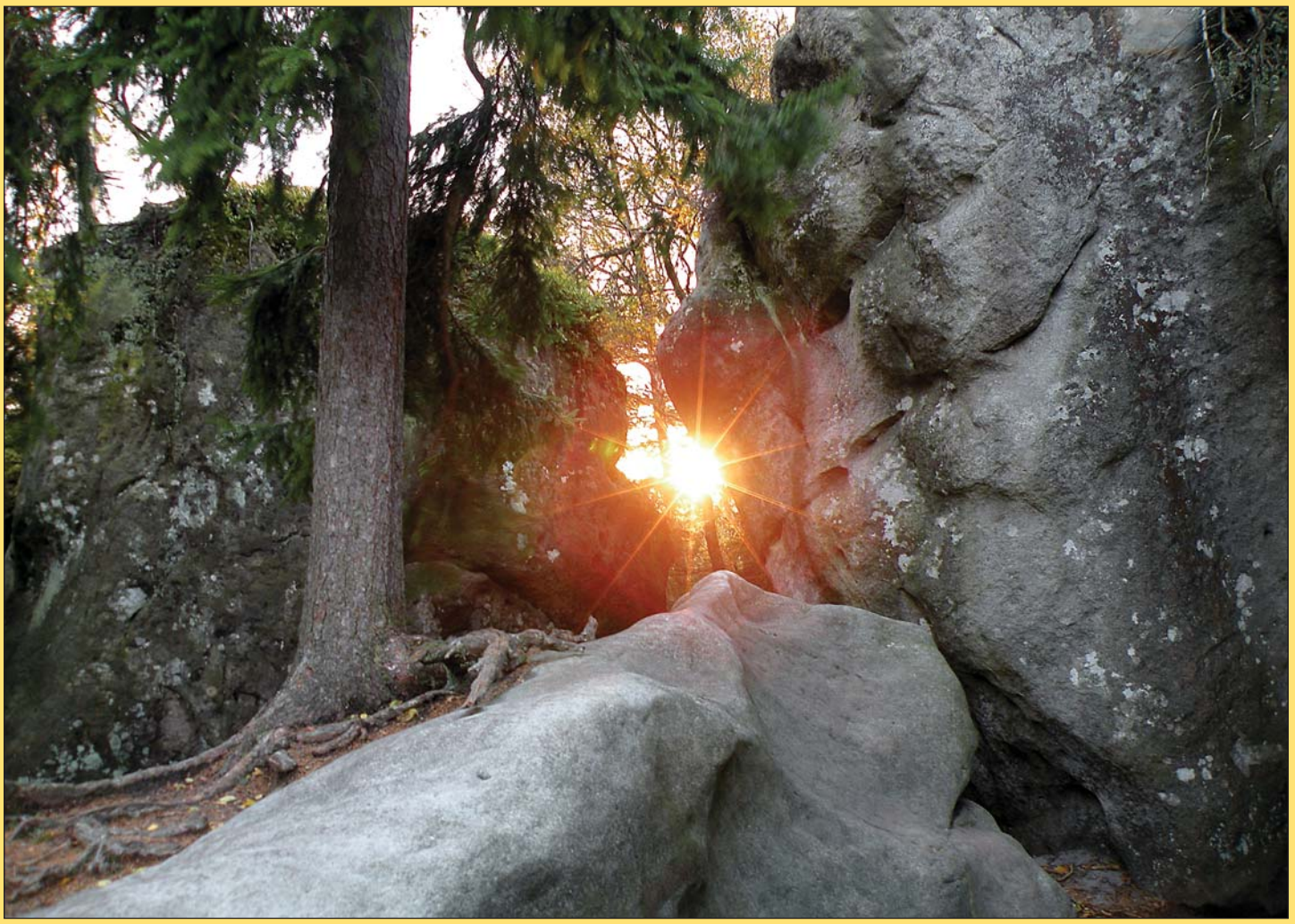
REPUBLIC OF POLAND

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



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FIFTH 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 then 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 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 been a member of European Union (EU-27), which favours further opening of the Polish market (including the labour market) and development of foreign trade, supports the inflow of capital and modern technologies and provides access for public institutions and economic entities (including farmers) to EU funds supporting the implementation of EU policies that are important for the economy.

