard. Furthermore, a number of publications have been prepared and disseminated to promote energy-saving activities, such as: *Energy-saving house, Thermo-modernisation of buildings*.

4.8. Agriculture

4.8.1. Policy

The basis for agricultural management is provided in the *Strategy for the development of rural areas and agriculture for 2007–2013 (with elements of prognosis until 2020)*. The Strategy's aim is to improve the living and working conditions of inhabitants of rural areas through economic growth taking account of environmental requirements. This goal is to be achieved by implementing the following priorities, such as: improvement of the competitiveness in agriculture and forestry, rationalisation of land management and improvement of the quality of living in rural areas. Priorities of the agricultural policy for the nearest years include, inter alia: influence on the development of multifunctional agriculture through financial and legal instruments and maintenance of competitiveness of farms and of the entire European agriculture on the world market and maintenance of spatial agricultural management, including the problem areas. In the development of rural areas the most important targets are: sustainable development of agriculture and rural areas (the key issue is to engage resources and sources of wealth), economic stability of rural areas developed on the basis of work in agriculture and beyond, as well as social approval for transformation and environmental integration.

4.8.2. Measures

Legislative and organizational measures:

- **Rational use of fertilisers, including nitrogenous fertilisers** – in 2000 in the course of measures taken by the Minister of Agriculture and Rural Development the doses of natural fertilisers have been limited to 170 kg N/ha·year in terms of pure ingredient. Also the use of fertilisers in flooded soils, in soils covered with snow and in frozen soils, as well as soils on mountain slopes has been forbidden. Moreover, a requirement for large commercial farms to have a fertilisation plan has been introduced. To facilitate rational fertilisation a consultancy system has been introduced to provide assistance in determining the exact required doses of fertilisers, and farmers are obliged to use the Common Good Agricultural Practice. In order to determine the contents of mineral nitrogen in agricultural soils monitoring of soils in Poland is carried out in early spring and in autumn. The use of mineral fertilisers in 2001–2004 is presented in Table 34.

Table 34. Consumption of mineral fertilisers in 2001–2004

Consumption [in thousand tonnes]	2001/2002	2002/2003	2003/2004
NPK fertilisers total, incl.:	1574.2	1511.7	1622.1
Nitrogenous fertilisers	861.8	831.7	895.0
Organic fertilisers	56800.0	48800.0	56000.0

Source: GUS.

[31] In over 90% of cases it is individual or commercial housing. Building investments are subject to Building Law and are subject to control from building supervision.

[32] Regulation of the Minister of Infrastructure of 15 January 2002 on detailed scope and format of the energy audit (Dz.U. of 2002 No. 12, item 114).

- **Rational energy management in agriculture, including energy production from biomass waste, and from solid and liquid manure** – new boiler houses using biomass waste, timber and straw were built in the rural areas with financial support. It is estimated that around 200 straw-fired boilers and 250 wood-fired boilers were built in 2001–2004. They are low- and medium-capacity boilers (<500 kW). Apart from these measures taken in agriculture other activities focused on: supporting the purchase of seeding material for energy plants, supporting the purchase of individual installations for energy supply from renewable sources, and introducing preferential credits for the production of raw agricultural spirit or rape oil used as biocomponents in liquid fuels. These activities reduced CO_2 emissions in 2001–2004 by app. 2.843 Gg and CH_4 emissions by 5.7 Mg,
- **Support for using other renewable energy sources in agricultural production** – thanks to various forms of support app. 1,000 m^2 of solar water collectors and app. 300 m^2 of air collectors were created in agriculture, which corresponds to app. 2,046 GJ of energy obtained. This caused CO_2 emission to fall by app. 0.185 Gg/year,
- **Reduction of solid fuel coal and coke demand** – a decrease in the consumption of traditional fuels is observed in agriculture in 2001–2004. This resulted in a reduction of CO_2 emissions, which declined in 2004 in relation to the year 2001 by 883.450 Gg,
- **A change in the structure of fuels used in favour of hydrocarbon fuels and reduction of Diesel oil consumption** – in 2004 app. 48.5 million litres of bioethanol have been put into the fuel market, which caused a decrease in petrol consumption in agriculture by almost 50% compared to the period of 1996–1998. The share of biofuels (bioethanol and esters) in fuels used in transport (petrol and diesel oil) accounted for app. 0.3% in 2004. It is expected that this share will rise in 2006 to the level of 1.5%. However, the rapid growth of transport development in the rural areas, despite these measures, caused an increase in the total CO_2 emissions,
- **Technical modernisation of farms** – modernisation measures focused mainly on adapting farms to the EU standards. As regards environmental protection they concerned water and soil protection aspects. The problem of reducing greenhouse gas emissions had a lower priority in these activities. The only activity affecting reduction of methane emissions was the building of manure plates (gutters) for animal excrements and containers for liquid fermented and unfermented manure,
- **Improvement of farm animal raising systems, reduction of methane from animal excrements, application of methane removal methods in litter-free raising of ruminants** – methane emissions from these sources declined by almost 51.000 Gg, while nitrous oxide emissions increased by 750 Mg. These changes resulted mainly from changes in the population of animals, and to a lesser extent from measures taken in this field,
- **Preference to crops with a high CO_2 removal factor** – subventions to energy willow (*Salix* sp.) and Japanese rose (*Rosa multiflora* var.) plantations have been introduced (55.46 EUR/ha). The cultivated area of these plants covers app. 6,000 ha,
- **Development of new technologies for growing and harvesting plant biomass intended for use as a renewable energy source and raw material for the industry** – new technologies for growing and harvesting willow, miscanthus (*Miscantus sinensis*), Pensylvanian mollow (*Sida hermoaphrodita*) and hemp (*Cannabis sativa*) have been developed. The total area grown with these crops has been estimated at 6–7 thousand ha and shows an upward trend.
- Apart from the aforementioned support provided by GEF for such measures taken, **other preferential credits for investments on new production technologies have been put into operation, including those connected with manufacturing of raw material for the production of bioethanol and bio-components, as well as animal production.**

4.9. Forestry

4.9.1. Policy

The ultimate goal of the forest policy, which has been formulated in a document the *National Forest Policy*, adopted by the Council of Ministers in April 1997, is to lay down measures targeted at sustainable multifunctionality of forests, their usefulness and protection, as well as their role in the shaping of the environment. This goal will be achieved through an increase in the national forest cover to 30% in 2020 and to 33% in the mid 21st century, reinstatement and rehabilitation of forest ecosystems and regeneration of the devastated and neglected treestands in private forests. Implementation of these measures should lead to increased removal and capture of carbon dioxide.

4.9.2. Measures

Legislative and organisational measures:

- **Combating changes in land-use** – transformations of forest land into non-forest purposes are of marginal significance in relation to the constantly growing total forest land area,
- **Rational forest management, incentives and measures supporting afforestation, preservation of environmental stability of forests** – forest management is conducted

pursuant to Act of 28 September 1991 on forests (Dz.U. of 2005 No. 45, item 435, as amended) and it includes both afforestation of non-forest land, reforestation, and enlargement of standing stocks with timber removal limitation to the level of 50–60% of the annual biomass growth. In 2004 in total 12.7 thousand ha of agricultural land used for agricultural purposes including 9.7 thousand ha owned by the State Treasury has been afforested,

– **A plan for the utilisation of wood for energy purposes** – in 2004 an installation for co-incineration of biomass has been put into operation in the "Połaniec" Power Plant. The annual use of timber amounts to about 400 thousand m^3,

– **Research on the level of carbon removal** – a research project has been launched, named *The role of forests and forest management in designing CO_2 balance in Poland*.

4.10. Waste and wastewater

4.10.1. Policy

The major goals of waste management in Poland have been laid down in the *Second State Environmental Policy*. Issues concerning the actual waste management status, by individual sectors, are presented in the *National Waste Management Plan*[33] (KPGO) covering the period of 2003–2014.

The ultimate objective is to prevent the generation of waste "at source", to recover the resources and to re-use waste, as well as to finally dispose of unused waste in an environmentally safe manner. This can only be achieved by reducing the material and energy-consuming production, by using alternative renewable energy sources and by applying full product "life-cycle" analysis.

4.10.2. Measures

Utilisation of waste by plants that are their generators is slowly improving. In 2001 out of the total number of 1,369 plants producing waste that are covered by public statistics, 1,281 plants utilised their own waste, of which 676 plants used over 95% of waste. Whereas in 2004 the relevant figures were as follows: 1,482, 1,321 and 823, respectively. A particularly positive effect is an increase in the number of plants with a high percentage of waste that is recovered.

Legislative and organisational measures:

– **Recovery and recycling of waste** – as shown in Tables 35 and 36, in 2000–2004 the amount of waste recovered from the economy sector remained at a similar level

Table 35. Waste generated in the economy sector (excluding municipal waste) in 2000–2004

Years	Waste generated				
	Total amount [in million Mg]	Recovered	Treated		Stored temporarily
			Total	Disposed of at landfills	
	million Mg (% of generated)				
2000	125.5	96.5 (76.9%)	25.1 (20.0%)	22.3 (17.8%)	3.9 (3.1%)
2001	123.8	96.8 (78.2%)	23.9 (19.3%)	20.6 (16.6%)	3.2 (2.5%)
2002	117.9	93.2 (79.0%)	20.8 (17.6%)	17.1 (14.5%)	4.0 (3.4%)
2003	120.6	95.4 (79.1%)	21.7 (18.0%)	16.1 (13.3%)	3.5 (2.9%)
2004	124.0	97.4 (78.5%)	22.6 (18.2%)	17.1 (13.8%)	4.0 (3.3%)

Source: GUS.

Table 36. Waste generated in the economy sector (excluding municipal waste), treated and deposited on land, and the state of landfill sites in 2000–2004

Years	Waste generated annually							Waste deposited on landfill sites (accumulated) so far as of end of a year)	Waste landfill sites	
	Total	Recovered	Treated				Stored temporarily		Unreclaimed area (as of end of a year)	Reclaimed area annually
			Total	through						
				thermal processing	composting	landfilling				
	in thousand Mg								in hectares	
2000	125484.1	96468.5	25117.7	186.9	73.7	22346.7	3897.9	2011034.5	10973.1	368.6
2001	123810.0	96771.0	23857.1	245.3	86.1	20506.7	3181.9	1977946.6	10642.4	291.5
2002	117894.2	93175.5	20768.0	309.7	82.8	17051.9	3950.7	1813329.6	10194.4	145.9
2003	120551.4	95415.0	21657.6	411.7	115.3	16064.7	3478.8	1779769.2	9895.0	145.2
2004	124029.5	97414.7	22578.3	263.0	158.1	17133.3	4036.5	1745347.0	9685.5	375.2

Source: GUS.

[33] Resolution no. 219 of the Council of Ministers of 29 October 2002 on the national waste management plan (M.P. of 2003 No. 11, item 159).

Table 37. Recovery and recycling of packaging and products (in %)

Waste products	2002		2003		2004	
	Recovery [%]	Recycling [%]	Recovery [%]	Recycling [%]	Recovery [%]	Recycling [%]
Packaging	–	24.7	–	26.7	36.3	24.5
Lubricating oils	35.5	26.8	52.3	33.9	42.3	30.5
Tires	27.5		43.5		58.9	11.5
Air-conditioning equipment	6.2	6.2	20.5	20.7	77.6	96.7
Refrigerating equipment	10.6	10.6	6.2	10.5	39.5	49.9
Household refrigerators	3.8	3.8	21.1	21.1	–	–
Nickel-cadmium accumulators	5.5	5.4	12.7	13.2	35.1	39.4
Galvanic cells Batteries	1.0	0.0	5.0	4.1	9.7	6.8
Discharge lamps	7.5	2.7	13.2	13.3	18.2	18.5

Source: MŚ.

(app. 79%), the amount of waste that were disposed of rose insignificantly (from 17.6% in 2002 to 18.2% in 2004), the amount of waste deposited in landfills declined systematically (from 17.8% in 2000 to 13.8% in 2004), and the amount of waste that was stored remained at the same level; changes in waste recovery and recycling are shown in Table 37.

– **Modernization of the landfilling of solid waste** – pursuing the implementation of measures, identification of landfills intended for liquidation has been undertaken and ranking lists of landfills intended for modernisation have been prepared. In 5 voivodships this task has been fully accomplished, while in others work is still underway; as shown in Table 38, the amount of municipal waste that is collected for disposal at landfills is constantly and significantly declining with a decrease in 2004 in relation to 2000 by app. 20%.

Table 38. Quantities of municipal waste deposited in 2000–2004

Year	2000	2001	2002	2003	2004
Amount of waste [thousand Mg]	12225.7	11109	10509	9924.8	9759.3

Source: GUS.

At the same time the monitoring of municipal waste, conducted in 2000–2004, especially related to the waste accumulation indicator (kg/Mg·year) shows a stagnation of this indicator. Taking account of the demographic changes, the amount of municipal waste collected for disposal should remain at a similar level (with a tendency towards a slight increase). A decline observed in the amount of municipal waste collected for disposal is unlikely to be connected with a reduction in waste generation. This drop may be affected by: increasing poverty of the public, limited waste collection services, and in particular "incomplete" reporting on collected municipal waste by economic entities.

– **Utilisation of landfill gas and biogas for energy production** – in 2001 out of a total number of 1,036 municipal waste landfills in Poland 112 were fitted with de-gassing installations (for landfill gas recovery); out of this number 7 disposed of the landfill gas without recovering the energy, and 21 with energy recovery (4 for heat production and 17 for electricity production). In 2004 the number of landfills declined to 1049, out of which 207 applied de-gassing: 9 without energy recovery, and 32 with energy recovery (5 for heat production and 27 for electricity production),

Wastewater

– **Implementation of biological wastewater treatment processes based on BAT** – data of the years 2000–2004 (Tables 39 and 40) indicate a significant progress in the biological treatment of wastewater, especially in an increased share of high-performance treatment processes, which are to a great extent based on BAT. This relates to ENR treatment plants with an elevated removal of nutrients (nitrogen and phosphorous). Building of new treatment plants and modernisation and reconstruction of the old ones allowed to increase the high-efficiency treatment in biological treatment plants from 36.2% to 56.4% in 2004,

– **Reduction of energy intensity in wastewater treatment processes** – over the last decade the energy consumption of wastewater treatment plants has decreased, as a result of:
  – changes in wastewater treatment technologies and introduction of BAT,
  – the use of energy-saving equipment and introducing systems for their operation adjusted to the actual pollution loads in treated wastewaters,
  – utilisation of biogas from sludge fermentation for the production of heat and electricity for the purposes of treatment plants.

Table 39. Treated and untreated municipal wastewaters

Wastewater	2000		2001		2002		2003		2004	
	[million m³/year]	[%]	[million m³/year]	[%]	[million m³/year]	[%]	[million m³/year]	[%]	[million m³/year]	[%]
Total	**1494.0**	**100.0**	**1425.3**	**100.0**	**1190.9**	**100.0**	**1323.7**	**100.0**	**1293.6**	**100**
Treated	*1243.4*	*83.2*	*1227.4*	*86.1*	*1353.1*	*88.0*	*1159.1*	*87.6*	*1152.3*	*89.1*
Mechanically	84.8	5.6	74.0	5.1	61.1	4.5	59.5	4.5	54.2	4.2
Biologically	1158.6	77.6	1153.4	81.0	1129.9	83.5	1099.6	83.1	1098.0	84.9
including ENR*	450.5	30.2	501.4	35.2	546.3	40.4	608.7	46.0	650.8	50.3
Untreated	*250.6*	*16.8*	*197.9*	*13.9*	*162.2*	*12.0*	*164.8*	*12.4*	*141.3*	*10.9*

* ENR – treatment plants with Enhanced Nutrient Removal, largely based on BAT.
Source: GUS.

Table 40. Percentage of different methods of municipal wastewater treatment

Wastewater treatment method	2000	2001	2002	2003	2004
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Mechanical treatment	6.8	6.0	5.1	5.1	4.7
Biological treatment	93.2	94.0	94.9	94.9	95.3
including ENR	36.2	40.9	45.9	52.5	56.4

Source: MŚ.

The percentage of treatment plants equipped with closed fermentation chambers has increased from app. 46% to app. 54%, and also the level of biogas use has increased from app. 80% to 98%. The methane emission level has significantly decreased. The estimated CH_4 emissions from wastewater treatment plants and from sludge processing amounted to app. 30 Gg CH_4/year in 2000, whereas in 2003 to around 8 Gg CH_4/year.

5. PROJECTIONS OF GHG EMISSIONS AND REMOVALS, AND THE EFFECTS OF POLICIES AND MEASURES

5.1. Projections of greenhouse gas emissions and removals

Following the guidelines of the UNFCCC, two projection scenarios were developed for GHG emissions: "with measures" and "without measures" for the years: 2005, 2010, 2015 and 2020. The key scenario is the "with measures" scenario in which currently implemented policies and measures were accounted for. Both scenarios were elaborated in accordance with the requirements for national GHG inventories following methodologies presented in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* and in *Good Practice Guidance and Uncertainty Management*.

Macroeconomic assumptions used in the "with measures" scenario are presented in Table 41. Annual averaged GDP growth is expected to be 5.1% in 2005–2010, 5.2% in 2011–2015 and 4.8% during 2016–2020. According to demographic projections, Poland's population will continue to decrease from 38,123 thousand in 2005 to 37,626 thousand in 2020. According to energy forecasts, during 2005–2020 we may expect steady improvement of effectiveness of energy use in all sectors of economy (Table 42), and also significant increased use of natural gas and renewables for electric energy production. The demand for electric energy is expected to grow steadily.

In forecasting the development of energy sector, the methodology introduced by International Atomic Energy Agency (IAEA) was applied. The methodology is used worldwide in energy related studies. In this methodology, the driving force behind the growing energy demand is the economic growth described by macroeconomic variables. To elaborate the energy demand forecast, the end-use model MAED was applied, i.e. bottom-up approach. Model of this type is the only recommended by IAEA approach for projections of energy demand in long-term forecasts (10 or more years). Projections of useful energy use were made based on assumed scenario of macroeconomic development, energy policy, progress and innovative measures adopted in energy use. These projections were made for each direction of energy use within each sector of economy. Coefficients of energy efficiency improvement were determined based on 1994–2004 statistical data. Results of MAED model provide input to energy-ecological simulation model BALANCE, which determines demand for final energy disaggregated into energy carriers and determines national energy balances and provides estimates for the amounts of emitted air pollutants. The basic idea behind the model is the market approach: each producer and each energy user operate on a simulated energy market, which results in optimal costs for energy supply. Hence, the BALANCE model brings the most probable projection of future state of energy economy – under given assumptions and boundary conditions with respect to primary fuel prices, national energy policy, technological progress, limited access to energy carriers, and also time limita-

Table 41. Projected changes of main macroeconomic indexes in 2005–2020 according to scenario "with measures"

Specification	Changes	2005–2010	2011–2015	2016–2020
GDP	Mean annual increase [%]	5.1	5.2	4.8
Population	Change over a period [%]	-0.6	-0.7	-1.1
Change of gross electric energy demand	Per cent increase over the period	20.5	16.5	15.3
Increase of electric energy production based on natural gas	Per cent increase over the period	26.7	35.1	64.9
Increase of electric energy production based on renewable sources	Per cent increase over the period	197.6	20.8	21.9
Increase of share of electric energy produced based on natural gas	Per cent increase over the period	0.21	0.56	1.69
Increase of share of electric energy produced based on renewable sources	Per cent increase over the period	4.5	0.3	0.5

Source: ARE.

Table 42. Projected improvements of effectiveness of energy use in relation to 2003 (expressed in %)

Specification	2005	2010	2015	2020
Heavy industry				
Electric energy users	1.78	8.79	13.87	17.87
Hot water and steam	2.35	11.60	18.32	23.59
Process heat	2.77	13.67	21.58	27.79
Non-energy use	0.00	0.00	0.00	0.00
Other industry				
Electric energy users	1.77	8.75	13.81	17.79
Hot water and steam	4.52	22.27	35.15	45.27
Process heat	1.06	5.21	8.22	10.59
Agriculture				
Electric energy users	1.26	6.19	9.77	12.58
Motor fuels	0.06	0.34	0.57	0.77
Other fuels	2.01	9.93	15.67	23.90
Services				
Space heating	3.01	9.50	15.03	19.94
Water heating	2.53	8.00	12.66	16.79
Cooking	1.90	6.00	9.50	12.59
Lighting	2.85	9.00	14.24	9.00
Electric appliances	-1.27	-4.00	-6.33	-8.40
Households				
Space heating	1.06	3.67	5.56	7.05
Water heating	-0.14	2.47	4.36	5.85
Cooking	0.46	3.07	4.96	6.45
Lighting	9.65	12.20	14.05	15.51
Electric appliances	-0.35	2.20	4.05	5.51

Source: ARE.

tions for investment processes. The optimal pathways for sources of electrical energy in the national grid were determined using WASP-IV model. For tasks "what happens, if?" optimization model MESSAGE was applied – which communicates with the BALANCE model. The energy demand is determined by using the MAED model on the basis of statistical data of 1994–2004 and the economic development scenario that has been prepared (together with the GUS population projections). This energy demand is an input information to the BALANCE model, whose one of the outputs is information on final energy demand. Projected final electric energy consumption, with the results of the simulation regarding the development of public and industrial combined heat and power plants, and with the agreed modernisation plan of the existing system power plants are all inputs for the WASP optimisation model. The model outcome is an optimum pathway for the development of system power plants. The known structure of combined heat and power production – together with the previously determined final energy demand – allow to determine by the BALANCE model the projected demand for primary energy carriers, projected energy prices and emissions of pollutants.