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

As a result of the political and economic transformations that have been taking place since 1990, the national GHG emissions dropped to much below the target level for Poland under the Kyoto Protocol. In the years 1988–2007, GHG emissions (without sector 5, Land use, land use changes and forestry) decreased by as much as 29.3% below the base year. That goal has been achieved through implementation of a package of policies and measures primarily leading to improvement of energy use efficiency and restructurisation of fuel consumption.

As a country undergoing modernisation of its economy, Poland foresees an increase in the GHG emissions. The cause of this is, first of all, the structure of fuel use (hard coal and lignite), which makes further emission reduction difficult, through switching to gas or nuclear power, of which the last one does not exist in Poland yet. Modernisation and restructuring processes in companies will be aimed 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 approved the document entitled "Poland's Climate Policy – Strategies for Greenhouse Gas Emission Reductions in Poland until 2020", the strategic goal of which 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 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". That goal is consistent with the objectives of the EU Climate Policy, in which effective climate protection has been given the highest priority in the strategy for sustainable development.

This Communication was prepared in line with Part II of decision UNFCCC/CP/1999/7. It contains data for the period 2004–2007: as far as the inventory and projections of greenhouse gas emissions are concerned, reference was made to 1988 (as regards industrial gases until 1995). Additional information required under Art. 7.2 of the Kyoto Protocol were presented in various chapters of the Communication; a detailed list can be found in Annex 2.

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1) United Nations Framework Convention on Climate Change (Dz.U. of 1996, Issue 53, item 238).

2) Kyoto Protocol to the United Nations Framework Convention on Climate Change (Dz.U. of 2005, Issue 203, item 1684).

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 particular, 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), poviat (county) and gmina (commune) level funds. The funds' income comes from fees for the environment use 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 2007, 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 increased from 20.8% in 1946 to 28.9% in 2007, but it is still lower from the target index for Poland, i.e. 33–34%. The forest cover index is differentiated spatially; it ranges from 20.9% in the Łódzkie Voivodship (Central Poland) to 48.8% in the Lubuskie Voivodship (Western Poland).

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 and potentially accessible renewable energy resources, mainly from biomass and water and, to a significantly lesser extent, to the wind, geothermal and solar energy.

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, permitting an unrestrained parallel exchange of air streams. As a result, 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.

In 2007, GDP increase amounted to 6.6% and was the highest over the last seven years. Economic growth has been recorded in Poland since 2003; that year, GDP growth exceeded 3%. GDP per capita, although gradually growing, is still significantly lower in Poland than in highly-developed countries. An important factor of economic growth was the development of services, industry and housing. Despite the significant progress in energy efficiency in the Polish economy, Poland still has a high potential in this field. The intense economic changes, resulting in a decrease in the consumption of primary and final energy with growing GDP resulted in a decrease of GDP energy consumption. It applies both to the primary and final energy. Since 2000, the GNP power consumption decrease rate has amounted to 2% a year.

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 unit energy use in flats has dropped.

Changes in the industry ownership structure and branch manufacturing structure are accompanied by organisational, technical and technological changes in manufacturing processes that at the same time contribute to an increase in energy efficiency and therefore to a decrease of energy consumption within industrial production and reduction of greenhouse gases emissions. The highest energy efficiency improvement rate is observed in the machinery and transport means industry, improvement of energy efficiency of the most power-demanding industry branches: the iron and steel, chemical, wood and paper industry is occurring the most slowly.

A manifestation of traditional Polish agriculture is still moderate (according to European standards) level of use of mineral fertilisers and chemical plant protection products. In Polish agriculture, plant and animal production are balanced; in the global agricultural production value, plant production prevails. In the agriculture structure, cultivation of non-food

plants is getting more and more important, including cultivation of energetic plants.

A significant progress has been achieved in environmental protection over the last dozen or so years. As a result of a significant decrease in the energy- and material consumption of production processes, changes in the proecological activities financing system and adaptation of protection standards to EU standards, the negative influence of the economy on the environment has decreased. In many respects, the state of the environment does not differ significantly from that observed in the developed countries. At the same time, the "Natura 2000" protected areas network has been created, 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 UNFCCC Secretariat. 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.

Detailed inventory results of GHG emissions and removals by IPCC sectors for the years 1988–2007 that have been obtained so far are presented in Annex 1.

Within the period from the base year (1988) to 2007, emission of greenhouse gases decreased significantly (without taking into account Sector 5. Land use, land use changes and forestry); its value is lower by as much as 29.3%. The decrease in the emissions was caused mainly by decrease of carbon dioxide emission by 30.1%. Emission of methane and nitrous oxide also dropped, by 31.5% and 26.1%, respectively. The decrease trend continued until 2002, then there was a slight increase in the GHG emission stimulated by the speeded up economic growth which lasted until 2006. Then, there was a slight decrease in the emission. Total GHG emissions in 2007 were dominated by carbon dioxide, which accounted for 82.3% of the total. Methane emissions constituted 9.3%, nitrous oxide: 7.5% and industrial gases constituted 0.9% of the aggregated GHG emission.

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. It also applies to the commitment to reduce GHG emissions taken in 2007 within the European package of actions concerning energy and climate and it will be met.

The comprehensive GHG emission reduction measures are as follows:

– attendance in the European Union Greenhouse Gas Emission Trading System,
– the use of the Joint Implementation mechanism and GIS (Green Investment Scheme),
– 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), EcoFund 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 improvement of energy efficiency, improvement of the level of fuel and energy security, diversification of energy production structure through introduction of nuclear power, development of use of renewable energy sources, including biofuels, development of competitive fuel and energy markets and limitation of energy impact on the environment.

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 fulfil 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:
   - improvement of energy efficiency,
   - promotion of renewable energy 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[3)],
   - 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,
   - 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 fertilisers, including nitrogen fertilisers,
   - efficient use of energy in agriculture, including energy production from biomass, 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,
   - strategy of wood use 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, national GHG emission projections until 2030 were determined (divided into years 2015, 2020 and 2030) with taking into account the adopted and implemented policies aimed at reduction of GHG emission. These projections constitute the "with measures" scenario, hereinafter referred to as "PEP'09", in connection with approval of the assumptions of the draft of the Poland's Energy Policy until 2030, prepared in 2009 by

[3)] Best available techniques and best environmental practice.

the Ministry of Economy for assessment of the future changes of GHG emissions in Poland.

The emission projections were prepared for the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), HFC gases group (hydrofluorocarbons), PFC gases group (perfluorocarbons) and sulphur hexafluoride (SF_6) and for the following five sectors according to the IPCC source classification: *Energy* (including *transport*), *Industrial processes*, S*olvent and other product use*, *Agriculture* and *Waste*. For the purposes of the *Land use, land use change and forestry* sector (LULUCF), only the amount of balance of CO_2 emission and removal was assumed, concerning activities conducted within the Art. 3.3 (afforestation, reforestation and deforestation) and additional activities selected by Poland within the Art. 3.4 (forest management) of the Kyoto Protocol, without an assessment of such balance for the whole 5.LULUCF sector, as was presented in the Fourth National Communication.

For the national carbon oxide emission, critical are data concerning the projected use of fuels (92% of the national CO_2 emission in 2007), which were determined on the basis of the forecast for fuel and energy demand until 2030, constituting the basis of Poland's Energy Policy until 2030.

Total greenhouse gases emission in the PEP'09 scenario in 2015 was by 75,160 Gg CO_2 eq. lower than that in the Fourth National Communication, and in 2020 – by 112,992 Gg CO_2 eq. lower. Therefore, decrease of the projected emission in relation to the Fourth National Communication was lower by 17% for 2015 and ca. 24% for 2020.

A comparison of emissions in the projected years 2015–2030 with data for base year 1988 revealed a decrease in emission by more than 30% in total for all sectors; the highest emissions reduction occurred in the *Energy* and *Agriculture* sectors. *Industrial processes* and *Waste* are characterised by an increase of emissions from 2015. The projected emission until 2030 is much lower than the national emission level following from the adopted reduction target of the Kyoto Protocol – emission reduction by 6% in the years 2008–2012 in relation to the base year 1988.