In the case of the "without measures" scenario, the forecast of GDP growth was made upon a multi-year 1995–2004 trend based on data of the Central Statistical Office – GUS, which was then extrapolated for the 2005–2020 period, by applying the growth rates used in *Energy Policy*, i.e. 5.8% growth during 2005–2010 and 5.1% growth in 2011–2020. Moreover, a modified trend of primary energy use to GDP ratio for the period 1995–2020 was assumed, which assumes slower but continuous decrease of that ratio. A linear, decreasing trend of the ratio was assumed with annual decrease by 0.35%. The starting year for the assumed trend was 1997. Based on the modified trend of primary energy use to GDP ratio, a new projection was made for the primary energy use: "without measures" scenario. According to the projection for the year 2020, the total use of primary energy is higher by 976 PJ (19.6%) than the respective figure in the "with measures" scenario.

Figures 7 to 12, presented below, show the comparison of projected emissions "with measures" and "without measures" scenarios in the base year, 2000, 2003 and 2005, 2010, 2015 and 2020 in the main IPCC source categories. In the case of the following source categories: 3. *Solvents and other product use*, 4. *Agriculture* and 5. *Land use, land-use change and forestry*, both scenarios "with measures" and "without measures" yield very similar results, so no differences can be seen in the respective figures. It should be noted that GHG emission estimates for the base year and the following years may change due to recalculation of the entire time series scheduled for 2006. The need for the recalculation of the national GHG emission inventory comes from the necessity to standardize the inventory methodology and in order to follow the recommendations made by the Expert Review Team of the UNFCCC Secretariat that reviewed the Polish GHG inventory in 2005.

In sector 1. *Energy* (Figure 7) GHG emissions in 2000–2003 were much lower than in the base year. While in the 2005–2020 period, emissions are expected to grow in both scenarios (in scenario "without measures" the growth is higher), but still the level of emissions remains well below 1988.

The projected emissions in sector 2. *Industrial Processes* (Figure 8) in both scenarios: "with measures" and "without measures" differ only in case of sulphur hexafluoride – SF_6 emissions – from production, assembly and use of electric appliances that contain that gas. Therefore, the differences in sector emissions expressed in CO_2 equivalent are insignificant and cannot be seen in the figure. The projections show that GHG emissions in that sector will continue grow in the period 2005–2015 and then they will stabilize until 2020.

In sector 3. *Solvents and other product use* (Figure 9) GHG emissions are expected to decrease during the time period covered by the projections. Projections for that sector cover only the period until 2010 due to the lack of 2010–2020

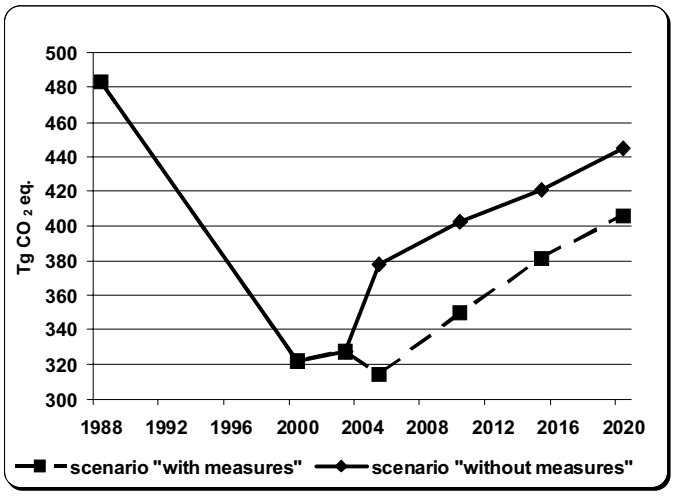
projections for the non-methane volatile organic compounds based on which carbon dioxide emissions are estimated in this source category.

In sector 4. *Agriculture* (Figure 10) 2005–2020 GHG emissions are generally expected to stabilize after 2005 except for enteric fermentation, which is expected to decrease due to the projected decrease of livestock population of cattle. Emission data for years covered by the projections cannot be directly compared with the respective data for the period 2000–2003 because of the ongoing in 2006 recalculation of greenhouse gas emissions in that sector.

Emission projections made for sector 5. *Land use, land-use change and forestry* (Figure 11) showed a decreasing trend for net removal of greenhouse gases, from app. 28 Tg in 2005 to slightly above 20 Tg in 2020. These changes are mainly caused by the projected increase of biomass removed in commercial harvest until 2020. This will bring net decrease of removal despite projected growth of forest area (due to afforestation) and projected growth of biomass stocks.

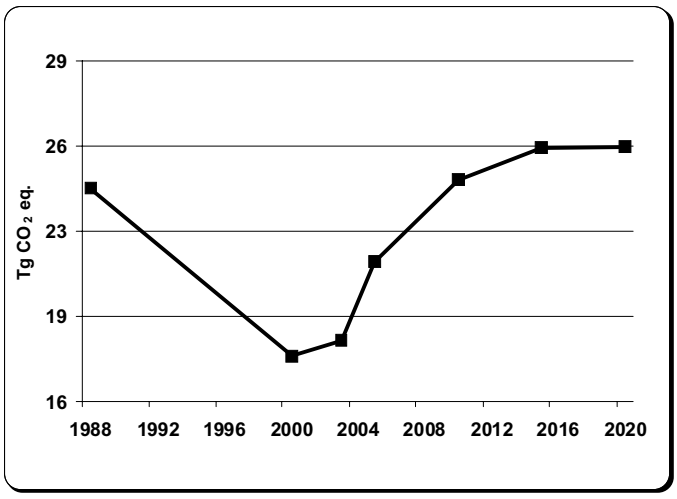
In sector 6. *Waste* (Figure 12) GHG emissions are expected to grow in 2005–2020, especially after 2010 due to projected completion of new municipal waste incineration plants and growing amounts of sewage sludge. Emission data for years covered by the projections cannot be directly compared with those for 2000–2003 due to ongoing recalculation of greenhouse gas emission estimates in that sector.

Figure 7. Greenhouse gas emissions from sector 1. *Energy* in 1988–2020 (Tg CO_2 eq.)



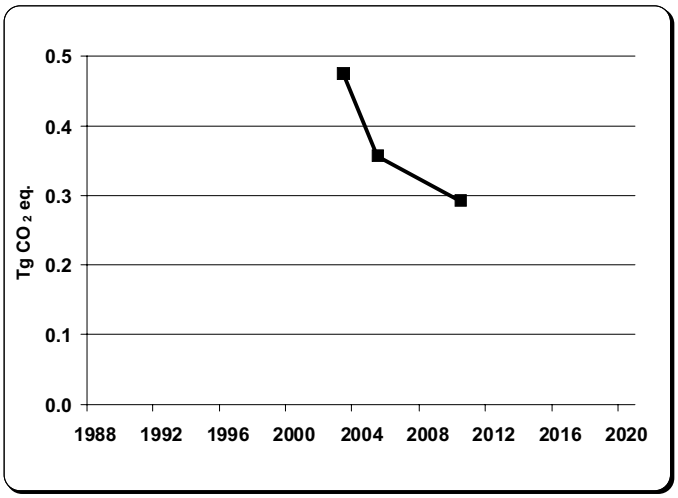
Source: MŚ.

Figure 8. Greenhouse gas emissions from sector 2. *Industrial Processes* in 1988–2020 (Tg CO_2 eq.)



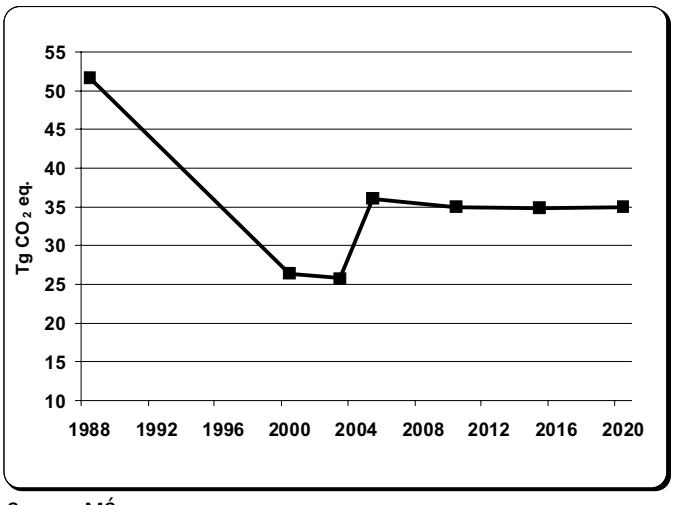
The base year for HFCs, PFCs and SF_6 is 1995 for Poland.
Source: MŚ.

Figure 9. Greenhouse gas emissions from sector 3. *Solvent and Other Product Use* in 1988–2020 (Tg CO_2 eq.)



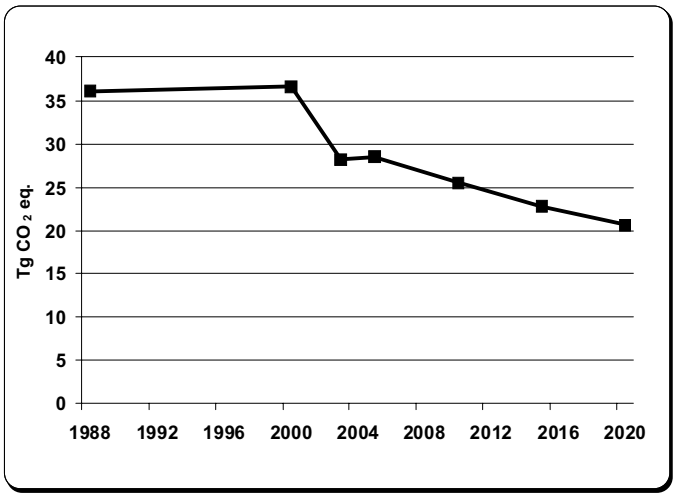
Source: MŚ.

Figure 10. Greenhouse gas emissions from sector 4. *Agriculture* in 1988–2020 (Tg CO_2 eq.)



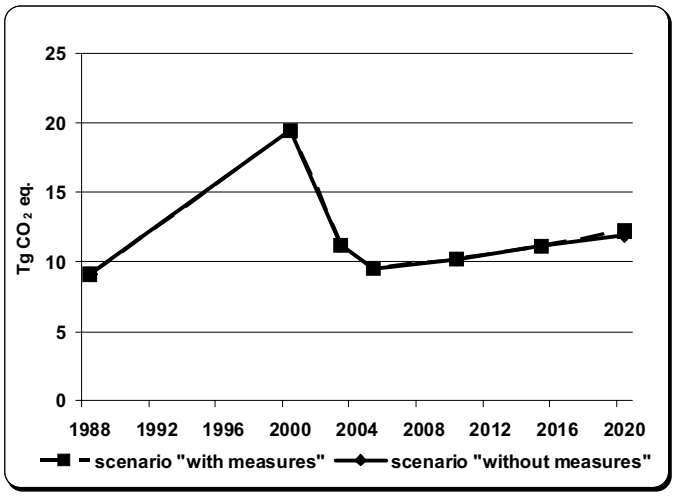
Source: MŚ.

Figure 11. Greenhouse gas net removals from sector 5. *Land use, land-use change and forestry* in 1988–2020 (Tg CO_2 eq.)



Source: MŚ.

Figure 12. Greenhouse gas emissions from sector 6. *Waste* in 1988–2020 (Tg CO_2 eq.)



Source: MŚ.

Detailed data on greenhouse gas emissions in the base year and years covered by the projections are shown in Table 43 ("with measures" scenario) and Table 44 ("without measures" scenario). In both scenarios, GHG emissions are expected to grow but without exceeding the level of the base year emissions. The emissions increase in the 2005–2020 period is caused mainly by increasing demand for energy and therefore resulting in emissions growth in sector 1. *Energy.*

In Tables 45 and 46, below, the current greenhouse gas emission projections for: 2005, 2010, 2015 and 2020 are compiled against the levels projected for the purposes of the Third National Communication. Therefore, scenarios for individual sectors that correspond best with the present scena-

Table 43. GHG emission projections for the "with measures" scenario; comparison with the base year

GHG in CO_2 equivalent		1988/1995	2005	2010	2015	2020	2005	2010	2015	2020
		[Gg]	[Gg]	[Gg]	[Gg]	[Gg]	% of base year			
1	Energy	482817.0	314564.67	349991.6	381014.2	405993.1	65.2	72.5	78.9	84.1
2	Industrial processes	24170.2	21377.80	24503.5	25741.0	25755.8	88.4	101.4	106.5	106.6
3	Solvents and other product use	1006.5	357.33	292.5	0.0	0.0	35.5	29.1	0.0	0.0
4	Agriculture	51741.6	36068.33	35001.1	34856.6	35045.1	69.7	67.6	67.4	67.7
5	Land use, land-use change and forestry	-36022.4	-28461.29	-25442.3	-22763.4	-20637.6	79.0	70.6	63.2	57.3
6	Waste	9093.6	9484.42	10204.5	11148.3	12232.9	104.3	112.2	122.6	134.5
Sum of projections in sectors (without sector 5)		568828.9	381852.55	419993.2	452760.2	479026.9	67.1	73.8	79.6	84.2

Source: MŚ.

Table 44. GHG emission projections for the "without measures" scenario; comparison with the base year

GHG in CO_2 equivalent		1988/1995	2005	2010	2015	2020	2005	2010	2015	2020
		[Gg]	[Gg]	[Gg]	[Gg]	[Gg]	% of base year			
1	Energy	482817.0	377896.4	402315.1	420898.9	444448.3	63.5	67.6	70.1	75.5
2	Industrial processes	24170.2	21385.4	24515.9	25758.2	25777.8	88.5	101.4	106.6	106.7
3	Solvents and other product use	1006.5	357.3	292.5	0.0	0.0	35.5	29.1	0.0	0.0
4	Agriculture	51741.6	36068.3	35001.1	34856.6	35045.1	69.7	67.6	67.4	67.7
5	Land use, land-use change and forestry	-36022.4	-28461.3	-25442.3	-22763.4	-20637.6	79.0	70.6	63.2	57.3
6	Waste	9093.6	9484.4	10194.6	11148.3	11881.6	104.3	112.1	122.6	130.7
Sum of projections in sectors (without sector 5)		568828.9	445191.9	472319.1	492662.0	517152.8	78.3	83.0	86.6	90.9

Source: MŚ.

Table 45. Comparison of greenhouse gas emission projections in selected sectors with data included in the Third National Communication

Third National Communication					Fourth National Communication				
Scenarios	**2005**	**2010**	**2015**	**2020**	**Scenarios**	**2005**	**2010**	**2015**	**2020**
Power engineering [million tonnes of CO_2]					**Sector 1.A.1.a Electricity and heat production** [million tonnes of CO_2]				
base-line	128	123	–	101.5	"with measures"	180	200	224	241
passive	159	173	–	187	"without measures"	217	228	236	250
Energy [million tonnes of CO_2]					**Sector 1. Energy** [million tonnes of CO_2]				
base-line	382	394	428	439	"with measures"	300	334	364	388
passive	372	372	379	383	"without measures"	363	385	402	423
Transport [thousand tonnes of CO_2 eq.]					**Sector 1.A.3 Transport** [thousand tonnes of CO_2 eq.]				
base-line reduction	32188.0	34527.0	35182.0	35755.0	"with measures"	38971.1	45629.4	50813.7	56496.9
base-line reference	34203.0	37776.0	39153.0	39611.0	"without measures"	40690.1	44793.1	49735.4	54983.2
Manufacturing industry [million tonnes of CO_2 eq.]					**Sector 1. Energy (without transport)** [million tonnes of CO_2 eq.]				
base-line	224	283	364	469	"with measures"	275.6	304.4	330.2	349.5
passive	203	259	339	442	"without measures"	337.2	357.5	371.2	389.5
Forestry [million tonnes of CO_2]					**Sector 5. Land-use change and forestry** [million tonnes of CO_2]				
Full implementation of KPZL	–	32.9	–	37.1		28.5	25.4	22.8	20.6
Without implementation of KPZL	–	32.2	–	34.8					

Source: MŚ.

Table 46. Comparison of nitrous oxide emission projections in selected sectors with data included in the Third National Communication

N_2O emission [Gg]	Third National Communication				Fourth National Communication			
	2005	**2010**	**2015**	**2020**	**2005**	**2010**	**2015**	**2020**
Sectors	**progress scenario**				**"with measures" scenario**			
1.A Fuel combustion	7.880	8.093	8.406	8.725	6.892	7.892	8.621	9.190
2.B Chemical industry	13.890	14.190	7.890	7.890	15.116	15.116	15.116	15.116
4. Agriculture	61.094	63.717	65.006	66.334	74.426	73.746	74.455	75.491
Sum	82.864	86.000	81.302	82.949	96.434	96.755	98.193	99.797
	reference scenario				**"without measures" scenario**			
1.A Fuel combustion	7.808	7.794	7.980	8.168	8.114	9.581	10.214	10.917
2.B Chemical industry	13.890	14.190	14.090	13.990	15.116	15.116	15.116	15.116
4. Agriculture	57.063	59.852	61.539	62.714	74.426	73.746	74.455	75.491
Sum	78.761	81.836	83.609	84.872	97.657	98.444	99.786	101.524

Source: MŚ.

rios "with measures" and "without measures" prepared for the Fourth National Communication have been taken from the Third National Communication. It is difficult, however, to compare those data directly due to the limited scope of sectors considered in previous projections. Projections of greenhouse gas emissions in the Third National Communication related only to carbon dioxide and nitrous oxide, and for certain sectors projections covered total emissions, expressed as CO_2 equivalent.

Tables 47 and 48 present GHG emissions expressed in CO_2 equivalents disaggregated into individual gases for the base year (1988 for basic gases, and 1995 for F-gases), 2000, 2003 and for the years covered by projections: 2005, 2010, 2015 and 2020 for the "with measures" (Table 47) and "without measures" (Table 48) scenarios and broken down into the main source categories.

Emissions trends in both considered scenarios are close to each other. Until 2005, GHG emissions continue to decrease. After 2005, the emissions are expected to grow steadily, following the changes in sector 1. *Energy,* in which steady growth of emissions is projected over the entire 2005–2020 period. Steady emissions growth 2005–2020 is projected also in sector 2. *Industrial Processes*. In sector 4. Agriculture, GHG emissions will grow significantly compared to 2003 emissions estimates, with slight downward trend in the 2005–2015 period followed by a slight increase towards 2020. GHG emissions in sector 6. *Waste* are also projected to grow during 2005–2020, mainly because of putting into operation new waste incineration plants.

In both scenarios: "with measures" and "without measures", and for all years beginning with the base year, carbon dioxide emissions have the largest contribution to

Table 47. GHG emissions in main IPCC source categories for the "with measures" scenario

GHG in CO_2 eq. [Gg]		1. Energy	2. Industrial processes	3. Solvents and other product use	4. Agriculture	5. Land use, land-use change and forestry	6. Waste	Sum of projections in sectors (without sector 5)
	CO_2	457005.1	18550.38	882.5		-36030.7	566.2	477004.14
	CH_4	23337.9	336.62	0.0	20112.0	7.5	7364.0	51150.55
	N_2O	2474.1	4993.43	124.0	31629.6	0.8	1163.4	40384.46
1988/1995	HFC		26.44					26.44
	PFC		250.18					250.18
	SF_6		13.15					13.15
	Sum	**482817.03**	**24170.20**	**1006.46**	**51741.63**	**-36022.44**	**9093.60**	**568828.93**
	CO_2	302465.4	12346.7		0.0	-36600.1	0.0	314812.1
	CH_4	17212.9	174.9		9857.9	4.1	18602.0	45847.7
	N_2O	2228.9	4349.3		16510.6	0.4	806.0	23894.8
2000	HFC		594.7					594.7
	PFC		224.4					224.4
	SF_6		16.3					16.3
	Sum	**321907.2**	**17706.3**	**0.0**	**26368.5**	**-36595.6**	**19408.0**	**385390.0**
	CO_2	307099.8	11479.8	473.8	0.0	-28211.2	29.1	319082.4
	CH_4	17746.6	294.9		9281.4	3.9	10361.0	37683.8
	N_2O	2322.9	4401.4		16418.4	0.4	793.3	23936.0
2003	HFC		1824.8					1824.8
	PFC		278.3					278.3
	SF_6		19.7					19.7
	Sum	**327169.3**	**18298.8**	**473.8**	**25699.8**	**-28206.89**	**11183.4**	**382825.0**
	CO_2	300275.2	13 895.3	357.3		-28463.8	293.1	314820.9
	CH_4	12152.9	312.6		12996.3	2.3	8367.2	33829.0
	N_2O	2136.5	4 686.1		23072.0	0.2	824.2	30718.8
2005	HFC		2178.66					2178.7
	PFC		285.08					285.1
	SF_6		20.08					20.1
	Sum	**314564.7**	**21377.8**	**357.3**	**36068.3**	**-28461.3**	**9484.4**	**381852.5**
	CO_2	333920.6	16994.3	292.5		-25444.8	293.8	351501.2
	CH_4	13624.6	326.4		12139.6	2.3	9081.8	35172.5
	N_2O	2446.4	4686.1		22861.4	0.2	828.9	30822.9
2010	HFC		2188.96					2189.0
	PFC		282.83					282.8
	SF_6		24.86					24.9
	Sum	**349991.6**	**24503.5**	**292.5**	**35001.1**	**-25442.3**	**10204.5**	**419993.2**
	CO_2	363714.8	18222.8			-22765.9	1102.3	383039.8
	CH_4	14626.9	326.0		11775.4	2.3	9215.0	35943.3
	N_2O	2672.6	4686.1		23081.2	0.2	831.1	31271.0
2015	HFC		2204.78					2204.8
	PFC		271.63					271.6
	SF_6		29.64					29.6
	Sum	**381014.2**	**25741.0**	**0.0**	**34856.6**	**-22763.4**	**11148.3**	**452760.2**
	CO_2	387623.5	18 222.8			-20640.1	2012.3	407858.5
	CH_4	15520.8	328.0		11643.1	2.3	9382.1	36874.1
	N_2O	2848.8	4 686.1		23402.1	0.2	838.5	31775.4
2020	HFC		2217.69					2217.7
	PFC		266.73					266.7
	SF_6		34.42					34.4
	Sum	**405993.1**	**25755.8**	**0.0**	**35045.1**	**-20637.6**	**12232.9**	**479026.9**

Source: MŚ.

Table 48. GHG emissions in main IPCC source categories for the "without measures" scenario

GHG in CO_2 eq. [Gg]		1. Energy	2. Industrial processes	3. Solvents and other product use	4. Agriculture	5. Land use, land-use change and forestry	6. Waste	Sum of projections in sectors (without sector 5)
	CO_2	457005.1	18550.4	882.5		-36030.7	566.2	477004.1
	CH_4	23337.9	336.6		20112.0	7.5	7 364.0	51150.6
	N_2O	2474.1	4993.4	124.0	31629.6	0.8	1 163.4	40384.5
1988/1995	HFC		26.4					26.4
	PFC		250.2					250.2
	SF_6		13.1					13.1
	Sum	**482817.03**	**24170.20**	**1 006.5**	**51741.6**	**-36022.4**	**9093.6**	**568828.93**
	CO_2	302465.4	12346.7		0.0	-36600.1	0.0	314812.1
	CH_4	17212.9	174.9		9857.9	4.1	18602.0	45847.7
	N_2O	2228.9	4349.3		16510.6	0.4	806.0	23894.8
2000	HFC		594.7					594.7
	PFC		224.4					224.4
	SF_6		16.3					16.3
	Sum	**321907.2**	**17706.3**		**26368.5**	**-36595.6**	**19408.0**	**385390.0**
	CO_2	307099.8	11479.8	473.8	0.0	-28211.2	29.1	319082.4
	CH_4	17746.6	294.9		9281.4	3.9	10361.0	37683.8
	N_2O	2322.9	4401.4		16418.4	0.4	793.3	23936.0
2003	HFC		1824.8					1824.8
	PFC		278.3					278.3
	SF_6		19.7					19.7
	Sum	**327169.3**	**18298.8**	**473.8**	**25699.8**	**-28206.89**	**11183.4**	**382825.0**
	CO_2	362895.1	13895.3	357.3		-28463.8	293.1	377440.7
	CH_4	12485.9	312.6		12996.3	2.3	8367.2	34162.0
	N_2O	2515.4	4686.1		23072.0	0.2	824.2	31097.7
2005	HFC		2178.66					2178.7
	PFC		285.08					285.1
	SF_6		27.72					27.7
	Sum	**377896.4**	**21385.4**	**357.3**	**36068.3**	**-28461.3**	**9484.4**	**445191.9**
	CO_2	384975.8	16994.3	292.5		-25444.8	293.8	402556.4
	CH_4	14369.0	326.4		12139.6	2.3	9081.8	35916.9
	N_2O	2970.2	4686.1		22861.4	0.2	819.0	31336.7
2010	HFC		2188.96					2189.0
	PFC		282.83					282.8
	SF_6		37.28					37.3
	Sum	**402315.1**	**24515.9**	**292.5**	**35001.1**	**-25442.3**	**10194.6**	**472319.1**
	CO_2	401647.3	18222.8			-22765.9	1102.3	420972.3
	CH_4	16085.2	326.0		11775.4	2.3	9215.0	37401.7
	N_2O	3166.3	4686.1		23081.2	0.2	831.1	31764.7
2015	HFC		2204.78					2204.8
	PFC		271.63					271.6
	SF_6		46.84					46.8
	Sum	**420898.9**	**25758.2**	**0.0**	**34856.6**	**-22763.4**	**11148.3**	**492662.0**
	CO_2	423185.5	18222.8			-20640.1	1662.3	443070.5
	CH_4	17878.7	328.0		11643.1	2.3	9382.1	39231.9
	N_2O	3384.1	4 686.1		23402.1	0.2	837.2	32309.5
2020	HFC		2217.69					2217.7
	PFC		266.73					266.7
	SF_6		56.40					56.4
	Sum	**444448.3**	**25777.8**	**0.0**	**35045.1**	**-20637.6**	**11881.6**	**517152.8**

Source: MŚ.

GHG emissions with sector 1. *Energy* as the dominating source category. In case of methane, the two dominant source categories are: 1.B. Fugitive emissions from fuels and 6. *Waste*. Methane emissions are expected to grow over the 2005–2015 period following the growth in sector 6. *Waste*, in which methane emission are supposed to increase over the entire period 2005–2020. Trend and level of emissions of nitrous oxide depend mainly on developments in sector 4. *Agriculture*. Projections for 2005–2020 indicate slight increase of N_2O emissions.

5.2. Effects of policies and measures

Information on the inventory of greenhouse gas emissions and removals has been presented in Chapter 3 and it relates to the period 1988–2004. Identification of sectors and sub-sectors with the highest reductions of GHG emissions has been carried out on the basis of inventories of: 1997, 2000 and 2003. This work focused mainly on CO_2 emissions in the two sub-sectors of sector 1.A. Fuel combustion: Energy industries, and Manufacturing industries and construction, as they account for 73% of the total emission from fuel combustion, i.e., 59% of the total national CO_2 emissions. Emissions of CH_4 and N_2O from fuel combustion, in terms of CO_2 equivalent, are rather low and do not significantly affect the national greenhouse gas emission total. Analysis of changes in emissions and emission intensities over the years 1997–2003 shows that the emission reduction may result from a change of activity or emission factor. Sub-sectors with highest share in the total national emission were mainly subject to evaluation. Figure 13 presents the percentages of CO_2 emissions in the national emissions total, excluding sector 5. *Land-use change and forestry*, broken down into sub-sectors. The figure illustrates the most important emission sources taking account of only those sub-sectors that accounted for over 0.5% of the total emissions in 2003. It shows that public power plants clearly have the highest share in the national CO_2 emissions.

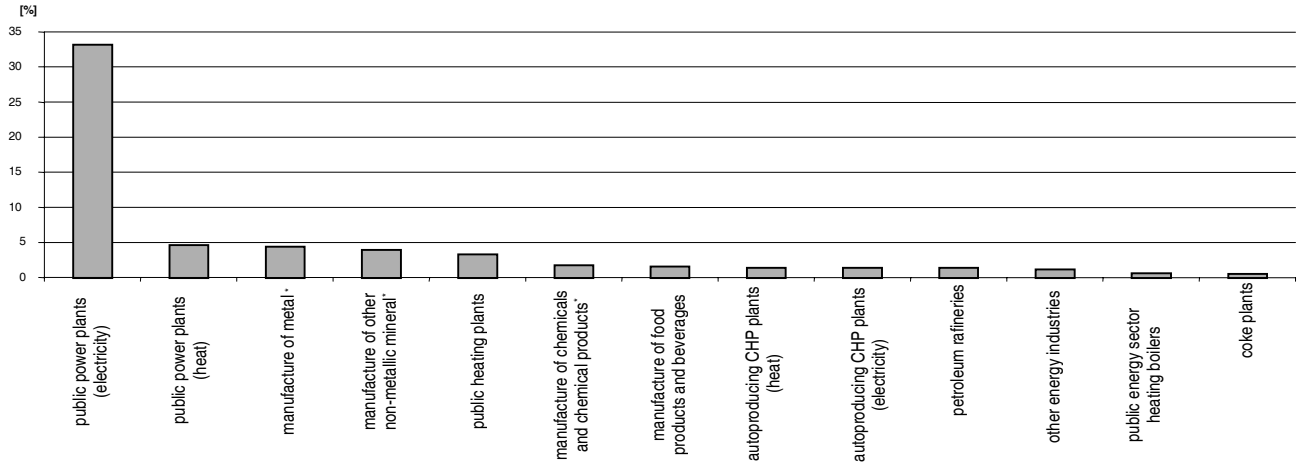
The highest decrease in CO_2 emissions over the period 1997–2003 has taken place in the sub-sector related to metal production (a decrease of emissions by over 10,000 Gg). Emissions have also significantly declined, by over 5,500 Gg, in the manufacturing of products from other non-metal resources (inter alia, cement, lime, glass and ceramics). A significant reduction in CO_2 emissions in 1997–2003 has also occurred in heat production processes. In this sector emissions dropped in public heating plants (by almost 3,700 Gg), in public power plants in heat production (by almost 2,200 Gg), in heating boilers of the public energy sector (by over 2,100 Gg) and in autoproducing heating plants (by over 1,500 Gg), which in total demonstrates considerably high reduction of CO_2 emissions from thermal energy production. CO_2 emissions also declined in the following sectors: production of food products and beverages (by app. 3,000 Gg), refineries (by 2,800 Gg) and production of chemical products (by app. 2,000 Gg). These changes are illustrated in Table 49.

However, Table 50 shows that in 2000–2003 the highest emission decrease took place in metal production and manufacture of other non-metallic mineral products. Decreased CO_2 emissions result mainly from the reduction of emissions from fuel combustion in the sub-sectors considered.

Additionally, CO_2 emissions from industrial processes were taken into consideration in the following sectors: manufacture of chemicals and chemical products, manufacture of other non-metallic mineral products, and manufacture of basic metals.

Sectors with greatest changes in emissions over the examined period were subject to in-depth analysis based on stati-

Figure 13. Share of CO_2 emissions from selected sub-sectors in the total national CO_2 emissions in 2003 (taking account of process emissions for the distinguished sub-sectors)



* Sub-sectors with CO_2 process emissions included, apart from emissions from fuel combustion.
Source: IOŚ/KCIE.

Table 49. Reduction of CO_2 emissions in 1997–2003 [Gg]

SUB-SECTORS	PKD**	Including process emissions	Excluding process emissions
Manufacture of basic metals*	27	10123.5	10101.0
Manufacture of other non-metallic mineral products*	26	5512.5	4297.5
Public thermal plants		3679.4	4133.0
Manufacture of food products and beverages	15	3081.8	3679.4
Petroleum refineries		2809.2	3081.8
Public power plants (heat)		2156.1	2809.2
Public energy sector heating boilers		2128.5	2156.1
Manufacture of chemicals and chemical products*	24	2080.0	2128.5
Non-public thermal plants		1531.7	1531.7
Other energy industries		1264.7	1264.7
Manufacture of machinery and equipment	29	1246.6	1246.6
Manufacture of textiles	17	960.6	960.6
Manufacture of furniture; other manufacturing activity	36	725.3	725.3
Manufacture of pulp and paper	21	693.0	693.0
Manufacture of coke		580.8	580.8
Manufacture of metal products / excluding machinery and equipment	28	441.3	441.3
Manufacture of motor vehicles, trailers and semi-trailers	34	340.4	340.4
Manufacture of other transport equipment	35	280.1	280.1
Processing of leather and manufacture of leather products	19	240.2	240.2
Manufacture of rubber and plastic products	25	229.7	229.7
Manufacture of electrical machinery and apparatus	31	219.6	219.6
Manufacture of wood and wood products	20	194.5	194.5
Manufacture of wearing apparel and furriery	18	82.3	82.3
Manufacture of medical, precision and optical instruments	33	32.5	32.5
Manufacture of radio, television and communication equipment and apparatus	32	23.2	23.2
Manufacture of tobacco products	16	20.5	20.5
Manufacture of office machinery and computers	30	3.6	3.6
Total		**40681.60**	**41497.10**

* Sub-sectors with CO_2 process emissions included, apart from emissions from fuel combustion.
** PKD – Polish Classification of Activities.
Source: MŚ.

Table 50. Reduction of CO_2 emissions in 2000–2003 [Gg]

SUB-SECTORS	PKD	Including process emissions	Excluding process emissions
Manufacture of basic metals*	27	5244.6	5368.3
Manufacture of other non-metallic mineral products*	26	3898.8	1818.0
Manufacture of chemicals and chemical products*	24	644.6	1734.7
Extraction of metal ores and minerals	13 and 14	453.5	453.5
Non-public thermal plants		441.7	441.7
Manufacture of textiles	17	169.9	169.9
Manufacture of electrical machinery and apparatus	31	150.6	150.6
Petroleum refineries		129.9	129.9
Manufacture of machinery and equipment	29	129.4	129.4
Manufacture of motor vehicles, trailers and semi-trailers	34	121.8	121.8
Manufacture of other transport equipment	35	110.6	110.6
Other energy industries		80.8	80.8
Public thermal plants		78.1	78.1
Manufacture of wood and wood products	20	67.0	67.0
Processing of leather and manufacture of leather products	19	18.3	18.3
Manufacture of wearing apparel and furriery	18	12.9	12.9
Manufacture of tobacco products	16	10.7	10.7
Manufacture of radio, television and communication equipment and apparatus	32	7.4	7.4
Manufacture of office machinery and computers	30	3.8	3.8
Total		**11744.40**	**10907.40**

* Sub-sectors with CO_2 process emissions included, apart from emissions from fuel combustion.
Source: MŚ.

stical data by examining the emission intensity for the selected most important sub-sectors (Table 51).

As shown in Table 51, CO_2 emission intensity for all analysed periods was lower in 2003 in relation to the 1997 level. The highest fall in CO_2 emission intensity (excluding steel production from open-hearth furnaces that was not produced in 2003) took place in iron casting (over 42%), production of sugar (app. 28%) and electrolytic copper (over 26%). As mentioned above, a drop in the emission intensity is mainly caused by reducing the emission intensity from fuel combustion, which was affected by reduced energy intensity of production in the sectors examined. Below is an example of unit energy consumption [MJ/tonne of manufactured product]:

	1997	2000	2003
iron casting	13963.7	10306.8	9028.2
electrolytic copper	10390.5	9575.2	6936.7
sugar	10187.4	8181.0	6917.2

Generally, a decline of emission intensity factor over time reflects the changes in the shares of fuels towards reducing the use of coal, increasing energy efficiency and introducing low-emission intensity technologies (e.g., increased share of clinker production by using the dry method with a lower emission intensity factor compared to the wet method of production).

Data presented in Table 52 show that CO_2 emissions from public power plants producing electricity over the years 1997–2003 increased by 1,773 Gg, but the emission intensity from this sub-sector has been systematically dropping (in 2003 it was by over 5% lower than in 1997), while

Table 51. Emission intensity and emission intensity changes for selected sources in 1997–2003

Emission source	Emission intensity [kg CO_2/Mg] or [kg CO_2 eq./Mg]			Change of emission intensity in 1997–2003 [%]
	1997	2000	2003	
Steel from open-hearth furnaces	312.5	753.0	0.0	-100.0
Iron casting	2767.8	1855.7	1603.9	-42.1
Sugar	1426.3	1071.6	1031.7	-27.7
Electrolytic copper	2594.0	2231.7	1907.8	-26.5
Nitric acid	142.6	111.3	112.9	-20.8
Coke	239.0	213.3	189.3	-20.8
Petroleum refineries (manufacturing and processing of petroleum products)	363.3	291.2	297.4	-18.2
Steel from electric furnaces	608.8	538.4	515.6	-15.3
Pig-iron	2541.8	2318.5	2237.2	-12.0
Hot-rolled products and semi-finished products	324.9	274.9	288.4	-11.2
Cement clinker-wet method	1152.3	1079.5	1022.9	-11.2
Burnt lime (quicklime)	1305.0	1214.4	1188.7	-8.9
Cement clinker-dry method	909.3	870.4	842.0	-7.4
Electrolytic aluminium	16332.3	15931.7	15384.2	-5.8
Cement - milled	46.4	44.1	45.2	-2.5
Ammonia	3513.0	3379.0	3463.5	-1.4
Converter steel	169.6	168.8	167.4	-1.3
Coke (CH_4 in CO_2 eq.)	4.3	4.2	4.2	-0.6
Nitric acid (N_2O in CO_2 eq.)	1996.40	1996.89	1996.90	0.02
Ammonia (CH_4 in CO_2 eq.)	103.99	103.98	104.04	0.05

Source: MŚ.

emissions from public power plants producing heat decreased in the given period by 2,156 Gg (emission intensity has been also declining in this sub-sector). Emission intensity for the total heat production in 1997–2003 fell by app. 4% despite fluctuation in different heating sub-sectors. As regards total electricity production the emission intensity decreased by almost 5%. Additionally, N_2O emissions from the production of nitric acid and caprolactam in the chemical industry sector were analysed (Table 53).

Table 53. Emissions of N_2O from industrial processes in selected sub-sectors of the chemical industry (expressed in CO_2 equivalent)

Industrial process	N_2O emission expressed as CO_2 equivalent [Gg]		
	1997	2000	2003
Chemical industry	4870.10	4349.30	4401.38
Production of nitric acid	1906.19	4007.68	4053.56
Other (caprolactam and medical use of nitrous oxide)	267.84	339.76	347.82
N_2O emission changes in specified years [Gg]	**2000–1997**	**2003–2000**	**2003–1997**
	-520.8	52.1	-468.7

Source: IOŚ/KCIE.

During 1997–2003 N_2O emissions declined in this sector by 1.5 Gg, i.e. by almost 470 Gg CO_2 eq., and in 1997––2000 emissions dropped by app. 521 Gg CO_2 eq., while in 2000–2003 an increase in emissions by 52 Gg CO_2 eq. has been observed. Emission changes in this case reflect the changes in activities, i.e. production level/product use.

Table 52. CO_2 emissions and emission intensity connected with heat and power production

Emission source	CO_2 emission level [Gg]			Energy output [TJ]			CO_2 emission intensity [kg/GJ of energy produced]			Change of emission intensity in 1997–2003 [%]
	1997	2000	2003	1997	2000	2003	1997	2000	2003	
Public power plants – electricity	125146.6	123619.0	126919.6	471454.3	481790.1	504783.3	**265.4**	**256.6**	**251.4**	-5.3
Public power plants – heat	19780.9	17242.9	17624.8	187460.4	166040.3	172859.4	**105.5**	**103.8**	**102.0**	-3.4
Autoproducing power plants – electricity	5078.4	4855.4	5197.4	28747.1	25925.3	28579.8	176.7	187.3	181.9	2.9
Autoproducing power plants – heat	3600.2	2771.0	5288.3	35867.6	30740.3	52264.7	100.4	90.1	101.2	0.8
Public heat plants	16214.5	12613.2	12535.1	134660.7	108239.1	107947.8	120.4	116.5	116.1	-3.6
Non-public heat plants	2518.9	1428.9	987.2	19218.8	11644.3	9357.2	131.1	122.7	105.5	-19.5
Public energy sector heating boilers	4358.0	2161.5	2229.5	42220.0	21049.8	21168.7	103.2	102.7	105.3	2.0
Total electricity production	130225.0	128474.4	132117.0	500201.4	507715.4	533363.1	260.3	253.0	247.7	-4.9
Total heat production	46472.5	36217.5	38664.9	419427.5	337713.8	363597.8	110.8	107.2	106.3	-4.0

Figures written in bold are used for calculations of emission intensity from industrial processes.
Source: MŚ.

5.3. Assessment of emission reductions under current policies and measures

In the course of implemented policies that have been described in detail in previous chapters, certain economic sectors experienced further reduction of greenhouse gas emissions. In the remaining sectors the total emissions demonstrated a rising trend, while the unit emissions declined due to measures that have been taken (Chapter 4).

Increased share of biomass in fuel balance. When assessing emission reduction resulting from the increase of biomass share in fuel structure, it was assumed that, if there were no increase of biomass combustion compared to 2003 level, the additional amount of energy from biomass combustion would have to be compensated by additional use of fossil fuels. Projected CO_2 emissions from biomass combustion amounted to: 21,455 Gg in 2005, 29,587 Gg in 2010, 32,732 Gg in 2015 and 34,829 Gg in 2020. CO_2 emission reduction resulting from projected increased use of biomass was estimated at more than 2,100 Gg in 2005, and 1,600 Gg in 2020 (the rate of biomass share increase will drop over 2005––2020). Biomass combustion is the dominating source among all renewable energy sources (REN). In 2003, app. 85% of energy (electrical and heat) generated by REN came from biomass combustion.

Fuel conversion. The amount of emission reduction related to the change in fuel structure, was estimated as a difference between emission calculated according to projected fuel use for years 2005, 2010, 2015 and 2020, and emission calculated under the assumption of the same total fuel use but with the fuel structure frozen at the 2003 level. Emission reduction resulting from the projected fuel conversion (mainly coal to natural gas) excluding biomass, was estimated at over 5,300 Gg in 2005, and app. 24,000 Gg in 2020.

Increased share of cogeneration. CO_2 emission reduction effect resulting from cogeneration (simultaneous production of electrical energy and heat) was estimated compared to 2003 level. It was assumed that the emission change can be estimated based on the percentage changes of respective shares of cogeneration during 2005–2020 period, compared to cogeneration share in 2003. CO_2 emission was calculated based on the estimated fuel amount that would have to be combusted if there were no increase of cogeneration share. CO_2 emission reduction resulting from projected increase of cogeneration, was estimated as 2,400 Gg in 2005 up to app. 31,700 Gg in 2020.

Summary effect. The total CO_2 emission reduction resulting from the projected increase of biomass use, fuel conversion (excluding biomass) and increased cogeneration was estimated as over 9,900 Gg in 2005 and over 67,000 Gg in 2020. These estimates were made on the basis of "effective variant" included in *Poland's Energy Policy until 2025*[34], adopted by the Council of Ministers on 4 January 2005.