In order to assess the effectiveness of the implemented policies of GHG reduction policies, an analysis of changes of emissions and emissivity in the period 1997–2007 was carried out. Analysed were recalculated GHG emission inventories from 1997, 2000, 2003 as well as GHG inventory for 2007 for identification of sectors and sub-sectors in which the highest GHG emission occurred.

The highest CO_2 emission decrease occurred within the period 1997–2007 in the following subsectors: *Public Electricity and Heat Production* and *Other* (excluding mobile ones). In the period in question, emission in these sectors dropped by more than 9,000 Gg in each of them. A significant decrease of CO_2 emissions also occurred in the following sectors: *Iron and steel* (by ca. 4,800 Gg), *Food, Processing, Beverages and Tobacco* (by 4,300 Gg), in the *Chemicals* (by ca. 3,900 Gg) and *Pulp, Paper and Print* (by ca. 1,200 Gg).

The decrease of emission intensity with time reflects changes in the contribution of fuels in limiting the consumption of coal and carbon-based fuels, increase of energy efficiency and implementation of low-emission technologies.

1.6. Vulnerability assessment, climate changes effects and adaptation measures

In the years 2004–2007, research work was conducted on assessment of the degree of influence of climate changes on the most vulnerable sectors of economy, i.e. agriculture, water resources, coastal zone and forestry. That research permitted defining the necessary adaptive measures and will constitute the basis for commencement of work on the national and sectoral adaptation strategies.

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

Poland as 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, 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.

In 2007 Poland, within ODA granted assistance to developing countries in the amount of PLN 1.01 billion (USD 362,83 million), which amounted to 0.09% GNP. The amount of the official developmental assistance offered by Poland increased by ca. 9% in comparison to 2006.

Within ODA granted in recent years, Poland in the years 2005–2007 implemented ca. 20 projects as part of supporting and providing technological assistance as well as promoting technological development in developing countries and other countries with economies in transition.

1.8. 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.

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.

On 30 October 2008, the Minister of Science and Higher Education established the National Programme for Scientific Research and Development Activities (KPBNiPR). The purpose of the "Advanced energy generation technologies" strategic programme, implemented within the KPBNiPR is support of research and development and implementation work, connected with environmental-friendly, modern coal mining and processing technologies.

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.

Research in the sphere of monitoring of selected Important Climate Variables is conducted by scientific and research institutes. Degree of advancement of individual components of the observation system is different. It is definitely the highest in the area of systems of ground measurement of Important Climate Variables from the field of meteorology (on the land, in the oceans and in higher atmosphere layers) and hydrology (snow cover and rivers and lakes monitoring). The degree of use of satellite systems as regards meteorological and oceanographic variables is very high, it is lower as regards hydrological variables and other land characteristics.

1.9. Education, training and public awareness

The necessity to improve ecological awareness of Polish citizens is emphasised in all strategic documents concerning the widely understood environmental protection, specifying the following directions of actions: development of school education as regards environmental protection, facilitation of access to information on the environment and shaping of behaviour in accordance with the sustainable development principle, consumer education, recommending country-wide social campaign forming sustainable consumption patterns, as well as a closer cooperation with journalists as regards education of all social groups. Ecological 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.

The following authorities (as the leading agencies) are responsible for ecological education, including education in the sphere of climate protection: the Ministry of National Education and the Ministry of Education with the participation of all the remaining agencies. Many activities are conducted by the Ministry of the Environment or under the patronage of the minister, including activities such as the education and promotion campaign concerning climate changes announced by the European Commission, the *European Day without a Cars* campaign, *World Earth Day,* International Environmental Protection Day. For many years, information of human activity-related climate changes have been regularly disseminated to the public in the *Zmiany klimatu* (Climate Changes) information bulletin.