Additional measures required for implementation. Based on the analysis of activities included in the Climate Policy, Poland will achieve the emission reduction target in the first commitment period covering 2008–2012 without additional measures. Therefore, taking and implementing such measures is unjustified both from the point of view of the implementation of the Kyoto Protocol and also economically.

5.4. Participation in emission trading, JI and CDM

Emission allowance trading – a flexible mechanism, pursuant to Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Directive 96/61/EC[35], was transposed into Polish law in Act of 22 December 2004 on emission allowance trading of greenhouse gases and other substances[36]. Work on the National Allocation Plan for the years 2005–2007 began in 2003, and in September 2004 the NAP was submitted to the European Commission. The European Commission in its decision of 8 March 2005 accepted the NAP under the condition that the Polish Government reduces the total amount of allowances by 16.5%. As a result the total limit of allowances in the 2005–2007 period was set at **717.3 million allowances** (i.e. **239.1 million annually**), which lead to verification of allocated amounts of allowances for individual installations covered by the scheme. After analysis, corrections were made to allocation methodology which resulted in updated allocations to sectors and individual installations set in the Regulation of the Council of Ministers of 27 December 2005 on the adoption of the *National Allocation Plan for carbon dioxide emissions for the years 2005–2007* and the list of installations temporarily excluded from the Community emission trading scheme for the period between 1 January 2005 until 31 December 2007 (Dz.U. No. 264, item 2206). On 30 June 2006, the European Commission confirmed that the Polish *National Allocation Plan for 2005–2007 CO_2 emissions* is consistent with the Commission Decision of 8 March 2005 on the Polish NAP, and hence Poland was included into the Community emission trading scheme.

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34) M.P. of 2005 No. 42, item 562.
35) OJ L 275 of 25.10. 2003, p. 32; OJ EU Polish special edition, Chapter 15, vol. 7, p. 631.
36) Dz.U. of 2004 No. 281, item 2784.

By virtue of the Act of 22 December 2004 on emission allowance trading of greenhouse gases and other substances, the following regulations were adopted:

- Regulation of the Minister of the Environment of 10 April 2006 on the conditions and ways to set costs of verifications of annual reports (Dz.U. No. 71, item 496),
- Regulation of the Minister of the Environment of 31 March 2006 on types of installations covered by Community emission allowance trading scheme (Dz.U. No. 60, item 429),
- Regulation of the Minister of the Environment of 7 March 2006 on information required for the development of the National Allocation Plan (Dz.U. No. 43, item 308),
- Regulation of the Minister of the Environment of 12 January 2006 on the way to monitor emission levels of substances covered by Community emission allowance trading scheme (Dz.U. No. 16, item 124),
- Regulation of the Minister of the Environment of 13 September 2005 on the designation of the National Administrator of emission trading scheme (Dz.U. No. 186, item 1562). The function of the Administrator is played by the Institute of Environmental Protection in Warsaw. The Administrator is a unit that coordinates the functioning of emission allowance trading scheme,
- Regulation of the Council of Ministers of 27 December 2005 on the adoption of the National Allocation Plan for carbon dioxide emissions for the years 2005–2007 and on the list of installations temporarily excluded from the Community emission allowance trading scheme between 1 January 2005 and 31 December 2007 (Dz.U. No. 264, item 2206).

The National Administrator of Emission Trading Scheme was established at the Institute of Environmental Protection in Warsaw. A necessary condition for the functioning of the Community system was the establishment of the national registry. Poland selected SERINGAS system developed by French Caisse des Depots et Consignations. On 16 May 2006, Poland submitted to the European Commission additional information, in which confirmed that Poland fulfilled all the conditions included in the Commission Decision of 8 March 2005 and provided a description of measures that were undertaken by the Polish Government for that purpose.

Pursuant to the requirements of Directive 2003/87/EC, by 30 June 2006 each Member State should have submitted to the Commission for acceptance its *National Allocation Plan for CO_2 emission allowances for 2008–2012*. To fulfil the requirement, work on the development of the National Allocation Plan was initiated. The National Administrator of Emission Trading Scheme (KASHUE) developed the NAP for the years 2008–2012 (NAP – KPRU II), which was then submitted to the European Commission on 30 June 2006. The basis for the NAP elaboration were the sectoral development strategies worked out by industry associations that represent plants covered by the system.

Clean Development Mechanism (CDM) – Poland does not take part in the implementation of that mechanism.

Joint Implementation (JI) – Poland has large potential for greenhouse gas reduction from agriculture, waste and some industry branches. Our country has also significant potential for the implementation of projects on renewable energy sources. These areas provide the field for projects to be implemented within the framework of Joint Implementation. Poland implements actively the mechanism of Joint Implementation through undertaking – on Polish territory – jointly with other countries from Annex I to the UN Framework Convention on Climate Change, measures resulting in emission reduction of greenhouse gases. The will for common realization of the Convention goal, through the mechanism of Joint Implementation was expressed in signed agreements and MoU (Memorandum of Understanding) by the Governments of Finland, Canada, Denmark, the Baltic States and the International Bank for Reconstruction and Development (Prototype Carbon Fund). Poland also participates actively in international programmes and funds dealing with realization of Joint Implementation projects, like e.g. Dutch ERUPT programme. During the pilot phase of Art. 6 mechanism of the Kyoto Protocol – Activities Implemented Jointly (AIJ) the following projects were implemented:

- Polish-Dutch project of using cogenerated electrical energy and heat in Szamotuły – completed in December 2000,
- Polish-Norwegian project of fuel switch from coal to natural gas in app. 30 non-industrial boiler houses all over Poland – completed in 2002.

The cooperation concerning the proper mechanism of Joint Implementation led to the acceptance of the following projects:

- Polish-Dutch project on use of biomass from municipal greens for heating purposes in Jelenia Góra – project completed in October 2001,
- Polish-Canadian project on hydro power plant on the Bóbr River at Leszno Górne – completed in 2001,
- Polish-Danish project on 30 MW wind farm Zagórze – completed in 2002,
- Polish-Dutch project on landfill gas recovery in Konin,
- Polish-Danish project on use of landfill gas and sewage sludge in Zakopane,
- Prototype Carbon Fund – project on geothermal heating plant in Stargard Szczeciński – project completed in March 2005,
- Polish-Dutch project on use of landfill gas in the Warmińsko-Mazurskie Voivodship – project currently implemented.

There are a number of potential Joint Implementation projects in various stages of preparation, beginning with those in initial phase, and ending with those in advanced phase, which await final approval. As regards the initial phase of project preparation, the Ministry of the Environment has already issued approximately thirty Letters of Endorsement. The number is increasing with the increasing number of submitted JI project proposals. The Polish procedure of analyzing and approval of Joint Implementation projects is consistent with the respective international guidelines, however it has not yet been officially adopted by the Polish Government. A new act is being prepared which will regulate matters concerning Joint Implementation projects in Poland, providing legal basis for approvals of project, and for project implementation. The new act will also transpose into the national law the provisions of the so-called "Linking Directive" (2004/101/EC)[37]. The drafted act is expected to come into force on 1 January 2007. The provisions of the new act will introduce into the Polish law procedures and principles concerning joint implementation projects, thus providing transparent framework that should facilitate their realization.

5.5. Main obstacles in the implementation of domestic policies and measures

Most obstacles have their origin in problems common to most of the countries that undergo political and economic transition. These problems include:

- coal based structure of primary fuels, conditioned historically through availability of own resources and accompanying social circumstances,
- still relatively low energy efficiency of the economy,
- dynamic development of road transport.

5.6. Programmes for improving emission factors, activity data and information on socio-economic models used for preparing greenhouse gas emission projections

In making the national greenhouse gas inventory, emission factors are used that come from various sources:

- energy – CO_2 emission factors for fuel combustion are national factors (for main fuels they are updated annually based on empirical functions derived from domestic studies). Also for assessment of fugitive emissions national emission factors are used,
- industrial processes – in some processes default factors are used[38] from IPCC methodology or international publications, and in other processes domestic emission factors are used (e.g. for iron and steel production, ammonia, nitric acid)
- agriculture – in enteric fermentation sub-sector for horses and pigs default factors are assumed, while for the other animals (cattle and sheep) domestic factors are used. In manure management sub-sector, default emission factors are used taking into consideration domestic data on shares of different waste management systems. Emission estimates from soils are based on default or literature emission factors,
- land use change and forestry – for emission assessments from forest areas domestic factors exist, while for the other activities default emission factors are used. The biggest problem remains in removal factors in forests and especially forest soils,
- waste – for this sector default emission factors are used at various stages of calculations, in combination with detailed domestic data.

Domestic emission factors are derived when there are reasons to assume that default emission factors do not reflect national conditions. The necessity of deriving domestic factors results from fragmentary results of various research projects and experts' assessments. A separate problem is the periodic updating of existing emission factors that undergo changes following technological changes. However, due to financial reasons such updates are made to a limited extent. No socio-economic models are used when compiling the national emission inventories. The source for activity data is the official public statistics and all the changes in assessment of activities result from national and Community law.

Projections of the demand for useful energy are made based upon the economic development scenario, energy policy and upon the progress and innovation in energy use. Projections are made for each direction of energy use and for each sector of economy. Models applied for projections of greenhouse gases emissions are described in detail in Chapter 5.1. Models: BALANCE, MAED and WASP were developed in Argonne National Laboratory, Argonne, Illinois, USA: WASP in 1970s, while MAED and BALANCE in 1980s. These models – as a package of analyses of the energy system ENPEP (Energy and Power Evaluation Program) – were distributed freely by IAEA among IAEA member states within the framework of Technical Cooperation Projects. Model MESSAGE was developed in 2000 at IIASA in Vienna and is distributed by IAEA.

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[37] Directive 2004/101/EC of the European Parliament and of the Council of 27 October 2004 amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in respect of the Kyoto Protocol's project mechanism (OJ L 338 of 13.11. 2004, p. 18).

[38] Emission factors in IPCC Guidelines.

6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE EFFECTS AND ADAPTATION MEASURES

6.1. Agriculture

An analysis of vulnerability of the agricultural sector to climate change that was carried out in Poland in the late 1990s proves that the following, in particular, are to be expected:

- an extended agricultural economic and vegetation period,
- widened possibilities to cultivate and obtain increased yields of thermophilous crops,
- shorter crop ripening periods,
- increased photosynthesis intensity,
- reduced yields due to increased pests' population and plant diseases,
- interference of germinating processes resulting from temperature rise,
- reduced soil humidity,
- increased costs of animal production.

Assessment of adaptation costs is complex and difficult. The adaptation of agriculture will be a long-lasting process, considering an additional need for the adaptation of this sector to the requirements of the European Union Common Agricultural Policy. The adaptation processes will mainly include: changes in plant cultivation, agri-technology modifications, changes in the selection of plant species grown and places of cultivation. Costs will depend on the adaptation period. If the adaptation is to be extended over time the annual costs will be smaller. At present, a research project is underway, whose aim is to prepare a regional programme for the adaptation of agriculture in north-eastern Poland with guidelines on good agricultural practice under climate changing conditions.

Some of the projected effects of climate change in agriculture are already observed in Poland. A good example is the reduction of thermal barriers for growing corn for seeds, which contributed to increased growing area of this crop. At the same time in the south-eastern part of Poland an increasing harmfulness of the European corn borer (*Ostrinia nubilalis Hb*) is noted in corn growing, which should be associated with improved thermal conditions favouring the development of this pest. In the course of temperature rise over the last decade the limitations in the production of other thermophilous plants such as soya bean, millet or sunflower, have also declined.

Whereas, under the observed increasing trend of the average annual air temperature (by 0.9ºC in the 20th century), maintained also in the period of 2001–2010, the vegetation period is likely to become longer, by even as much as 10 days ($t_{average} > 5$ºC). Longer vegetation period will affect changes in the dates of crop sowing and other agritechnical activities. It will also create possibilities for intercrops and stubble aftercrops. Increased development rate is of special importance to thermophilous plants such as corn, soya bean, millet and sunflower, whose thermal requirements have limited their growth in Poland in the past. So far, only over small areas of Dolny Śląsk (Lower Silesian Region) and the Sandomierska Basin the probability of corn ripening exceeded 80%. While, the probability north of the Szczecin-Białystok line was below 20%. A simulation that was performed shows that in 2001–2010, further temperature rise will create favourable conditions for growing corn (apart from small areas in the northern Poland and in the mountains), and the probability of corn ripening throughout the country will significantly exceed 80%.

Simulation of climate changes in Poland carried out on the basis of GFDL and GISS general models of atmospheric circulation and on statistical and empirical models elaborated for country-specific crop production circumstances correspond, in general, with other yield projections in Europe. Thus, the simulations according to the GFDL scenario showed app. 10% reduction in wheat and rye yields, while according to the GISS scenario the average yields of wheat and rye will only undergo slight changes compared to the present levels. Sugar beet yields will rise by a few per cent, and those of corn, soya bean and sunflower by several dozen per cent. Both scenarios predict very serious decreases in potato yields, and in the case of the GFDL model even to the level of app. 30% of the present yields. The regional variability inside Poland may be, in the case of certain crops (e.g. potatoes), greater than at present, while for other crops – smaller (e.g. corn). It is worth noticing that the prognoses presented above did not take into account other elements of non-climate-related plant cultivation background, such as e.g. the nutritional effect of carbon dioxide, possible changes in the spreading and intensity of agrophages, as well as soil transformation. It also should be added that in higher temperatures the frequency of extreme weather

events would possibly be higher, which will specifically affect agriculture.

Adaptation of agriculture to the climatic conditions already observed and predicted requires alterations in the organisation of production. Certain measures should be taken now, and others in the long-term. Special attention should be given to appropriate crop rotation. It is extremely important in the production process to adjust the timelines of agritechnical treatment activity to the vegetation conditions of plants (dates of sowing, application of fertilisers and plant protection agents), taking account of regionally-specific production to minimise climate-driven risk of yield losses.

6.2. Coastal zone

The major measures aimed at the protection of the Baltic Sea coastal zone and adaptation to potential sea level changes have been laid down in the Act of 28 March 2003 on the establishment of a long-term "Programme on the protection of the coastline" (Dz.U. No. 67, item 621). The main tasks of the Programme are to: build, reconstruct and maintain a protection system against flooding of the coastal areas, including removal of damages in the coastal flood control system, to ensure stabilisation of the coastline and to prevent beach declining, as well as to monitor the sea coast. As an example of the activities that have been undertaken may be the sand-feeding of the foreland of the front bank at Krynica Morska on the Vistula Sand-Bar or feeding with sand of the three parts on the Helski Peninsula. Similar work has been carried out at open sea, inter alia, the modernisation of coast strengthening in many places, including Ustka and Ustronie Morskie, the construction of flood embankments on Kopań Lake Sand-Bar, the conservation of the cliff at Trzęsacz, modernisation of the silting pipelines in Kołobrzeg. Artificial feeding, modernisation of bank strengthening or conservation of the flood embankment were also carried out around the Szczeciński Bay. As a result in 2004 actions aimed at protection of the coast from sea erosion were undertaken over a total distance of over 120 km of the Polish coastline. In 2004 the PAN Institute of Hydro-Engineering has finalised updating the assessment of the impacts of Baltic Sea level changes on the Polish coast. The analysis shows that sea water level changes affect app. 2,400 km^2 and over 244,000 people. The adaptation costs have been estimated at app. 30 billion USD and 18 billion USD is areas highly endangered by flooding due to Baltic Sea water level rise.

6.3. Water resources

It is expected that climate impact on water management in Poland may be revealed mainly through changes in water balance (outflow and evaporation), inland water quality changes and increased frequency of extreme hydrological events (droughts and floods). Adaptation measures of water management to climate change should be taken in the above-mentioned areas in cases of possible or existing threats to the public and the economy in fulfilling their water demand requirements, or to the safety of the country. Therefore, the problem of preparing water management in Poland for climate change currently resolves itself into monitoring of water balance changes and scientific research aimed at predicting potential changes in this balance in the future and changes of biological, chemical and physical features of the aquatic ecosystems.

Research work on climate change impact and water management adaptation to these changes is carried out by different institutes and universities within the framework of their statutory financial resources and individual research grants. It should be mentioned that in 2004 work has been undertaken under a research project entitled *Extreme meteorological and hydrological events in Poland*. A task entitled *Elaboration of a projection model for predicted effects of extreme events and practical measures for reducing risks of threats* will be accomplished under this project.

An important role in the development of international cooperation in climate research studies and their application in water management is played by Centres of Excellence, established in 2003 and co-financed by the European Commission, inter alia, the Centre of Excellence on Geophysical Methods and Observations for Sustainable Development, established at the Institute of Geophysics of the Polish Academy of Sciences, and the Centre of Excellence in Wetland Hydrology at the Agricultural University in Warsaw.

Measures laid down in the *Water Management Strategy*, prepared by the Ministry of the Environment in 2005 favour the adaptation of water management to changed climate conditions. They include, primarily, enhancement of the effectiveness of protection against floods and drought effects, inter alia, by increasing river valley retention, stimulating actions to retain water in the soil through modernisation of irrigation systems or by building and modernising flood control facilities (reservoirs, water falls, flood embankments, polders). The Strategy also underlines the need for fulfilling future water demands of the public and of the economy in compliance with the principles of sustainable water consumption, by, inter alia, completing multi-functional retention reservoirs and developing the so-called small water retention, as well as by building new retention reservoirs of beyond-regional-level importance. Caring for the quality of water and its availability also lies under the scope of these measures.

6.4. Forestry

The forecasted climate change may cause a variety of effects to forests in Poland, including, inter alia:

– changes of the biotic environment,
– limiting capabilities for retaining groundwaters and mitigating extreme surface water flows,
– soil degradation and erosion, and landscape steppification,
– reduction of fauna and flora genetic resources,
– losses of biodiversity and natural landscape.

Climate change may also affect the frequency and spatial range of fires, pests and pathogens. Certain social and recreational functions of forests may also undergo limitation. Changes in vegetation caused by climate change and economic use of land will most likely lead to fragmentation of plant species and a decline in the diversity of landscape and biodiversity. The species creating natural vegetation in certain areas nowa-days, may have problems in adapting to new, unfavourable environmental conditions, resulting from climate change in these areas. These species may also be found too far from new places with favourable conditions for their growth, created in the course of climate change, so the colonisation of these places may become impossible. Newly-created plant populations will likely be composed of a small number of species and it is possible to assume that they will be vulnerable to invasions of the more adjusted species of phytophages and pathogens, which in the ecological meaning, will partly restore the species population and biodiversity.

The use of non-local species and ecotypes may be justified if the predicted climate change goes beyond the tolerance limits for the local species. It is also essential to establish a system of corridors of nature to allow natural migration of fauna and flora species, along with the changing climatic conditions.

Efforts made by Polish foresters to enrich the composition of forest species and to adjust it to the quality of forest habitats have already led over the past 55 years to an increase in the share of broadleaved trees from 13% to 22%, which was also affected by climate warming in this period. It is planned to further increase the share of broadleaved species up to 33% of the total treestand, and the spatial share of multi-species treestands up to 48%, by reducing at the same time the area of pine-tree monocultures.

Monitoring of forests shows that the worsening of treestand condition contributes to climate change, including the observed warming and deepening water shortage in many regions of the country. Increased deposition of nitrous compounds and increased atmospheric concentration of CO_2 contributing to the eutrophication of forest habitats and enhancement of an increase in the treestand growth are also important factors affecting the treestand condition. This phenomenon makes treestands less resistant to adverse environmental impacts.

7. FINANCIAL ASSISTANCE AND TECHNOLOGY TRANSFER UNDER ART. 4.3, 4.4 AND 4.5 OF THE CLIMATE CONVENTION

Poland as a Party not listed in Annex II to the Convention does not have a duty to fulfil the provisions, under Articles 4.3, 4.4 and 4.5 of the Climate Convention. However, by understanding the need for supporting sustainable development in the developing countries and in those with economies in transition, provides such assistance, to the extent possible.

7.1. International development assistance

The Polish development assistance for countries undergoes constant and significant increase. For instance, in 2004 Poland provided 137.3 million USD for supporting the development of the developing countries and those in transition (mainly the developing countries). This assistance accounts for almost 0.05% of the Polish GDP in 2004. Irrespective of the aforementioned development assistance in 2004 Poland contributed to the development assistance budget of the European Union.

Additionally, over 20 million USD was submitted mainly to countries in transition. Activities related to bi- and multilateral humanitarian assistance were also undertaken amounting to app. 1 million USD, which was divided among Iran, North Korea, Sudan (Darfur) and the region of South and East Asia.

7.2. Transfer of technology

Poland provides support for the promotion of technological development. For instance, the following financial resources were provided in 2004 within the development assistance by:

– granting a preferential credit under a combined assistance scheme for Serbia and Montenegro (projects for the energy and mining sectors),
– granting a preferential credit under a combined assistance scheme for China for projects on environmental protection, as well as on health protection, education, infrastructure, communication and mining.

8. RESEARCH AND SYSTEMATIC OBSERVATION

8.1. National-level activities

8.1.1. Introduction

The organisation of scientific research and development in Poland is based on four pillars: the institutes of the Polish Academy of Sciences (PAN), university-level high schools, research and development institutes, and development units (mainly in industrial enterprises). The Polish Academy of Sciences is a corporation of scientists representing all scientific fields, and at the same time conducting research studies in its own institutes, mainly in the area of basic research. Universities, apart from playing their major role, which is providing education for students, conduct research studies basing on scientific staff and students. Depending on the nature of the university such studies include both the basic research studies and development studies that are carried out in collaboration with economic entities. Whereas, research and development institutes have been established mainly to meet the needs of the economy and the public in the field of research and development studies, and to implement the tasks of the state services. For the purposes of climate research in the field of measurements and observations such tasks are assigned mainly to the Institute of Meteorology and Water Management.

8.1.2. Principles for funding research and observation

The financing of research from the state budget includes funding of activities targeted at implementing the state policies on research, science and technology, and innovation, and, in particular, research and development studies (R&D) as well as undertaking other activities especially important for the civilization progress. Financial resources for scientific research are granted to:

- research institutes – to conduct statutory activities and for investments for the purposes of scientific research or development studies,
- universities and other academic schools – for their own research,
- scientific institutions representing scientific research networks – for joint research projects,
- research institutes and other authorized entities – for undertaking measures or tasks planned for implementation at a specified time and under certain terms,
- ministers that coordinate different divisions of the governmental administration, to the heads of the central government administration bodies, and to the President of the Polish Academy of Sciences – for activities supporting research.

Financial resources for research and development originate also from other, non-budgetary, sources, such as: economic entities, research institutions of the Polish Academy of Sciences (PAN), research and development institutes, as well as those obtained under EU framework programmes and other international research programmes and initiatives. The share of these financial resources in the funding of research in Poland keeps rising, and it is expected to become even more significant.

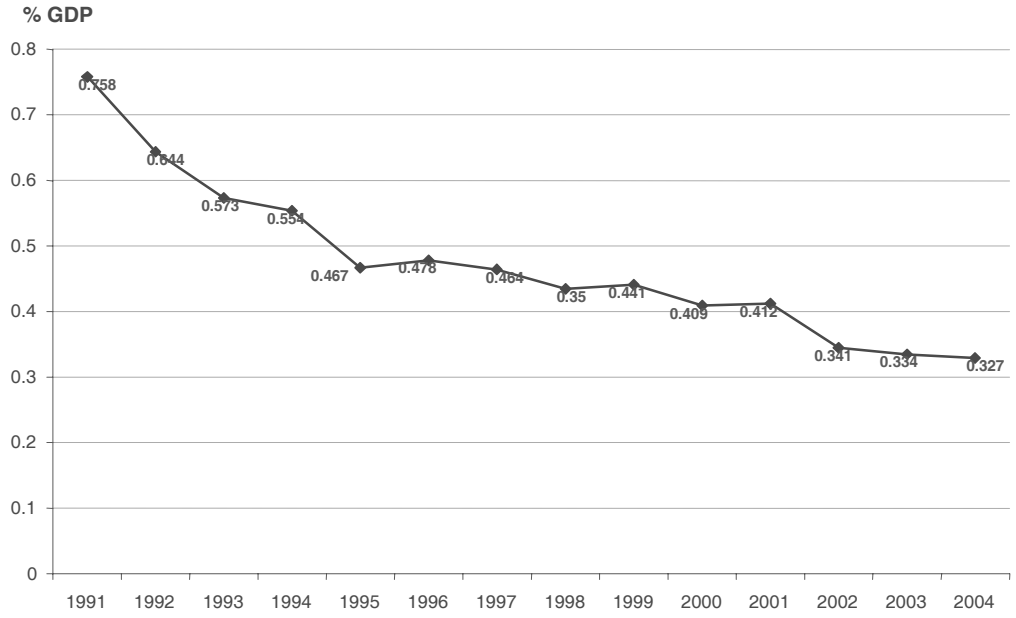
The budgetary expenditures on scientific research in Poland are among the lowest in Europe and amount to 0.313% of GDP (in 2005)[39]. Whereas the gross domestic expenditures on research and development (GERD) in relation to GDP account for 0.58% of GDP (in 2004)[40]. GERD per capita amounts to 64.5 USD PPP[41] (in 2003). The figures above place Poland at one of the last positions among the old and new EU Member States (the European GERD was 1.90%)[42]. The causes of this unfavourable situation are complex and they, inter alia, include:

[39] Source: publication of the Department of Financing Scientific Research at the Ministry of Science and Higher Education (MNiSW).
[40] Source: Science and Technology in 2004 (in Polish), GUS publication.
[41] USD PPP – acc. to purchasing power parity of US dollar. Source: Science and Technology in 2004 (in Polish), GUS publication.
[42] Source: Science and Technology in 2004 (in Polish), GUS publication.

– low budgetary expenditures on research and their inappropriate structure,
– lack of a sufficient number of economic mechanisms to encourage the private sector to support research and development studies,
– lack of a developed network linking science with the economy sector.

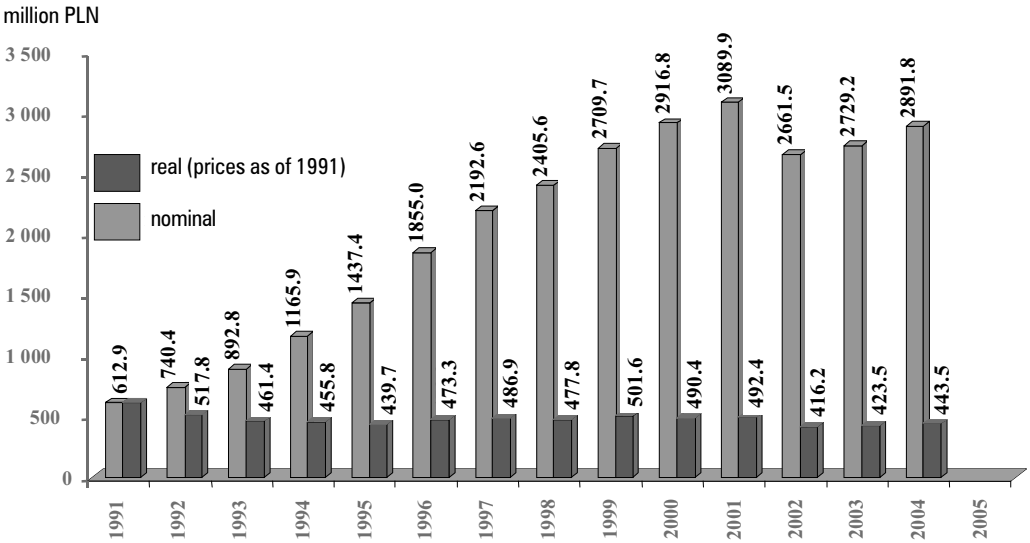
As illustrated in Figures 14 and 15, since the beginning of the 1990s a constant decrease in the expenditures on research has been observed, which resulted mainly from the declining share of the state budget in the funding of research and development (R&D) and from lack of increased financing by the economy sector. Lack of effective mechanisms for encouraging the enterprises to contribute to R&D funding makes Polish research studies unattractive to the economy. This affects the innovation initiative in the economy, which is becoming more dependent on imported patents, licences and technologies.

Figure 14. The share of budgetary expenditures on research in GDP in 1991–2004



Source: former Ministry of Scientific Research and Information Technology (MNiI).

Figure 15. Budgetary expenditures on research in 1991–2004



Source: former MNiI.

8.1.3. Climate studies in the state research policy

National Framework Programme. The National Framework Programme, which was adopted in 2005, serves as a basis for the minister responsible for science-related matters to announce calls for some several dozen research projects that are commissioned annually. This Programme sets out nine research fields of considerable significance to the socio-economic development of the country, within which priority research fields have been identified with a view to development acceleration. A research theme entitled The economy as a climate change factor has been launched under this Programme as one of the strategic research fields, which is the environment. Its aim is to define the ways of reducing greenhouse gas emissions in Poland and to increase their capture, reduce the use of non-renewable energy sources in favour of renewable sources, as well as to combat the negative consequences of emissions of these gases for the economy and nature.

Poland's Climate Policy. This document, which was elaborated by the Ministry of the Environment in 2003 and adopted by the Council of Ministers, contains the following recommendations on research studies, education, training and raising public awareness.

As regards research it would be necessary to:
- conduct studies on the use of energy and its production,
- continue research studies to track climate change and the variability of climate and climatic processes,
- continue research on climate change scenarios for Poland connected with the growing concentration of greenhouse gases in the atmosphere,
- continue research on the consequences of climate change and on the adaptation to these changes in Poland,
- provide financing for the aforementioned activities.

Furthermore, it is necessary to conduct systematic observations in the following fields:
- monitoring of the variability of Poland's climate,
- monitoring of emissions and removals of greenhouse gases;
- monitoring of the state of the atmosphere and hydrosphere,

and to participate in:
- the Global Climate Observing System (GCOS),
- the oceanic observation systems,
- the Earth's surface observation systems,
- international programmes, e.g. the World Climate Programme, the European Climate Change Programme, the International Geosphere-Biosphere Programme, the Intergovernmental Panel on Climate Change (IPCC).

8.1.4. Research activity fields in climate change

Polish scientific research studies in the field of climatology cover a wide range of topics among which the following can be distinguished:
- physical climatology;
- topoclimatology (climatology of urban areas, in particular);
- dynamic climatology;
- regional climatology, applied climatology and climate change survey.

The following major issues may be identified in climate change research:
- historical research on climate change, modelling of climatic processes, and the development of scenarios for predicted climate change,
- climate change impacts on the natural environment, on the economy and the public,
- impact of human activity on climate, and
- social and political aspects of climate change.

Historical climate change is a subject of interest to many climatologists, and similar to the situation in other countries, most research studies cover mainly the period of instrumental measurements, i.e. more or less from the end of the 18th century and the beginning of the 19th century and surveys are most often limited to country's regions, sometimes only individual towns. Long-term homogenous series of atmospheric temperatures elaborated for the Polish stations, such as: Warsaw, Cracow, Puławy, Gdańsk, Hel, Koszalin, Szczecin, Bydgoszcz, as well as Śnieżka may serve as an example. Complex research studies relating to the territory of the entire country are only possible from the beginning of the 50s of the 20th century. The key role in this field is played by the Institute of Meteorology and Water Management, which conducts work on extending the scientific research background with the documentation from the beginning of the 1920s. These studies dominate among other Polish climatic achievements. The pre-instrumental period, for which the only available data are "proxy" data in the form of geomorphology change, the dendrological and limnological data, as well as historical records, is also represented in Polish literature. The reconstruction of the thermal and precipitation conditions was based on historical materials from Cracow from the first half of the 16th century. Studies belonging to this group aimed at seeking historical climate change trends and potential regularities of these changes. In general, they confirm the results obtained in this area in the neighbouring countries. Several surveys attributed the causes of climate change observed in Poland, focusing mainly on their links with the regional and global processes (changes of regional atmospheric circulation, Oscillation of the North Atlantic, Arctic Oscillation, temperature changes of the surface of the North Atlantic, etc.).

Special attention should be given to research studies based on own observations related to the climatology of pollutants (Śląsk, Cracow), evolution of the urban boundary layer (Cracow, Łódź), tropospheric ozone and UV radiation (Belsk, Legionowo), as well as changes in the concentrations of greenhouse gases and halogens (Cracow). These studies, despite their relatively short data series, constitute an important and to a certain extent sophisticated contribution to the knowledge on Polish climate.

The attainment of the Polish climatology is smaller in the field of modelling climate change. This is mainly due to the costs required for such research studies and to their cross-cutting inter-disciplinary nature. Work undertaken in this field to date has been carried out individually by different scientists, often in cooperation with foreign climatology centres. They mainly focussed on the so-called "downscaling" (dynamic and static) and on the interpretation of the results of the General Atmospheric Circulation models (and sometimes also the ocean circulation) in relation to the whole territory of Poland or its selected regions. They constitute an interesting attempt of evaluating the expected climate change in Poland and of attributing the causes of the changes observed.

The second research field – the impact of climate change on human activity – is strongly represented in the Polish scientific community. Studies are focused on several scientific areas most vulnerable to climate change. These are: water resources, agriculture, coastal zone, ecosystems, forestry and the energy sector. This relatively new research field, also at global scale, is to a great extent of universal nature, and thus the attainment of Polish scientists gains greater approval and response reflected in scientific literature than studies on traditional climatology. The most complex Polish elaboration in this area was a publication on greenhouse gas emission reduction strategies and adaptation of the Polish economy to climate change.

Climate change will also influence human technical activity, especially the energy sector. An analysis has been carried out in this field to identify measures which will be essential to take in order to adapt this sector to the changed conditions (mainly reduction of greenhouse gas emissions) through the improvement of energy efficiency, reduction of energy intensity of the economy, development of renewable energy sources, changes in the energy supply structure etc.

In 1994–2004 around 80 research projects on climate change and the process of global warming have been carried out. They included both, projects of European importance:

- climate change impacts on water resources,
- reconstruction of climate changes in the quaternary period (geomorphologic methods) and in the historical period (dendrochronology, historical sources),
- climate change impact on plant production,
- strategies for reducing greenhouse gas emissions and adapting the economy to climate change (water resources, agriculture, coastal management),
- analysis of changes in the greenhouse gas emissions and atmospheric concentrations of ozone and halogens,
- regional scenarios of future climate change (within a limited scope),

and projects that were considered important at national and local levels:

- assessment of climate changes in the 20th century,
- adaptation of living organisms and crops to climate change,
- statistical analysis of climate elements at local and regional scales,
- applied research on the impacts of climate conditions on economic and technical activity,
- extreme meteorological and hydrological events in Poland.

The following topics may be considered as priority tasks under the Climate Convention and the Kyoto Protocol, as well as the European Union (in the research policy of the Community climate change problems have been given the highest priority by the European Community in the field of environmental research policy):

- assessment of future climate changes in the light of increased greenhouse gas emissions,
- assessment of the impact of climate change on economic activity and on the public (sea level rise, agriculture and forestry, energy sector, human health, ecosystems, water resources, extreme events, regional conflicts, migrations, sudden climate change) taking account of their vulnerability connected with these changes,
- climate change reduction methods with their cost analysis,
- methods and costs of adaptation to climate change.

Furthermore, scientists from various Polish centres participated in numerous projects on climate changes and their specific consequences, which were funded with foreign resources, mainly of the European Union. The IMGW, due to its specific role in climate research in Poland, took part in a project on the European Climate Assessment 2000 (ECA 2000) concerning climate change in Europe, within the framework of the European Climate Support Network (ECSN). Additionally, the IMGW and certain other research centres are involved in regional analysis of climate change and its consequences in the Baltic Sea region (Baltic Assessment on Climate Change, BACC).

8.2. Participation in international programmes

8.2.1. Polish contribution to the research activity of the International Geosphere-Biosphere Programme (IGBP) and its subprogrammes

The activity of the Polish National Committee (PKN) of the IGBP covers a broad research and organisational area:

– research on the impacts of global changes of the geosphere, biosphere and anthroposphere on the entire natural environment of the country,
– projections and examination of these impacts on domestic economic and social development,
– research on increasing extreme events (floods, droughts, hurricanes, landslides, hailstorms, storms, fires, etc.) and on projections and prevention of their environmental, economic and social effects.

PKN IGBP of the Polish Academy of Sciences (PAN) provides information to the national community on the results of research studies, as well as on the development of the IGBP and other international programmes that cooperate with it. Furthermore, the Committee provides inspiration and coordination of priority research studies related to global climatic and environmental changes. The results of Polish research studies are presented at national and international conferences. The Committee constitutes a forum for presenting domestic research studies as well as research projects on global and environmental changes, and on their consequences.

A special publication of the Polish National Committee, *Papers on Global Change IGBP*, presents the results of Polish scientists in global change, and heads for the papers of foreign authors. The Advisory Board of this publication comprises scientists of various research fields representing the world's science (Japan, Germany, Russian Federation, Switzerland, USA and Hungary). The Committee annually publishes the IGBP Polish Newsletter within its informative and reporting activity.

Biospheric Aspects of the Hydrological Cycle (BAHC). Studies on the impact of the unstableness of geophysical processes on domestic water resources with particular consideration of extreme hydrological events, such as floods and droughts, were subject to detailed analysis. The studies undertaken identify hazards of water resources and extreme hydrological events resulting from temperature changes. The problem of droughts was also investigated, inter alia, on the territory of the Wielkopolska region with regard to the requirements of different plant habitats, and the rate of global climate change impact on the river regime was also analysed in selected river basins with different physico-geographical features. The work of Polish scientists has gained international recognition and is used, inter alia, in the reports of the Intergovernmental Panel on Climate Change. In the recent period a team of scientists from ZBŚRiL PAN got involved in research studies under the MICE programme (Modelling the Impact of Climate Extremes, MICE), followed by its continuity – the ENSEMBLES project.

Other teams of Polish scientists were also involved in the work on the impact of land-use on water and heat balances, and others in the aspects of the protection of the coast against predicted rise of the ocean level by analysing possible losses connected with those changes and by identifying measures essential for ensuring economic security in this area.

Global Change and Terrestrial Ecosystems (GCTE). Stationary research studies on pollution balance in forest ecosystems were carried out in the Carpathians and Sub-Carpathian Basins. Studies on the impacts of global change on the carbon cycle in forest ecosystems and on the effects of forest reclamation in industrial areas were carried out in parallel. Also, monitoring of ion exchange was carried out in the lowland and post-lake ecosystems. By analysing changes taking place in the population of pine forests in the southern cross-section of Europe (from Laponia to the Carpathians) a clear trend was noticed for forest range to move towards the north as climate warming proceeds. Changes in the vertical structure of plant species under global atmospheric temperature rise were subject to analyses carried out in the Carpathians.

Research in agriculture focussed on the assessment of climate change impact on plant production and it was carried out mainly in Puławy. These studies proved that the expected temperature changes will have a significant influence on plant production and to ensure production efficiency it would be necessary to introduce changes in crop production structure. Studies on energy and material flows in agricultural landscape form a separate group of issues.

Analyses of the consequences of climate change in forestry and estimates concerning adaptation capacities of Polish forests to changed climate conditions were also undertaken that ended up with certain recommendations concerning changes in forest management. The range of avifauna in Poland in the context of observed climate warming was also examined.

International Global Atmospheric Chemistry (IGAC). Monitoring of stable and radioactive isotopes in the atmosphere was targeted at discovering the isotopic composition of CO_2 and CH_4, and the proceeding changes connected with human interference. Research studies on the location of the boundary layer in the vertical profile of the atmosphere in urban areas by using sodar and teledetection methods were also carried out. These studies correspond to research on atmospheric ozone changes, as well as on changes in UV-B radiation and tropospheric ozone.

These studies partly include methods for impact assessment of different types of activities on climate and their aim is to establish relevant indicators and greenhouse gas emission standards, as well as to develop methods to reduce adverse effects. A number of studies in this field are of innovatory nature and represent a very high level.

Past Global Changes (PAGES). Research on past environmental changes focussed on the investigation of mechanisms of changes in the last glacial and Holocene periods. Special attention in the glacial period has been given to climate changes registered in loess sediments and to the deglaciation process and permafrost recession. Particularly important was the discovery of one-year old laminas in Lake Gościąż, representing the last 12.5 thousand years. They provided the basis not only for a detailed reconstruction of environmental changes, but also for the calibration of radiocarbon curve and the determination of the duration of the cooling period of the early dryas.

Reconstructions of hydrological changes mainly based on analyses of sediments and river forms, as well as landslides, lakes and marshlands were also carried out under international programmes. It was, inter alia, proved that Holocene consisted of more humid phases with a high frequency of extreme events. Vegetation changes were reconstructed using an isotopic method. Polish scientists participate also in interdisciplinary research programmes on the history of Lake Baikal and of Scandinavian lakes, and are involved in the European palinology database.

Joint Global Ocean Flux Study (JGOFS). Studies on the integration of solar radiation with the maritime environmental biosphere, on the modelling of hydrophysical field structure, and on energy supply for the seas through photosynthesis were carried out in this area of interest. Several new methods, inter alia, using satellite technology, were developed that are useful for Baltic Sea monitoring. Implementation of the elements of satellite technology in environmental monitoring is currently carried out by the IMGW and independently by the PAN Institute of Oceanology and the University of Gdańsk. Polish research studies in polar zones significantly contribute to the knowledge on the impacts of global warming on ocean ecosystems.

Land Ocean Interactions in the Coastal Zone (LOICZ). Special attention has been given to the coastal zone in terms of expected global warming leading to sea level rise and possible increase of the frequency of storms and of their strength. Studies on the dynamics of the coastal zones and sea sediments and on the evolution of the Baltic coastline over a longer period of time were also carried out, similar to the modelling of physical processes at river mouths, salt and CO_2 exchange in the sea contact zones, as well as the chemistry and pollution of coastal waters. Extended studies on long-term temperature variability of sea water, its salinity, and on the inflow of nutrient substances into the Baltic Sea are carried out in the IMGW.

International Human Dimensions Programme on Global Environmental Change (IHDP). The IHDP programme gives priority to the „Social attitude as a driving force in the understanding of the causes and effects of changes in the environment and of the use of Earth's natural resources". Research has been undertaken to integrate activities of physical, economic and social sciences to improve the understanding of human behaviour in the environment, which leads to its degradation, both at local and global levels.

The Polish National Committee of the International Geosphere-Biosphere Programme (PKN IGBP) has taken the role of an initiator to establish the IHDP National Committee. The problem of human activity impacts on global climate change has been a subject of interest of several seminars and conferences, organised by PKN IGBP, as well as of numerous publications.

8.2.2. Cooperation under the World Climate Programme (WCP)

Polish scientists and experts actively participate in the work of the WMO and its commissions and individual programmes. For example, the scientists from the Institute for Research on Agricultural and Forest Environment (ZBŚRiL PAN) were involved in research activities under the *World Climate Programme – Water* aimed at seeking changes, both gentle trends, as well as sudden jumps in the extreme values of the long time series of river flows (for around 200 stations all over the world). Three reports have been published as a result of those studies under the WCASP series (2004), i.e. the *World Climate Applications and Services Programme*.