An important educational basis is the network of regional ecological education centres maintained by self-governments, social organisations and organisations operating at national and landscape parks which, conducting various forms of activities, involve local communities and support formal education. Actions of individual NGOs dealing with dissemination of knowledge on dangers connected with climate changes were reinforced through cooperation within the Climate Coalition.

The role of the Internet in popular dissemination of information and support of ecological education is getting more and more important. In line with this tendency, the Ministry of the Environment established a website, www.ekoportal.gov.pl. Similarly, a lot of attention to climate-related issues is paid by websites of large NGOs, e.g. www.ekologia.pl, www.koalicjaklimatyczna.org, ziemianarozdrozu.pl, www.chronmyklimat.pl.

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

2.1. Institutional arrangements

2.1.1. State governance

The Republic of Poland is a constitutional republic ruled upon a mixed parliamentary and presidential system and a classic division of authority into legislative, executive and judicial powers.

Legislative power is exercised by a two-chamber parliament, composed of the Sejm (Chamber of Deputies) and the Senate (Chamber of Senators). Both Chambers of Parliament sitting in joint sessions constitute the National Assembly.

The executive power belongs to the President and to the Council of Ministers. The Government performs its duties through government administration organs and units: at the national level – the ministries, central offices and foreign services and at the regional level – the voivodes (representatives of the Government in 16 voivodships), voivodship offices (subordinated to voivodes) and territorial units of combined governmental administration.

Poland has a three-level territorial division, it consists of communes (gminas), counties (poviats) and provinces (voivodships). Territorial self-government units are independent and their independence is subject to judicial protection. The basic territorial self-government unit is a commune (gmina). By the end of 2007, there were 16 voivodships, 314 poviats and 65 cities with poviat status and 2478 communes.

2.1.2. Organs and institutions involved in the climate policy implementation

In Poland, responsibility for the execution of tasks pursuant to the United Nations Framework Convention on Climate Change, made in New York on 9 May 1992 (Dz.U. Issue 53, item 238), hereinafter referred to as the Climate Convention and the Kyoto Protocol to the United Nations Framework Convention on Climate Change, made in Kyoto on 11 December 1997 (Dz.U. of 2005, Issue 203, item 1684), hereinafter referred to as the Kyoto Protocol, is borne by the Minister of the Environment. The Minister of the Environment coordinates activities and issues executive regulations as regards environmental protection, including regulations concerning climate protection and emissions trading. The Minister of the Environment, aided by the Chief Environmental Protection Inspector coordinates activities of the State Environmental Monitoring, the purpose of which is the examination of condition of the environment.

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) – in its structure, operate the 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 and preparing reports on emissions of impurities into the air);
– 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) – responsible for climate change systematic observation. The National Focal Point for the Intergovernmental Panel on Climate Change is operating within the structure of IMGW.

At the central management level, competences from the sphere of the Climate Convention, apart from the Minister of the Environment, are held by the ministers responsible for the implementation of the sustainable development strategy, ecological policy and climate policy of the state to the sectoral policy. They are, first of all:

– Minister of Economy – responsible for the energy policy and industry as well as economic cooperation with foreign countries;

– Minister of Infrastructure – responsible for the development of the transport sector and building industry;
– Minister of Agriculture and Rural Development – responsible for the implementation of government policy in the sphere of agriculture and rural areas development;
– Minister of Regional Development – responsible for coordination and management of resources from European Union funds.

An important organ responsible for the execution of tasks pursuant to the Climate Convention and the Kyoto Protocol is the Central Statistical Office (GUS), conducting research and providing access to its findings gathered under public statistics. The statistics include data concerning emission of GHGs and other air impurities, statistics concerning energy, fuel production and consumption as well as many other issues connected with the Climate Convention and data concerning production, import and export of substances affecting the ozone layer.

Financial support for environmental activities is provided by the National Fund for Environmental Protection and Water Management – NFOŚiGW and the voivodship, poviat and 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 environmentally friendly activities, including air protection, climate protection, environmental education and other fields.

2.2. Population profile

By the end of 2007, the population of Poland amounted to ca. 38.115 million and since 2004, it has decreased by more than 40,000 people. Decrease in the population of Poland has been observed for 11 years. The direct cause of the decrease of the population of Poland is the decrease in the number of births with a rather stable number of deaths, observed in the years 1984–2003. Poland is still in the state of birth depression, although since 2004, a gradual increase in the number of births has been observed.

An important influence on the population of Poland have migrations abroad. In recent years, the number of immigrants has been constantly increasing, although the migration balance remains negative.

The average population density is 122 persons per 1 km^2; however, the average population density in Poland varies significantly depending on location. In the most urbanised region, i.e. the Silesian Voivodship, it amounts to 377 persons per 1 km^2, whereas in the most sparsely populated eastern part of Poland it amounts to 59 persons per 1 km^2.

Currently, people living in urban areas constitute ca. 61.2% of the total population, the number and share of city inhabitants in the total population have been decreasing since 2004.

2.3. Geographic profile

2.3.1. Geographic location

Poland is situated within the area of the North European Plain with South Baltic Coast and Central Poland Lowlands. The area of Poland also covers part of East Baltic and Belarussian Lowlands, the Polish Highlands belt and part of the Bohemian Massif and the Carpathians. As regards physical and geographical features, Poland is located between Western and Eastern Europe. Their border lies at the narrow area between the Baltic Sea and the Black Sea and is based on differences of geological structures, differences between the oceanic and continental type of climate and biogeographical zones. For these reasons, the territory of Poland also is differentiated as regards landscape and nature.

2.3.2. Landscape differentiation and ecosystems

The dominating type of landscape are lowlands; 54% of Poland is situated below 150 m ASL and nearly 37% at the altitude of 150–300 m ASL. Highland and mountain areas (above 300 m ASL) occupy almost 8% of the territory of Poland, including only 0.1% covered by high mountains.

Table 2.1. Selected demographic indexes in Poland, in the years 2000–2007

Specification	Years							
	2000	2001	2002	2003	2004	2005	2006	2007
Population of Poland (in thousands, as of 31 December)	38,254	38,242	38,219	38,191	38,174	38,157	38,125	38,115
Annual population growth (%)	-0.02	-0.03	-0.06	-0.07	-0.04	-0.04	-0.08	-0.03
City inhabitants (% of the total population)	61.9	61.8	61.7	61.6	61.5	61.4	61.3	61.2
Balance of permanent immigration abroad (thousands)	-19.7	-16.7	-17.9	-13.8	-9.4	-12.9	-36.1	-21

Source: GUS.

The coast line forms a belt along the southern coast of the Baltic Sea with two curves of the coastline, the Gulf of Pomerania Bay with the Gulf of Szczecin and the Gulf of Gdańsk with the Vistula Lagoon. In the coast belt, plateau landscapes with moraine plains and hills prevail. Within the Gulf of Gdańsk coast area, delta landscape occurs with a well-shaped delta, the so-called Vistula Marshland. It is one of the most vulnerable areas to changes of the sea level within the Polish coast line (the lowest point within the area of the Vistula delta is located 1.8 m below the sea level).

The southern border of Poland is delimited by the Sudetes and the Carpathians. The Sudetes, along with the Foreland are characterised by an unusual differentiation as regards geology, surface shaping and natural habitats. In the Carpathians, the Vistula – the largest river in Poland has its origin; it is the only area in Poland where alpine landscape can be found (the Tatra mountains). The Carpathians and Sudetes are areas of large natural resources, subject to various forms of protection.

The fact that Poland is located within the transitional climate zone with inflows of oceanic and continental air masses, the differentiated relief, hydrographic layout and soil variation contribute to the natural richness of Poland.

Within the territory of Poland, there are 485 vegetable complexes; 12% are frequently encountered, 22% appear seldom, they can be found only in few places. The most valuable natural and semi-natural stands are vast water and mud areas, including peat bogs, extensive meadows and pastures in river valleys as well as mountain and xerothermal turfs with many endemic species. The most valuable ecosystems include large, compact forest complexes which, although they have been transformed by man and still used, are the most important refuges of many species in Poland.