In 2005 a *Climate Atlas of Poland* was published. It was prepared by IMGW and it contains a broad spectrum of climate elements observed in 1871–2000 in Poland. Furthermore, a programme for saving historical data, including their scanning and digitization from archive materials, inter alia, from the period of 1930–1950, is implemented in the IMGW. Studies on the variability of climate conditions in Poland based on long-term series of climate data are constantly continued.

8.2.3. Global Climate Observing System (GCOS)

Poland has designated a national focal point for cooperation within the GCOS, which is located at the Institute of Meteorology and Water Management (IMGW). Two stations from the territory of Poland were submitted for incorporation into the observation network of the GCOS. Poland was also represented in a regional GCOS seminar organized for Central and Eastern Europe, and thus showed its engagement in this field. This engagement has also been proved, inter alia, by preparing by the IMGW at the request of the GCOS Secretariat the regional strategy for the safeguarding of historical materials. Detailed information on observing systems under the GCOS: the Global Ocean Observing System (GOOS), the Global Terrestrial Observing System (GTOS) and the Global Atmosphere Watch (GAW) is presented in Chapter 8.3.

8.2.4. Participation in the work of the Intergovernmental Panel on Climate Change (IPCC)

The Polish focal point for the IPCC has been designated in 1990 by the Minister of the Environment and it is currently located at the Institute of Meteorology and Water Management in Warsaw. It coordinates work for the IPCC in Poland, provides opinions to IPCC documents and nominates experts to participate in working group sessions and expert meetings. Polish scientists are involved in the preparation and review of IPCC documents and reports.

Polish scientists took part in a series of preparatory meetings (the so-called scoping meetings) for the IPCC Fourth Assessment Report (AR4) on climate change. In the work related to the AR4 Poland is represented by Polish scientists preparing chapters on fresh water resources and their management and on the assessment of observed changes and natural impacts of managed ecosystems on climate change. A small group of Polish scientists has been invited by the IPCC to participate in the so-called expert review phase of the report. Polish scientists also participated in the preparation of two special IPCC reports on the protection of the ozone layer and the global climate system, and on carbon dioxide capture and storing, as well as in the preparation of a technical document – *Climate change and biodiversity*.

Polish contribution is also visible in the preparation of two documents supporting national estimates on greenhouse gas emission and removal inventories connected with deforestation and other changes in land use. Polish experts took part, both in the preparation of *Definitions and methodology options for emission inventories connected directly with degradation of forests and other plant habitats resulting from human activity*, as well as a *Guidebook on good practices in estimation, measurement, monitoring methods and on methods for reporting changes in carbon stocks and carbon dioxide emissions connected with land use, land-use change and forestry*.

8.2.5. Participation in the European Programme for the Global Ocean Observing System (EuroGOOS)

Polish institutions (IMGW, IO PAN, IM) being members of the EuroGOOS carry out important activities for the development of the European operational oceanography, which will significantly contribute to the Global Ocean Observing System – GOOS. The key element of work carried out under the EuroGOOS is to create and develop a stable system for oceanographic observations and measurements within the Baltic Sea area.

8.3. Systematic observation

8.3.1. Meteorological observing systems

In Poland observation and measurements under the global system for meteorological and climate observation are carried out by the State Hydrological and Meteorological Services of the Institute of Meteorology and Water Management (Table 54).

Table 54. Summarised information on the atmospheric observation system in Poland (this system includes IMGW stations, which operate under GSN and GUAN, and out of 6 GAW stations – 4 belong to IMGW, 1 to IOŚ and 1 to PAN)

Scope of information	GSN	GUAN	GAW	Other
How many stations are the responsibility of the Party?	61	3	7	1182
How many of them are currently operated? (2005)	61	3	7	1182
How many of them participate in international data exchange?	61	3	7	1182
Does the Party operate any international archive centre?	NO	NO	NO	NO
Does the Party operate any centre for archive/control quality?	YES	YES	NO	YES

Source: IMGW.

This system consists of:

1) 61 synoptic stations (GSN) with regular personnel and additionally fitted with independent, automatic meteorological stations;
2) 153 climatological stations and meteorological posts providing measurements and observations of meteorological parameters; equipped with automatic meteorological stations;
3) 1029 precipitation posts, of which 302 are fitted with automatic rain-meters for continuous measurements of precipitation levels;
4) 3 aerological measurement stations used for vertical atmospheric profiles up to 30 kilometres high.

The whole network follows a programme for measurements and observations, which is compliant with the standards of the World Meteorological Organisation and the equipment installed in the observation and meteorological network undergoes systematic control and periodical calibration. For this purpose, a Central Laboratory for Measuring Apparatus has been established at the IMGW.

Information from the network of measurement and observation stations and posts is, following its verification and control, stored in the IMGW national database on historical data, with no validity date, on paper carriers (the oldest going back to the end of the 18th century), on films and in electronic form (digital data cover the period from 1951).

Every three hours IMGW transmits to the GTS, which is supervised by the WMO, data from 22 GSN stations, and twice a day – the aerological data from 3 GUAN stations. CLIMAT DATA messages from 6 GSN stations, and CLIMAT TEMP messages from 3 GUAN stations are forwarded to NCDC/NOAA in Ashville (USA).

Apart from the IMGW and ZMŚP networks, meteorological measurements are also carried out by certain universities,

such as Gdańsk University (UG), Jagiellonian University (UJ), Nicolaus Copernicus University (UMK), Maria Curie-Skłodowska University (UMCS), Adam Mickiewicz University (UAM) as well as research institutes (IUNG, IGiPZ PAN). These stations carry out long-term systematic meteorological and specialised measurements, e.g. related to surface evaporation (UG) or take measurements of selected meteorological elements.

8.3.2. Ocean observing systems

The following research institutions participate in oceanographic observations: the Institute of Meteorology and Water Management (IMGW), the Oceanology Institute (IO PAN), the Institute of Hydro-Engineering (IBW PAN), both members of the Polish Academy of Sciences (PAN); the Maritime Institute (IM), the Maritime Institute of Fisheries (MIR) and Gdańsk University (UG).

The key role in the system in Poland is played by IMGW, which since the beginning of the 60s of the 20th century has been actively participating in one of the largest global observation programmes coordinated by the World Meteorological Organisation, which is VOS (Voluntary Observing Ships). Under this system, regular observations and meteorological measurements, and surface oceanographic measurements, essential for proper functioning of the system of forecasts and warnings for the sea areas and coastal zones, are carried out by trade ships. At the same time, IMGW participates in the Marine Climatological Summary Scheme (MCSS), a worldwide programme, whose ultimate goal is to collect data concerning observation and measurement results (VOS) on digital carriers and to prepare climate characteristics and atlases for sea areas. A representative of Poland coordinates work under this programme, which is realised under the auspices of a Joint WMO-IOC (UNESCO) Technical Commission for Oceanography and Maritime Meteorology (JCOMM). Furthermore, IMGW, for the purposes of research on climate change in NCAR (NOAA, USA), takes part in the work on the development of an international and global database containing results of all meteorological observations carried out at seas and oceans (ICOADS, International Comprehensive Ocean-Atmosphere Data Set). Currently, the aforementioned database contains almost 2 million records; the oldest observations come from the 17th century.

The oceanographic activity of IMGW within the scope of GCOS, includes regular measurements and observations of the maritime environment of the Polish zone of the southern Baltic Sea by using a research ship (measurements are carried out since the late 1950s), and measurements in coastal stations on the levels of the sea, temperature and water salinity, which are carried out in some stations since 1945. During regular sea expeditions meteorological observations and measurements within the scope of SHIP telegrams, measurements of temperature and water salinity in the vertical profile from water surface to the bottom and profile measurements of subsurface sea currents are carried out. Three maritime measurement stations in the region of the three Baltic deeps are elements of the international network of stations controlled under the HELCOM monitoring programmes, where measurements of the basic parameters of the state of the Baltic Sea environment have been carried out since several decades.

In the recent years the IMGW coastal measurement stations have undergone in-depth modernisation, and thanks to that systems of measurements, transmission and storing of data on sea levels and water temperatures improved.

All measurement data are subject to quality control and they are stored in the IMGW oceanographic electronic database. This database contains all regular measurement data collected since the 1950s, and measurement results of the sea level, temperature and water salinity at coastal stations since as early as 1938, and observations of sea condition, since 1962.

IMGW as a national centre for oceanographic data maintains an oceanographic database registered in IODE, and takes part in regular exchange of basic oceanographic data (temperature and salinity) with the database of the International Council for the Exploration of the Sea (ICES) in Copenhagen. In addition, IMGW represents Poland in the SeaSearch project, which is funded by the European Commission under the Fifth Framework Programme. The project's aim is to develop a pan-European network of oceanographic databases.

Measurements taken by the IO PAN research ship during its cruises in the Baltic Sea and in the Arctic include the following parameters: solar radiation, sea surface atmospheric temperature, concentration of aerosols and humidity above sea surface, and sea temperature and salinity, sea currents, light transmission deep into the sea for selected wave lengths, and others.

Currently, Poland has 67 Volunteer Observing Ship (VOS) platforms, 3 Ship of Opportunity Programme (SOOP) platforms, of which 1 is owned by IMGW and MIR, 1 by the IO PAN and

Table 55. Summarised information on the oceanographic observing system in Poland

Scope of information	VOS	SOOP	TIDE GAUGES	SFC DRIFTERS	SUB–SFC FLOATS	MOORED BUOYS	ASAP
For how many platforms is the Party responsible?(2005)	67	3	11	–	–	2	–
How many of them participate in international data exchange?	67	3	11	–	–	1	–
Does the Party operate any international archive centre?	NO	NO	–	–	–	–	–
Does the Party operate any centre for archive/control quality?	YES	YES	YES	–	–	–	–

Source: PAN.

one by IM, 11 TIDE GAUGES (sea-level measurement stations), all owned by IMGW, 2 MOORED BUOYS, i.e. autonomic measurement buoys, each owned by: IO PAN and IBW PAN (Table 55). IBW intends to remain only with the one buoy currently used.

Further work by IMGW under the programme on measurements of basic oceanographic parameters within the Polish Baltic economic zone depends, to a great extent, on the national policy concerning the maintenance of the basic measurement network for the Baltic Sea and its funding. The present measurement programme is carried out mainly thanks to the existing Baltic Sea Monitoring programme conducted by IMGW within the framework of the State Environmental Monitoring system. This programme constitutes a consistent maritime environment control system for the Baltic Sea covering both the abiotic and biotic parameters, and provides basic data for further studies on Baltic Sea status changes in the context of climate change. However, its further operation is seriously threatened in the light of the variable and unstable financial policy.

8.3.3. Terrestrial observing systems

Since 1998 the Department of Geomorphology at Maria Curie-Skłodowska University in Lublin (Table 56), and since 2003 – the Department of Cryology and Polar Research at Nicolaus Copernicus University in Toruń have been participating in the system for observing the Earth's surface.

Table 56. Information on Poland's participation in terrestrial observing systems

Scope of information	GTN–P	GTN–G	FLUXNET
How many stations are the responsibility of the Party?	303	–	–
How many of them are currently operated? (2005)	303	–	–
How many stations participate in international data exchange?	26	–	–
Does the Party operate any international archive centre?	NO	–	–
Does the Party operate any centre for archive/control quality?	NO	–	–

Source: PAN.

Poland is a member of the International Permafrost Association (IPA) and is involved in the Circumpolar Active Layer Monitoring (CALM) programme, which is a part of the Global Terrestrial Network - Permafrost (GTN-P). The CALM programme was developed in the early 90s of the 20th century in order to assess changes taking place in the active layer of long-term permafrost and to provide information for regional and global models. Measurement results that are collected by scientists at CALM stations are transferred to the CALM data centre at the University in Cincinnati (USA) and to the National Snow and Ice Data Center, Boulder Colorado (USA).

8.3.4. Satellite climate observing systems

The Institute of Meteorology and Water Management has a station for receiving and processing satellite data (Table 57), which allows to take advantage of the following geostationary and circumpolar satellite systems:
- Meteosat,
- Meteosat – Rapid Scan,
- NOAA,
- MSG ,
- METOP,
- FEN JUN.

Table 57. Information on the satellite observing system (for research and operation purposes) in Poland

Scope of information	Possible answer
Has the Party a space-based research programme in place?	Series/missions: cooperation under EUMESAT
Is there any commitment concerning the quality and continuity of the climate data obtained from satellite data?	NO
Is there any national programme for obtaining climate data from satellite data?	NO
Are the climate data files disseminated on regular basis?	Still in scientific/experimental phase
Are the data accessible free of charge?	Within the IMGW network
Does the Party operate any international archive centre?	NO
Does the Party operate any centre for archive/control quality?	YES

Source: IMGW.

The data received are processed into an image form with possible animation, and made accessible to users within and outside IMGW. Satellite system products supply the user services systems and provide input to the forecasting systems. Below are the most important types of satellite products that are developed and updated operationally:
- satellite images in all spectral channels of satellite sensors (calibrated and corrected geometrically),
- selected colour compositions RGB of 3 channels,
- products of satellite atmospheric sounding with A TOYS/ /NOAA sensors,
- products of SatRep – satellite image analysis,
- specialised products on the Earth's surface (sea iceing, snow cover, etc),
- products from other satellites retransmitted by Meteosat and MSG systems: images from GOES-E, GOES-W, GMS, JNDOEX,
- satellite products for media.

The Institute has a rich archive with the METEOSAT and NOAA satellite data from the 1960s in a photographic form, and since 1987 until now in a digital form. The Institute's research activity focuses mainly on the use of satellite information in

meteorology and hydrology, with a direct goal to implement the methods prepared into the services performed. Work on the use of data available from meteorological satellites in other fields, such as: oceanology, agriculture, research on natural environment, early warning systems for extreme events, is also carried out. The Institute actively cooperates with the Europe's Meteorological Satellite Organisation (EUMETSAT).

8.3.5. Monitoring of greenhouse gases

Measurements of greenhouse gas atmospheric concentrations in Poland are carried out at two stations located in the zone of limited anthropogenic impacts: in the Puszcza Borecka forest in the north-eastern part of the country and on the Kasprowy Wierch Mountain in the south of the country.

The measurement station on the Kasprowy Wierch Mountain (1,987 metres above sea level) was established in 1994 by the staff of the Environmental Physics Chair of the AGH University of Science and Technology (AGH) in Cracow. This station is located in the building of the IMGW High-Mountain Meteorological Observatory. Apart from atmospheric concentrations of selected greenhouse gases (CO_2, CH_4, SF_6), measurements also include their isotopic composition ($d13CO_2$, $d13CH_4$, $d18CO_2$, $d14CO_2$).

Although measurements of CO_2 atmospheric concentrations on the Kasprowy Wierch Mountain have only been carried out over a relatively short period of time, it is already possible to come up with certain conclusions concerning long-term changes and compare the amplitudes of CO_2 signals in subsequent years of observation. In 1998 and 1999 a significant rise in the average measured annual concentrations was observed, amounting to 4.2 ppm and 3.8 ppm, respectively. This rise was accompanied by a drop of the amplitude of the seasonal changes to 14.7 ppm and 19.2 ppm, respectively. In 2000–2002 the amplitude of seasonal changes rose once again to 20.4–22.3 ppm. The average annual concentrations also increased in the whole observation period from 360.8 ppm to 373.4 ppm (Table 58).

Table 58. Average annual CO_2 concentrations and an amplitude of seasonal CO_2 concentration changes, as well as average annual CH_4 concentrations measured at station KASLAB on the Kasprowy Wierch Mountain in 1995–2002

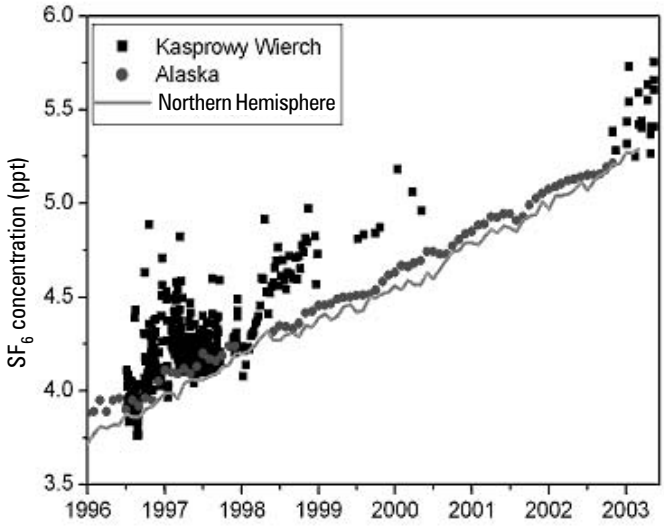
Year	Average annual CO_2 concentration [ppm]	Seasonal CO_2 concentration changes [ppm]	Average annual CH_4 concentration [ppb]
1995	360.8	20.5	1827
1996	362.8	21.2	1837
1997	362.6	21.6	1829
1998	364.8	14.7	1839
1999	368.6	19.2	1850
2000	369.5	20.4	1859
2001	370.6	21.3	1851
2002	373.4	22.3	1870

Source: AGH University of Science and Technology (AGH).

Similarly, the annual average methane concentrations measured on Kasprowy Wierch increased from 1,827 ppb in 1995 to 1,870 ppb in 2002 (Table 58). In the measurement recording of the average annual concentrations of this gas numerous maximum and minimum peaks are observed which are not connected with the seasonal changes (the summer lowest level is connected with the intensity of UV radiation and with more intensive reaction of methane with the free OH radicals). The origin for those relatively high oscillations of CH_4 is not clear, they may be connected with the local sources of this gas. Furthermore, comparison of data from Kasprowy Wierch with measurements taken at other European stations shows an increase in the average annual rise of CH_4 concentration in the lower part of the atmosphere when moving from the Atlantic Ocean towards the interior of the continent, which may be caused by anthropogenic tropospheric emissions of this gas.

The average daily SF_6 concentrations presented in Figure 16 show significant dispersion of results reaching as much as 30% of the concentration measured. Similar dispersion of average daily values was observed at a German station Schauinsland (1,205 metres above sea level). This most likely results from the variability of the SF_6 background concentrations in the atmospheric masses flowing over the European continent. For comparison reasons Figure 16 also shows the average monthly SF_6 concentrations measured at Point Barrow station

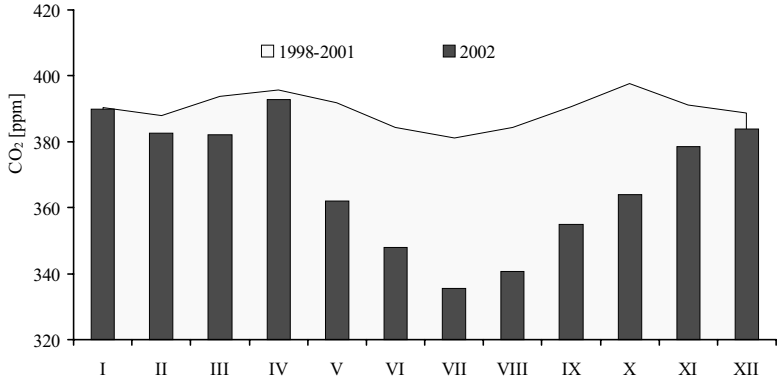
Figure 16. Measurements of SF_6 concentrations at station KASLAB on the Kasprowy Wierch Mountain between June 1996 and April 2003



Source: AGH.

on Alaska and the average northern hemispheric concentration range of this gas, determined mainly on the basis of the ocean stations. The growth rate of SF_6 concentrations on Kasprowy Wierch Mt. corresponds with the curve representing the northern hemisphere, but the majority of measurement results lie above this curve, which proves the impact of the ground-level emission sources of this gas on the European continent on the concentrations measured in the interior of the continent.

Figure 17. Average monthly CO_2 concentrations at station Puszcza Borecka in 1998–2002



Source: IOŚ.

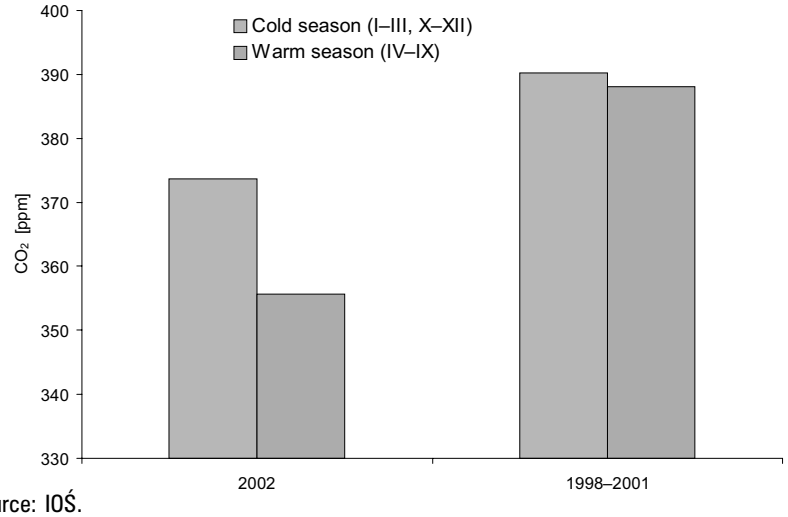
The Station for Integrated Environmental Monitoring "Puszcza Borecka", managed by the Institute of Environmental Protection, is located in the Puszcza Borecka forest in the north-eastern part of Poland and it plays the role of a regional station for monitoring background concentrations of the pollution of the terrestrial environment. The aim of research carried out at the station is to provide long-term assessment of environmental changes caused by human activity.

Measurements of CO_2 carried out at the station in 1998–2002 proved that the average amplitude of an annual cycle amounts to about 20 ppm, which accounts for almost 5% of the annual average. CO_2 concentrations reach the highest values during springtime and in autumn, whereas the lowest values are noted in summer. This cycle is associated with the activity of the biosphere and with increased combustion of energy fuels in the winter season.