2.3.3. Natural resources

Natural topography contributes to the economic use of the territory of Poland – percentage share of wasteland, also including natural wastelands, such as coastal dunes and rocks in high mountain sections is low (1.6%). Dominant land use forms are cultivated lands (more than 60% of the area of Poland), forests and woodlots (more than 30%). Trends in the use of the Polish territory are depicted in Table 2.2.

Poland's natural resources are fossil deposits, including thermal waters, and brines. Mined fossils include: hard coal, lignite, oil and natural gas, copper, zinc and lead ores, sulphur, rock salt and rock raw materials. Balance of selected resources as of 2007 is depicted in Table 2.3.

Poland also has considerable, technically and economically accessible, renewable energy resources, mainly from biomass and wind power. The total annual technical potential of renewable energy sources from all available sources is estimated at 1750 PJ, which constitutes almost half of the total current domestic demand for energy and fuels.

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 85% of water used is abstracted from surface water resources, more than 14% from

Table 2.2. Types of use of the area of Poland in the years 2000–2007 (ha, thousands)

Type of use	Area in years															
	2000		2001		2002*		2003*		2004*		2005		2006		2007	
	Ha, 000s	%	Ha, 000s	%	Ha, 000s	%	Ha, 000s	%	Ha, 000s	%	Ha, 000s	%	Ha, 000s	%	Ha, 000s	%
Agricultural land	18537	59.3	18504	59.2	19162	61.3	19241	61.5	19207	61.4	19148	61.2	19099	61.1	19069	61.0
Forests and tree-land[1)]	9094	29.1	9122	29.2	9147	29.3	9214	29.5	9264	29.7	9338	29.9	9389	30.0	9401	30.1
Waters	833	2.7	834	2.7	640	2.0	647	2.0	646	2.1	636	2.0	637	2.0	636	2.0
Mineral deposits (mining)	38	0.1	38	0.1	37	0.1	36	0.1	35	0.1	33	0.1	31	0.0	31	0.0
Transport areas	959	3.1	954	3.0	939	3.0	933	3.0	915	2.9	897	2.9	892	2.9	886	2.8
Residential areas [2)]	1050	3.3	1061	3.4	547	1.7	489	1.6	508	1.6	546	1.7	568	1.8	578	1.8
Wasteland	499	1.6	499	1.6	495	1.6	489	1.6	499	1.6	498	1.6	493	1.6	489	1.6
Other	259	0.8	257	0.8	302	1.0	220	0.7	195	0.6	172	0.5	160	0.6	179	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).

Table 2.3. Selected fossil fuels resources (as of 2007)

Specification	Resources [millions of tons]		Number of deposits [pcs]	
	balance	managed	documented	managed
Hard coal	43 087.72	16 113.48	136	47
Lignite	13 587.70	1 789.25	76	12
Crude oil	23.13	19.71	84	67
Natural gas	138.82	109.66	264	182
Copper ores	1543.79	1224.08	14	6
Zinc and lead ores	141.15	22.04	21	3
Sulphur	520.73	31.94	18	5
Halite	84 511.72	15 524.50	19	5
Natural aggregate	15 022.31	3468.38	6029	2278

Source: GUS.

groundwater resources and almost 1% from mining waters (from the dewatering of mines).

2.4. Climate

As a result of the influence of climate types and various amounts of energy reaching Earth in various seasons, depending on latitude, climate in Poland is zonal. The mean air temperature ranges from below 6ºC in south-eastern Poland to more than 10ºC in the south-western part of the country. The growing season lasts from 200 to 230 days, in accordance with the north east – south west thermal gradient. In accordance with that distribution, thermal winter lasts from 40 to 110 days. Precipitation sums range from below 500 mm in the central part of eastern Poland and in south-western Poland to almost 1,000 mm at the coast and more than 1,000 mm in the mountains.