In 2002 the average annual CO_2 concentration reached 368 ppm and was by almost 5% lower than the mean value for 1998–2001. A significantly higher amplitude of changes of average monthly values (57 ppm) has been observed in relation to the average amplitude for 1998–2001 (38 ppm). The amplitude of hourly changes was also record-breaking with its highest values reached in July (92 ppm), in the sweltering month with high rainfall and luxuriantly growing vegetation (Figure 17).

In 2002 the highest average daily values were observed from January to April and from November to December, like in the previous years. They were slightly lower than the 4-year average values. In the warm season the mean values noted were the lowest observed and distinctly lower than in the long-term period of 1998–2002 (by over 10%). At the same time (from May to September) extreme average hourly values were observed, which ranged from 293 ppm to 486 ppm. Such a high amplitude of changes of CO_2 concentrations (51% of the annual average) was connected with a high biogenic share in the vegetation period (CO_2 assimilation by the biosphere, and soil emission), as well as with low anthropogenic share.

Figure 18. Average CO_2 concentrations for the cold and warm seasons of 2002 and 1998–2001



Source: IOŚ.

Figure 18 presents average seasonal CO_2 concentrations in 2002 against the background of the 1998–2001 annual average values. Both mean values are markedly lower than the long-term average. The ratio of the average concentration for the warm season and the concentration in the cold season in 2002 (0.95) is much smaller than the one for the mean long-term series average (0.99). This reflects not only the relatively high biogenic share (significant advantage of vegetation assimilation processes over soil emission), but also a relatively low anthropogenic share in carbon dioxide concentrations in 2002.

Summing up, it can be stated that carbon dioxide concentrations in 2002 were lower than in the previous years due to an exceptionally warm and dry (with low relative humidity) spring and autumn. The values were characterised by a record-breaking amplitude of changes of average daily and average monthly levels, connected with high biospheric activity, starting already in March (similar to the years 2000–2001, but earlier than in 1998–1999).

9. EDUCATION, TRAINING AND PUBLIC AWARENESS

9.1. Educational policy

Educational policy in the field of environmental protection lies within the competences of two ministers: the minister responsible for education and the minister responsible for environmental issues. Raising public awareness and developing public concern in environment-related matters begins as early as at nursery school, through a six-year primary school, then a three-year gymnasium and post-gymnasium schools. Mandatory programme contents in this matter is included in a document issued by the Minister of National Education – *Programme basis for nursery school level and for all school-type education*. This document serves as a basis for educational programmes and manuals that are prepared. The Ministry of the Environment is responsible for supporting informal education, and thus the activities aiming at raising awareness in environmental matters that go beyond the official school programme. These activities are of countrywide nature and are addressed to the entire public, with particular consideration of children and youth.

In Poland the legislation in force includes provisions on conducting broad environmental education, which are laid down in the Act on Environmental Protection Law (Section VII. Environmental education, environmental research and advertising). The amended in 2003 Act on the Educational System introduced the following wording: "the educational system provides, in particular (...) dissemination among children and youth the knowledge on sustainable development principles and development of approaches favouring its enforcement at local, national and global scales".

Considerable attention to environmental education is also given in the *Second State Environmental Policy*, in *Poland 2025: Long-term Strategy for Sustainable Development*, and in *Poland's Climate Policy*. Environmental education and public participation in environmental matters has been indicated as one of the tools for implementing the *Second State Environmental Policy*.

The importance of environmental education is emphasised by a number of strategic documents, including the *National Environmental Education Strategy – through education to sustainable development*, adopted for implementation in 1997. In subsequent years the Strategy has been updated and adjusted to the changes connected with further reforms in Poland.

The *National Environmental Education Strategy* identifies and prioritises the key objectives for environmental education, indicating, at the same time, the possibilities for their implementation. Among one of its fundamental issues is that environmental education should encompass the entire public, including all age and profession groups, as well as decision-makers.

Environmental awareness of the public is developed in schools and through different types of actions conducted by public and social organisations and the media. Training of specific profession and social groups also plays a special role.

9.2. Formal education

The up-bringing of the public and the process of its education regarding environmental care begin for children at nursery schools, going through six-year primary schools, three-year gymnasiums and post-gymnasium secondary schools (general-grammar and profiled secondary schools, and technical and vocational schools).

Mandatory educational programmes in the aforementioned educational institutions have to follow the *Programme basis for nursery school level and all school-type education*, which was issued by the Minister of National Education on 26 February 2002. Individual programmes of education and school manuals that are prepared are based on this document.

Pre-school education, as it is foreseen in the aforementioned Programme basis, includes transfer of knowledge on a healthy life style, assessment of behavioural approaches that are in favour of or threatening to health, creation and taking advantage of opportunities to obtain knowledge on nature through observation, experimenting and discovery, as well as promotion of environmental habits and behaviour.

For the first educational phase of primary school (elementary school), i.e. classes I-III, the Programme sets the following educational objectives, among others, to enhance the need of contact with nature, and to observe natural phenomena and processes experienced by children. Other provisions concern forms of environmental protection in the nearest surroundings. In the second educational phase, in classes IV-VI,

environmental provisions are taken into consideration in a broader scope, mainly by introducing the so-called "environmental education pathway". During these lessons school children get acquainted with problems concerning the relationship between man and the natural environment, and sensitivity to threats resulting from human activity is developed. These issues are also present in the objectives and provisions of the subject named 'nature', within which the following, inter alia, aspects are discussed: the understanding of relations present in the natural environment; capabilities to observe natural phenomena and to describe them; the co-relations between humans and the environment; the development of a sense of responsibility for the environment.

In further phases of education, i.e. in gymnasium (lower-level secondary school) and lyceum (higher-level secondary school), environmental aspects regarding sustainable development and climate change are presented in educational programmes in the form of interdisciplinary "environmental pathway" and within the programmes of other subjects, such as: biology, geography, physics and chemistry. The educational programmes of these schools include the following issues:

- causes and effects of adverse changes in the atmosphere, biosphere, hydrosphere and lithosphere,
- environmental threats resulting from energy production and transport; nuclear energy - safety and waste management,
- the functioning of the natural Earth's ecosystem – phenomena, processes, co-relations, environmental variability in time and space, inter alia, weather changes and its forecasts, natural disasters; environmental equilibrium,
- operational and spatial connections and co-relations in the system of human-nature-economy; types of environmental management and their consequences, based on selected examples, e.g. covering zones, continents, countries, with particular consideration of Poland,
- economic and social aspects of relations between humans and their activities, and the environment; environmental value; benefits and losses connected with its exploitation; renewable and non-renewable natural resources,
- threats to civilization connected with conventional and nuclear energy; renewable energy sources.

A broad spectrum of environmental aspects and the knowledge on climate change caused by human activity is also disseminated by high schools and universities, especially by faculties connected with environmental protection at universities, teachers' education high schools and agricultural academies. There are also non-public high schools operating in Poland involved in education on hazards to the environment, including climate. Furthermore, post-graduate studies for high school graduates from different faculties also include environmental aspects in their programmes. Scolars and high school lecturers organise at their universities a series of open lectures accessible to the entire academic society (high school or town), which are carried out by experts in different fields of science connected with environmental issues, including climate change.

9.3. General information on training

Training of personnel involved in air protection management in Poland, covering climate change aspects, is just as important as environmental education for children and youth and awareness raising of the public. The Ministry of the Environment has taken measures towards raising qualifications of environmental personnel. The *Programme on the training of environmental personnel* has been prepared in 2003 and it is currently under implementation. Several training undertakings addressed to the personnel from voivodship offices, poviats and gminas are planned under the Programme.

Training on air protection (pursuing the commitments towards the Climate Convention and the Kyoto Protocol) is also carried out at the Training Centre for Environmental and Water Management Personnel in Dębe near Warsaw, which is supervised by the Ministry of the Environment. This Centre provides additional training and upgrading of the managerial staff of environmental experts and of other institutions and economic entities.

The Ministry of the Environment is also involved in the implementation of programmes on vocational practices and graduation training at the ministerial departments for students and graduates from public and non-public high schools. The aim of the *Ecocareer* programme is to create the possibility for students and graduates of environmental faculties to gain their first professional experience at work. Also other units subordinated to and supervised by the Minister of the Environment are engaged in this undertaking, as well as high school authorities.

Ministerial research institutes also undertake many educational activities. All institutes carry out practices for post-secondary schools and high school students. The majority of institutes provide educational courses for school students and organise a variation of events, competitions, the so-called "knowledge olympic games", open days for the visitors, etc.

9.4. Information and educational activity conducted by governmental institutions and NGOs

Environmental education in Poland is carried out by a number of institutions. The Ministry of the Environment is involved in developing environmental awareness of the Poles by organising various competitions, exhibitions, conferences, as well as other information and educational events.

A significant role in the process of developing environmental approach is played by mass media. The Minister of the Environment is cooperating with a variety of them, especially those that are branch-related, to disseminate updated and reliable information on environmental protection and water management. The Minister organises press conferences on climate change as well as seminars for journalists dedicated to this issue (Climate Convention, the Kyoto Protocol, emissions trading). This theme is also present in radio broadcasts commissioned by the Minister of the Environment and financed by the National Fund for Environmental Protection and Water Management.

The Ministry of the Environment publishes an information bulletin on *Climate change*, which contains a broad package of information, inter alia, on greenhouse gas emission trends, research projects, undertakings for preventing and adopting to future climate change, and on domestic and international measures that are taken.

In 2005 the Ministry of the Environment has launched a special environmental website (Ekoportal – ekoportal.com.pl) where information on the environment and its protection is provided. By providing broad communication capacities, the Ekoportal will also develop other forms of communication such as chats, discussion forums, news of the day.

The pan-European information and promotional campaign on climate change, prepared by the European Commission and running in 2006, is one of the examples of information and educational activities in which the Minister of the Environment is involved as an organiser or co-organiser. The campaign's objective is to raise awareness of the Europeans of climate change impacts on the environment they live in and to convince them that each of us can contribute to GHG emissions into the atmosphere through our every-day activity.

Two large promotional and information events planned for 2006 by the Ministry of the Environment will also take place under the key theme of climate change. The first one is a campaign on the European Mobility Week and a Car-free Day. The campaign is targeted at direct engagement in activities related to environmental protection by promoting public means of transport as an alternative to private car transport. In 2005, 87 towns participated in this action, which allowed Poland to rank fourth in Europe (following Spain, Austria and the Netherlands). The second event is the POLEKO International Ecological Fair, which is to take place in November 2006. Climate change will be its theme for this year. It is the largest environmental trade fair in Central and Eastern Europe that creates a platform for information exchange and promotion of the most sophisticated environmental technologies, and gives an opportunity to meet with environmental experts from Poland and from abroad.

Many activities related to environmental education are financed by the National Fund for Environmental Protection and Water Management

One of the elements of educational activities of the Minister of the Environment is the cooperation that has been maintained since many years with non-governmental environmental organisations and environmental education centres, whose major task is to develop public responsibility for the state of the natural environment and to encourage to undertake activities for air protection, including climate protection. Educational activities targeted at raising environmental awareness among wider social groups are carried out, inter alia, by environmental education centres, non-governmental organisations, national and landscape parks, Regional Directorates of the State Forests, educational centres of the Promotional Forest Complexes, gmina-owned centres of culture, botanic gardens and zoos.

A campaign *TIRs on railway tracks* serves as an example of such activity and is a part of a campaign for environmentally sound spatial and transport policy conducted jointly by the Citizens' Environmental Movement and the Greens' Federation – the Cracow Group. An exhibition has been organised and a folder published under this campaign to promote among the citizens the idea of transporting transit trucks crossing Poland on railway platforms. This exhibition was presented in major Polish cities.

The most active non-governmental organisations are involved not only in seeking solutions to local problems but they also participate in providing opinions to drafted legislation, and organise their own, often countrywide, educational actions (e.g. training, conferences, seminars). Their aim is to raise awareness of the Poles on the benefits likely to be achieved thanks to measures taken to reduce greenhouse gas emissions (undertakings combating emissions of greenhouse gases causing climate change – promotion of energy-saving and renewable energy sources, elimination of methane from coal mines and municipal waste landfills, and of freons from production processes), on threats connected with lack of such activity and on the potential consequences of climate change.

Activity related to transport, i.e. the economical driving (the so-called "eco-driving"), which is in favour of a significant reduction of fuel consumption and exhaust gas emissions, can serve as an example of information and educational activities targeted towards the need for behavioural change. Many projects have been accomplished in this field, and standards and requirements of the European Aviation Safety Agency (EASA) incorporated into the operational procedures at airports and air carriers, which caused more environmentally sound behaviour.

A Climate Coalition has been established in 2003 to disseminate knowledge on threats connected with climate change and to better coordinate the undertakings of the environmental movement in climate protection matters. Nine non-governmental organisations acceded to this open agreement.

The Coalition is involved in organising conferences, workshops and thematic training connected with climate change and in publishing guidebooks for different addressees, as well as in an information action through websites and mass media. The following examples are among the educational and information measures that have been taken:

- the programme *My school protects the Earth's climate*, whose mission was to promote in schools the knowledge on climate change risks and on possibilities of self-reducing our own impacts on the environment through rational use of energy, fuel and water,
- the project *Stop to global warming*, which contributed to the strengthening of cooperation between environmental non-governmental organisations dealing with global warming, and to the development of a stable form of cooperation in this field,
- the project *Institutions friendly to renewable energy sources (RES) – regional and local support for RES in Poland*, whose aim is to identify and inventory the institutions, which should be potentially interested in various aspects of the use of alternative energy sources,
- the *Polish Energy Efficiency Motors Programme* (PEMP), whose aim is to reduce the national CO_2 emissions connected with electric power production through effective power use in electric motors. PEMP is an executive programme co-financed by the Global Environment Facility (GEF) under the global climate protection.

In 2006, under the patronage of the Minister of the Environment and the Minister of Economy, the World Wildlife Fund (WWF Poland) has started a countrywide educational campaign on climate change limitation and better use of the energy efficiency potential. Its goal is to disseminate knowledge on climate change, its effects and co-relations between CO_2 emissions and Earth's temperature rise, to become aware of the relationship between the way of energy-use and surplus CO_2 emissions, as well as to promote the energy saving and responsible attitudes towards energy use. An electronic quarterly bulletin entitled *Climate Bulletin*, which has been issued by the Institute for Sustainable Development since 2002 serves as a tool for presenting public opinion with climate change issues and, in particular, climate policy.

9.5. Participation in international activities

The Ministry of National Education co-finances international environmental education programmes in which issues related to sustainable development are considered as a priority, e.g. the GLOBE Programme (in 1997 the Ministry of National Education of Poland signed an agreement with the United States National Oceanic and Atmospheric Administration regarding cooperation under the GLOBE Programme). The Global Learning and Observations to Benefit the Environment Programme is a worldwide environmental programme, which by creating a network of school pupils, students, teachers and scientists enables gaining of knowledge on global environmental problems. Around 80 Polish schools are currently participating in this programme.

Following the tradition, a large part of the Polish assistance was provided for scholarships and raising professional qualifications and awareness of students and working people from the developing countries and countries in transition. Poland has financed master's degree, postgraduate and doctoral studies as well as post-doctoral (habilitation) research practices. Foreigners from over 90 countries all over the world took advantage of this aid. Raising of professional qualifications was undertaken through training on technical assistance for Ukraine and Albania, and on environmental protection for Moldova. Poland has organised international seminars, e.g. the Polish-French seminar on climate change (25 June 2001).

ABBREVIATIONS

AGH	AGH University of Science and Technology
AIJ	Activities Implemented Jointly
ARE	Energy Market Agency (*Agencja Rynku Energii*)
AR4	Fourth Assessment Report
ASAP	Automated Shipboard Aerological Programme
ATOVS	Advanced Television Infra-red Observation Satellites
BACC	Baltic Assessment on Climate Change
BAHC	Biospheric Aspects of the Hydrological Cycle
BAT/BEP	Best Available Techniques/Best Environmental Practices
CALM	Circumpolar Active Layer Monitoring
CDM	Clean Development Mechanism
CHP	Combined Heat and Power
CRF	Common Reporting Format
Dz.U.	Polish Journal of Laws (*Dziennik Ustaw*)
EASA	European Aviation Safety Agency
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECA2000	European Climate Assessment 2000
ECSN	European Climate Support Network
ENPEP	Energy and Power Evaluation Program
ENR	Enhanced Nutrient Removal
ENSEMBLES	ENSEMBLES-based Predictions of Climate Changes and their Impacts
EOTA	European Organisation for Technical Approvals
ERT	Expert Review Teams
EU	European Union
EU-15	Old EU Member States, before enlargement
EU-25	Current EU Member States, after enlargement
EUMETSAT	Europe's Meteorological Satellite Organisation
EuroGOOS	European component of the Global Ocean Observing System (GOOS)
F-gases	Fluorinated gases
FLUXNET	Global Terrestrial Network–Carbon
GAW	Global Atmosphere Watch of WMO
GCOS	Global Climate Observing System
GCTE	Global Change and Terrestrial Ecosystems
GDP	Gross Domestic Product
GEF	Global Environment Facility
GERD	Gross Domestic Expenditure on Research and Development
GFDL	Geophysical Fluid Dynamic Laboratory
GHG	Greenhouse gases
GISS	Goddard Institute for Space Studies
GLOBE	Global Learning and Observations to Benefit the Environment
GMS	Geostationary Meteorological Satellite
GOES–E	Geostationary Operational Environmental Satellites – East
GOES–W	Geostationary Operational Environmental Satellites – West
GOOS	Global Ocean Observing System
GSN	GCOS Surface Network
GTN-G	Global Terrestrial Network-Glaciers
GTN-P	Global Terrestrial Network-Permafrost
GTN-C	Global Terrestrial Network-Carbon
GTOS	Global Terrestrial Observing System
GUAN	GCOS Upper Air Network
GUGiK	Head Office of Geodesy and Cartography (*Główny Urząd Geodezji i Kartografii*)
GUS	Central Statistical Office (*Główny Urząd Statystyczny*)
HDI	Human Development Index
HELCOM	Helsinki Commission (Baltic Marine Environment Protection Commission), under the Convention on the Protection of the Marine Environment of the Baltic Sea
IAEA	International Atomic Energy Agency
IBL	Institute for Forestry Research (*Instytut Badawczy Leśnictwa*)
IBRD	International Bank for Reconstruction and Development
IBW	Institute of Hydro-Engineering (*Instytut Budownictwa Wodnego*)
ICES	International Council for the Exploration of the Sea

ICOADS	International Comprehensive Ocean-Atmosphere Data Set
IDA	International Development Association
IGAC	International Global Atmospheric Chemistry Project
IGBP	International Geosphere-Biosphere Programme
IGiPZ	Institute of Geography and Spatial Management (*Instytut Geografii i Przestrzennego Zagospodarowania*)
IHDP	International Human Dimensions Programme
IIASA	International Institute for Applied Systems
IM	Maritime Institute (*Instytut Morski*)
IMGW	Institute of Meteorology and Water Management (*Instytut Meteorologii i Gospodarki Wodnej*)
INDOEX	Indian Ocean Experiment
IO	Institute of Oceanology (*Instytut Oceanologii*)
IOC - UNESCO	Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization
IODE	International Oceanographic Data and Information Exchange
IOŚ	Institute of Environmental Protection (*Instytut Ochrony Środowiska*)
IPA	International Permafrost Association
IPCC	Intergovernmental Panel on Climate Change
IUNG	Institute of Soil Science and Plant Cultivation (*Instytut Uprawy, Nawożenia i Gleboznawstwa*)
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
JGOFS	Joint Global Ocean Flux Study
JI	Joint Implementation
KASHUE	National Administrator of Emission Trading Scheme (*Krajowy Administrator Systemu Handlu Uprawnieniami do Emisji*)
KCIE	National Emission Centre, NEC (*Krajowe Centrum Inwentaryzacji Emisji*)
KPGO	National Waste Management Plan (*Krajowy plan gospodarki odpadami*)
KPRU	National Allocation Plan, NAP (*Krajowy plan rozdziału uprawnień do emisji*)
KPZL	National Programme for the Augmentation of Forest Cover (*Krajowy Program Zwiększania Lesistości*)
LOICZ	Land Ocean Interactions in the Coastal Zone
LP	The 'State Forests' National Forest Holding (*Lasy Państwowe*)
LPG	Liquified Petroleum Gas
LUCF	Land-Use Change and Forestry
LULUCF	Land Use, Land-Use Change and Forestry
MCSS	Marine Climatological Summary Scheme
METOP	Meteorological Operational satellite system
METEOSAT	Meteorological geostationary satellites
MG	Ministry of Economy (*Ministerstwo Gospodarki*)
MICE	Modelling the Impact of Climate Extremes
MIR	Marine Fishery Institute (*Morski Instytut Rybacki*)
MNiI	Ministry of Scientific Research and Information Technology (*Ministerstwo Nauki i Informatyzacji*)
MNiSW	Ministry of Science and Higher Education (*Ministerstwo Nauki i Szkolnictwa Wyższego*)
MOORED BUOYS	autonomic measurement buoys
MoU	Memorandum of Understanding
M.P.	Polish Monitor (*Monitor Polski*) - Polish journal of official strategic documents
MSG	Meteosat Second Generation
MŚ	Ministry of the Environment (*Ministerstwo Środowiska*)
NCAR	National Center for Atmospheric Research
NCDC	National Climatic Data Centre
NFOŚiGW	National Fund for Environmental Protection and Water Management (*Narodowy Fundusz Ochrony Środowiska i Gospodarki Wodnej*)
NGOs	Non-governmental organisations
NIR	National Inventory Report
NOAA	National Oceanic and Atmospheric Administration
NPR	National Development Plan (*Narodowy Plan Rozwoju*)
ODS	ozone depleting substances
OJ	Official Journal of the European Union
OSD	Operator of the Distribution System
PAGES	Past Global Changes
PAN	Polish Academy of Sciences (*Polska Akademia Nauk*)
PEMP	Polish Energy Efficiency Motors Programme
PGNiG	Polish Oil and Gas Company (*Polskie Górnictwo Naftowe i Gazownictwo*)
PHARE	Poland and Hungary Assistance for Restructuring of the Economy
PKD	Polish Classification of Activities (*Polska Klasyfikacja Działalności*) – equivalent to *Nomenclature des Activités de Communauté Européenne*, NACE
PKN	Polish National Committee (*Polski Komitet Narodowy*)
PPP	Purchasing Power Parity
PSE S.A.	Polish Power Grid Company (*Polskie Sieci Elektroenergetyczne S.A.)*

RES	Renewable energy sources
R&D	Research and Development
RGB	Red Green Blue
SFC DRIFTERS	Surface Drifters
SOOP	Ship of Opportunity Programme
SUB-SFC Floats	Sub-surface floats
TIDE GAUGES	sea level monitoring stations
TIROS	Television Infra-red Observation Satellite
TOVS	TIROS Operational Vertical Sounder
UAM	Adam Mickiewicz University in Poznań (*Uniwersytet Adama Mickiewicza*)
UG	Gdańsk University (*Uniwersytet Gdański*)
UJ	Jagiellonian University in Cracow
UMCS	Mary Curie-Sklodowska University in Lublin (*Uniwersytet Marii Curie–Skłodowskiej*)
UMK	Nicolaus Copernicus University in Toruń (*Uniwersytet Mikołaja Kopernika*)
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	US Agency for International Development
UV–B	ultraviolet radiation type B
VOS	Volunteer Observing Ship
WCASP	World Climate Applications and Services Programme
WCP	World Climate Programme
WMO	World Meteorological Organisation
WMO GTS	WMO Global Telecommunication System
WSCH	Great Chemical Synthesis (*Wielka Synteza Chemiczna*)
WWF	World Wildlife Fund
ZBŚRiL	Institute for Research on Agricultural and Forest Environment (*Zakład Badań Środowiska Rolniczego i Leśnego*)
ZMŚP	Integrated Environmental Monitoring (*Zintegrowany Monitoring Środowiska Przyrodniczego*)

Chemicals

CO_2	carbon dioxide
CH_4	methane
N_2O	nitrous oxide
HFCs	hydrofluorocarbons
PFCs	perfluorocarbons
SF_6	sulphur hexafluoride
CFCs	chlorofluorocarbons
HCFCs	hydrochlorofluorocarbons
C_4F_{10}	perfluorobutane
N	nitrogen
NO_x	nitrogen oxides
SO_2	sulphur dioxide

Currency

EUR	euro
PLN	Polish zloty
USD	American dollar

Units

Mg	megagramme, 1 Mg = 10^6 g (1 tonne)
Gg	gigagramme, 1 Gg = 10^9 g (thousand tonnes)
Tg	teragramme, 1 Tg = 10^{12} g (million tonnes)
km	kilometre
m^2	square metre
ha	hectare
m^3	cubic metre
dam^3	cubic decametre
hm^3	cubic hectometre
l	litre
toe	tonne of oil equivalent
ktoe	kilotonne of oil equivalent (thousand tonnes)
Mtoe	megatonne of oil equivalent (million tonnes)
kJ	kilojoule, 1 kJ = 10^3 J
TJ	terajoule, 1 TJ = 10^{12} J
PJ	petajoule, 1 PT = 10^{15} J
MW	megawatt
MW_{th}	thermal megawatt
MW_e	electric megawatt
GWh	gigawatt-hour, 1 GWh = 10^9 Wh
TWh	terawatt-hour, 1 TWh = 10^{12} Wh
ppm	gas particles per million air particles
ppb	gas particles per billion air particles
ppt	gas particles per trillion air particles

ANNEX 1. Greenhouse gas emission changes in 1988–2004 [Gg]

Carbon dioxide

Greenhouse gas source and sink categories	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Total emissions (including sector 5)	440 973.45	422 698.36	340 736.80	324 002.90	334 738.10	323 208.50	331 430.00	307 935.20	331 513.50	320 724.60	298 106.70	291 011.30	278 211.93	277 990.12	275 358.89	290 871.21	290 541.27
Total net emissions (excluding sector 5)	**477 004.14**	**459 733.78**	**380 697.00**	**366 959.00**	**371 591.00**	**363 133.00**	**371 588.00**	**348 172.00**	**372 530.00**	**361 626.00**	**337 448.00**	**329 697.00**	**314 812.05**	**317 844.22**	**308 276.89**	**319 082.41**	**316 700.05**
1. Energy	**457 005.10**	**438 973.97**	**371 485.00**	**357 711.00**	**360 988.00**	**353 884.00**	**362 166.00**	**338 028.00**	**363 592.00**	**350 962.00**	**326 962.00**	**319 088.00**	**302 465.35**	**307 325.43**	**298 834.29**	**307 099.78**	**302 510.63**
A. Fuel Combustion	456 953.03	438 923.37	371 433.00	357 661.00	360 927.00	353 814.00	362 083.00	337 942.00	363 498.00	350 876.00	326 857.00	318 963.00	302 281.50	307 109.56	298 629.62	306 887.05	302 264.54
1. Energy industries	265 734.32	260 515.03	236 582.00	233 002.00	223 009.00	202 569.00	200 331.00	187 346.00	195 987.00	192 784.00	184 916.00	180 001.00	176 324.20	177 878.20	175 249.80	182 213.32	180 529.17
2. Manufacturing industries and construction	55 428.13	52 673.85	49 999.00	37 186.00	37 259.00	52 869.00	68 068.00	68 122.00	74 682.00	70 024.00	63 186.00	53 271.00	52 055.70	47 183.90	44 577.10	43 188.92	40 232.20
3. Transport	25 845.65	25 833.68	29 103.00	27 815.00	30 475.00	27 675.00	29 533.00	25 285.00	28 098.00	26 662.00	28 126.00	31 382.00	28 206.90	30 121.26	29 552.52	30 490.20	33 704.90
4. Other sectors	109 462.57	99 419.65	55 749.00	59 658.00	70 184.00	70 701.00	64 151.00	56 324.00	64 106.00	60 857.00	50 103.00	54 011.00	45 400.00	50 083.90	48 262.60	48 871.71	45 796.61
5. Other	482.36	481.17	NA	NA	NA	NA	NA	865.00	625.00	549.00	526.00	298.00	294.70	1 842.30	987.60	2 122.91	2 001.66
B. Fugitive emissions from fuels	52.07	50.60	52.00	50.00	61.00	70.00	83.00	86.00	94.00	86.00	105.00	125.00	183.85	215.87	204.67	212.73	246.09
1. Solid fuels	2.17	1.84	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.74
2. Oil and natural gas	49.90	48.76	52.00	50.00	61.00	70.00	83.00	86.00	94.00	86.00	105.00	125.00	183.85	215.87	204.67	212.73	245.35
2. Industrial processes	**18 550.38**	**19 402.44**	**9 212.00**	**9 248.00**	**10 603.00**	**9 249.00**	**9 422.00**	**10 144.00**	**8 938.00**	**10 664.00**	**10 486.00**	**10 609.00**	**12 346.70**	**10 512.90**	**9 431.80**	**11 479.75**	**13 316.51**
A. Mineral products	12 266.46	12 333.30	7 715.00	8 301.00	9 439.00	8 468.00	8 292.00	9 364.00	8 193.00	9 872.00	9 790	9 983.00	10 573.20	8 840.80	8 217.70	8 492.42	9 196.32
B. Chemical industry	3 960.99	3 975.30	29.00	314.00	25.00	201.00	29.00	199.00	163.00	136.00	79.00	61.00	1 263.40	1 213.90	790.30	2 353.55	2 439.78
C. Metal production	2 322.94	3 093.84	544.00	633.00	337.00	580.00	359.00	581.00	582.00	656.00	617.00	565.00	510.10	458.20	423.80	633.79	1 680.41
D. Other production			924.00	NA	802.00	NA	742.00	NA	NA	NA	NA	NA	NA	NE	NE	NE	NE
G. Other																	
3. Solvent and other product use	**882.46**	**822.14**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**473.76**	**580.66**
4. Agriculture																	
A. Enteric fermentation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Manure management	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Rice cultivation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Agricultural soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Prescribed burning of savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field burning of agricultural residues	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land-use change and forestry*	**-36 030.69**	**-37 035.42**	**-39 960.20**	**-42 956.10**	**-36 852.90**	**-39 924.50**	**-40 158.00**	**-40 236.80**	**-41 016.50**	**-40 901.40**	**-39 341.30**	**-38 685.70**	**-36 600.12**	**-39 854.10**	**-32 918.00**	**-28 211.20**	**-26 158.77**
6. Waste	**566.20**	**535.22**												**5.89**	**10.80**	**29.12**	**292.25**
A. Solid waste disposal on land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Waste-water handling	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Waste incineration	566.20	535.22	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	5.89	10.80	29.12	292.25
D. Other																	

* Net removals.
NA – Not Applicable. NE – Not Estimated.

Methane

Greenhouse gas source categories	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total net emissions expressed as CO_2 equivalent excluding sector 5	51150.55	50675.73	58819.32	54361.86	51952.11	51060.87	51805.32	51598.26	47295.78	47845.14	49040.88	47251.89	45847.75	38816.31	37787.25	37683.81	39024.70
Total emissions (excluding sector 5)	**2435.74**	**2413.13**	**2800.92**	**2588.66**	**2473.91**	**2431.47**	**2466.92**	**2457.06**	**2252.18**	**2278.34**	**2335.28**	**2250.09**	**2183.23**	**1848.40**	**1799.39**	**1794.47**	**1858.32**
1. Energy	**1 111.33**	**1 040.85**	**1 031.32**	**951.22**	**821.32**	**932.92**	**954.77**	**982.55**	**998.43**	**992.10**	**874.08**	**827.67**	**819.66**	**837.20**	**827.50**	**845.08**	**847.73**
A. Fuel combustion	30.22	29.05	37.43	25.96	28.63	56.13	58.52	55.36	55.83	54.68	52.56	50.29	47.39	51.16	50.65	50.23	49.82
1. Energy industries	*2.68*	*2.59*	*8.76*	*2.33*	*7.72*	*2.00*	*7.46*	*1.63*	*1.74*	*1.81*	*1.85*	*1.77*	*1.63*	*1.75*	*1.75*	*1.79*	*1.86*
2. Manufacturing industries and construction	*3.04*	*2.78*	*15.24*	*1.96*	*10.43*	*2.56*	*14.33*	*3.46*	*3.64*	*3.68*	*3.56*	*3.12*	*3.25*	*2.99*	*3.01*	*3.06*	*2.53*
3. Transport	*6.90*	*7.36*	*7.51*	*8.14*	*8.63*	*8.10*	*8.80*	*8.42*	*9.40*	*8.99*	*7.42*	*7.09*	*5.20*	*5.01*	*4.80*	*4.60*	*4.66*
4. Other sectors	*17.57*	*16.29*	*5.92*	*13.53*	*1.85*	*43.47*	*27.93*	*41.82*	*41.03*	*40.18*	*39.71*	*38.30*	*37.30*	*41.35*	*41.06*	*40.71*	*40.71*
5. Other	*0.03*	*0.02*						*0.03*	*0.02*	*0.02*	*0.02*	*0.01*	*0.01*	*0.06*	*0.03*	*0.07*	*0.07*
B. Fugitive emissions from fuels	1 081.11	1 011.80	993.89	925.26	792.69	876.79	896.25	927.19	942.60	937.42	821.52	777.38	772.27	786.04	776.85	794.85	797.91
1. Solid fuels	*884.93*	*821.13*	*798.74*	*759.01*	*628.50*	*705.54*	*724.18*	*741.62*	*746.04*	*744.78*	*625.80*	*585.99*	*566.55*	*570.07*	*568.48*	*563.96*	*557.06*
2. Oil and natural gas	*196.17*	*190.67*	*195.15*	*166.25*	*164.19*	*171.25*	*172.07*	*185.57*	*196.56*	*192.64*	*195.72*	*191.39*	*205.72*	*215.97*	*208.37*	*230.89*	*240.86*
2. Industrial processes	**16.03**	**15.94**	**13.05**	**10.32**	**8.11**	**9.64**	**10.32**	**11.46**	**11.13**	**11.36**	**9.06**	**7.98**	**8.33**	**8.09**	**6.01**	**14.04**	**14.72**
A. Mineral products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical industry	11.91	12.02	9.84	7.67	7.56	7.22	7.61	8.69	8.64	8.78	6.59	5.83	6.05	5.88	3.87	11.54	12.15
C. Metal production	4.12	3.92	3.21	2.65	0.55	2.42	2.71	2.77	2.49	2.58	2.47	2.15	2.28	2.21	2.14	2.50	2.57
D. Other production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
G. Other																	
3. Solvent and other product use	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
4. Agriculture	**957.72**	**998.52**	**849.97**	**772.61**	**703.61**	**656.00**	**646.50**	**615.36**	**590.95**	**597.74**	**581.75**	**509.30**	**469.42**	**450.71**	**435.27**	**441.97**	**534.68**
A. Enteric fermentation	778.31	817.04	793.25	714.94	646.89	606.03	596.44	564.84	544.90	550.39	533.94	469.22	432.16	413.72	397.62	397.18	384.75
B. Manure management	177.95	179.94	55.24	56.31	55.59	48.56	48.93	49.18	44.78	46.18	46.45	38.86	36.08	35.71	36.49	43.72	148.60
C. Rice cultivation																	
D. Agricultural soils																	
E. Prescribed burning of savannas																	
F. Field burning of agricultural residues	1.45	1.54	1.48	1.36	1.13	1.41	1.13	1.34	1.27	1.17	1.36	1.22	1.18	1.28	1.15	1.07	1.33
G. Other																	
6. Waste	**350.67**	**357.82**	**906.58**	**854.51**	**940.87**	**832.91**	**855.33**	**847.69**	**651.67**	**677.14**	**870.39**	**905.14**	**885.81**	**552.40**	**530.61**	**493.38**	**461.19**
A. Solid waste disposal on land	205.64	217.84	766.92	735.12	844.43	735.57	761.14	759.10	562.14	588.18	784.14	824.87	809.70	446.83	425.72	392.65	388.84
B. Waste-water handling	145.02	139.98	139.66	119.39	96.44	97.34	94.19	88.59	89.53	88.96	86.25	80.27	76.11	105.57	104.89	100.73	72.35
C. Waste incineration																	
D. Other																	

NA – Not Applicable. NE – Not Estimated.

Nitrous oxide

Greenhouse gas source categories	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total net emissions expressed as CO_2 equivalent excluding sector 5	40384.46	41877.38	19427.70	16126.20	15562.00	15425.60	15574.40	16733.80	16715.20	16743.10	15983.60	23284.10	23894.80	23945.55	22633.35	23935.99	30004.20
Total emissions (excluding sector 5)	**130.2725**	**135.0883**	**62.6700**	**52.0200**	**50.2000**	**49.7600**	**50.2400**	**53.9800**	**53.9200**	**54.0100**	**51.5600**	**75.1100**	**77.0800**	**77.2437**	**73.0108**	**77.2129**	**96.7877**
1. Energy	**7.9809**	**7.7660**	**5.8000**	**6.3400**	**5.7900**	**6.6400**	**6.2100**	**6.7400**	**7.2400**	**7.0900**	**7.4200**	**7.4100**	**7.1900**	**7.4680**	**7.3490**	**7.4933**	**7.3878**
A. Fuel combustion	7.9809	7.7660	5.8000	6.3400	5.7900	6.6400	6.2100	6.7400	7.2400	7.0900	7.4200	7.4100	7.1900	7.4680	7.3490	7.4933	7.3878
1. Energy industries	*3.8482*	*3.7657*	*3.2300*	*3.3700*	*3.0600*	*2.9200*	*2.7400*	*2.7000*	*2.8100*	*2.7600*	*2.6700*	*2.5800*	*2.5300*	*2.5520*	*2.5010*	*2.5771*	*2.5558*
2. Manufacturing industries and construction	*0.8472*	*0.7896*	*0.3700*	*0.6300*	*0.3000*	*0.9300*	*0.8400*	*1.3300*	*1.5000*	*1.4300*	*1.2700*	*1.1200*	*1.0400*	*0.9330*	*0.9610*	*0.9239*	*0.8193*
3. Transport	*1.1179*	*1.1233*	*1.3700*	*1.2100*	*1.3900*	*1.2000*	*1.2300*	*1.3100*	*1.4400*	*1.3600*	*1.6700*	*1.8700*	*1.8900*	*1.9980*	*1.9590*	*2.0336*	*2.1480*
4. Other sectors	*2.1618*	*2.0817*	*0.8300*	*1.1300*	*1.0400*	*1.5900*	*1.4000*	*1.3500*	*1.4500*	*1.5100*	*1.7800*	*1.8200*	*1.7100*	*1.9520*	*1.9150*	*1.9336*	*1.8390*
5. Other	*0.0058*	*0.0058*	*NE*	*NE*	*NE*	*NE*	*NE*	*0.0500*	*0.0400*	*0.0300*	*0.0300*	*0.0200*	*0.0200*	*0.0330*	*0.0130*	*0.0250*	*0.0256*
B. Fugitive emissions from fuels																	
1. Solid fuels																	
2. Oil and natural gas																	
2. Industrial processes	**16.1079**	**16.3473**	**16.1400**	**13.0900**	**12.9200**	**13.0900**	**14.3100**	**15.8000**	**16.2100**	**15.7100**	**12.9100**	**12.0700**	**14.0300**	**14.3710**	**12.0020**	**14.1980**	**14.1258**
A. Mineral products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical industry	16.1079	16.3473	16.1400	13.0900	12.9200	13.0900	14.3100	15.8000	16.2100	15.7100	12.9100	12.0700	14.0300	14.3710	12.0020	14.1980	14.1258
C. Metal production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G. Other																	
3. Solvent and other product use	**0.4000**	**0.4000**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**0.4000**
4. Agriculture	**102.0310**	**107.3358**	**40.7300**	**32.5900**	**31.4900**	**30.0300**	**29.7200**	**31.4400**	**30.4700**	**31.2100**	**31.2300**	**55.6300**	**53.2600**	**52.8167**	**51.0998**	**52.9626**	**72.2127**
A. Enteric fermentation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA
B. Manure management	26.6278	26.7296	NE	NE	NE	NE	NE	NE	NE	NE	NE	20.1000	18.6500	18.1880	17.4280	18.7979	17.7175
C. Rice cultivation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Agricultural soils	75.3278	80.5294	40.6600	32.5200	31.4300	29.9500	29.6600	31.3800	30.4000	31.1500	31.1600	35.4700	34.5500	34.5640	33.6140	34.1100	54.4313
E. Prescribed burning of savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field burning of agricultural residues	0.0754	0.0768	0.0700	0.0700	0.0600	0.0800	0.0600	0.0600	0.0700	0.0600	0.0700	0.0600	0.0600	0.0647	0.0578	0.0547	0.0639
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA
6. Waste	**3.7528**	**3.2392**											**2.6000**	**2.5880**	**2.5600**	**2.5590**	**2.6615**
A. Solid waste disposal on land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Waste-water handling	3.6847	3.1766	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	2.6000	2.5880	2.5600	2.5590	2.5570
C. Waste incineration	0.0680	0.0626	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.1045
D. Other																	

NA – Not Applicable. NE – Not Estimated.

Industrial F-gases

Type of gases \ Years		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Emissions of HFCs	[Gg CO_2 eq.]	**26.44**	**96.82**	**153.56**	**167.02**	**206.44**	**594.67**	**1 073.35**	**1 523.37**	**1 824.77**	**2 436.34**
HFC-23	[Gg]						0.00017	0.00017	0.00021	0.00021	0.00021
HFC-32	[Gg]						0.00117	0.00198	0.00328	0.00659	0.00659
HFC-125	[Gg]						0.02922	0.04685	0.05998	0.08429	0.08429
HFC-134 a	[Gg]	0.02034	0.07445	0.11804	0.12831	0.15783	0.31199	0.58475	0.85164	0.96097	1.42877
HFC-152a	[Gg]						0.00646	0.00750	0.01003	0.01273	0.02401
HFC-143a	[Gg]						0.02690	0.04592	0.06199	0.08261	0.08261
HFC-227ea	[Gg]		0.00001	0.00004	0.00007	0.00044	0.00049	0.00109	0.00095	0.00291	0.00265
Emissions of PFCs	[Gg CO_2 eq.]	**250.18**	**235.68**	**248.89**	**251.20**	**239.79**	**224.40**	**269.95**	**286.50**	**278.34**	**285.05**
CF_4	[Gg]	0.03372	0.03167	0.03270	0.03304	0.03110	0.02863	0.03331	0.03585	0.03491	0.03595
C_2F_6	[Gg]	0.00337	0.00317	0.00327	0.00330	0.00311	0.00286	0.00333	0.00359	0.00349	0.00359
C_4F_{10}	[Gg]		0.00010	0.00089	0.00087	0.00129	0.00171	0.00326	0.00292	0.00276	0.00262
Emissions of SF_6	[Gg CO_2 eq.]	**13.15**	**7.55**	**9.01**	**12.45**	**14.39**	**16.30**	**18.45**	**21.29**	**19.72**	**22.56**
SF_6	[Gg]	0.00055	0.00032	0.00038	0.00052	0.00060	0.00068	0.00077	0.00089	0.00083	0.00094