In Poland, like in many regions of the world, climate changes have been observed in recent years: an increase in the mean annual air temperature, changes in the precipitation structure and an increase in the number of extreme phenomena. A comparison of the value of mean annual temperature at meteorological stations[4)], in a shorter observation period shows that it is getting warmer in Poland. An analysis of the value of mean annual air temperature for the next decades shows that the value gets higher every decade. In the last six decades, the highest values were recorded in the years 2000–2005 and were higher than in the period 1971–1980 by 0.4–0.6ºC (depending on the station location). The highest temperature increase is observed in winter, the highest increase rate is shown by minimum temperature. The mean annual air temperature in Poland in the years 1951–1980 amounted to 7.4ºC, in the period 1981–1990 it increased to 7.9ºC, in the period 1991–2000 to 8.1ºC and in 2001–2005: 8.3ºC[5)].

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 (more than 1,000 mm), whereas summer precipitation prevails over winter precipitation.

Generally speaking, changes in the precipitation structure have been observed in Poland in recent years. A comparison of annual precipitation sums from the period 1971–2000 and 2001–2005 shows that in the latter period, the annual precipitation sum increased from 616 mm to 635 mm, but regional differences also increased. In the first period, the annual precipitation sum ranged from 507 mm in the western part of the lowlands to 1,100 mm in mountain areas (excluding high mountain stations) and in the second period: from 483 mm in the central part of Eastern Poland to 1,198 mm in mountain areas.

Changes in the precipitation structure are connected with the occurrence of extreme phenomena. In some parts of Poland, the current monthly levels are fulfilled by short-term torrential rains, but in the remaining periods there are droughts or post-drought periods. In recent years, from a few hundreds to a few thousands of cases connected with rise of water level in rivers were recorded in Poland every year (mainly in mountainous and sub-mountainous areas and in the Vistula delta). However, in the low-lands and the Lublin Upland there are water deficits, which are considered permanent.

In recent years, also abnormally warm springs (2002, 2007), warm autumns (2006) and anomalously warm winters were observed (2000, 2006). Apart from the abovementioned flood and drought threat, consequences of climate changes

4) In Poland, the Institute of Meteorology and Water Management keeps the Central Climatological Database. The database contains data collected by 268 meteorological stations and posts and 1680 precipitation stations.

5) Data from 30 representative meteorological stations in Poland (w/o high mountain stations).

in Poland also involve increased fire danger in forests, decrease of ground water level and related disappearance of water and mud areas as well as stepping of natural habitats.

2.5. Socio-economic condition

2.5.1. Brief overview

Gross Domestic Product. In 2007, Poland was one of the fastest developing countries of European Union. Gross Domestic Product increased by 6.6%, whereas in the whole UE-27 GDP increased by 2.9%. Speeding up of the economic growth in Poland has been observed since 2003, when the GDP growth rate exceeded 3%. However, the amount of GDP per capita, even though it gradually increases, is still much lower in Poland than in highly-developed countries. In 2004, it amounted to USD 12,700 and in 2007: USD 16,300.

The development of the Polish economy encompasses all main sectors, i.e. services, industry and the building industry. In the GDP creation structure, the first place has been occupied by market services, the most important of which is trade. A trend of positive changes has been fixed in the share of non-market services in the GDP creation, although small, has been positive for the last few years. The share of the industrial sector in the GDP creation has been decreasing gradually every year, whereas 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. A small role in the economic growth is played by the agriculture and forestry. Selected information on the GDP volume, dynamics and structure in Poland in the years 2000–2007 are presented in Table 2.4.

2.5.2. Energy sector

Brief overview. Energy sector in Poland is based on the following raw materials:

- hard coal – hard coal mining has been decreasing in recent years, the cause of which is the liquidation of old and unprofitable mines as well as use of energy-saving technologies and machinery by energy recipients; hard coal can be found in the following Coal Basins: Upper Silesian, Lower Silesian and Lublin Coal Basin;
- lignite – opencast mining in the following Coal Basins: Konin, Turoszów and Bełchatów;
- Crude oil – crude oil extraction in Poland is trifling, Poland imports crude oil from Russia, the Arab countries and the North Sea basin;
- natural gas – domestic extraction covers 40% of Poland's demand for gas, the remaining part is imported from Russia and Ukraine;
- the remaining energy sources, including renewable energy – water energy, geothermal energy, energy from biomass, solar energy, wind energy – their share increases every year.

For many years, hard coal and lignite have been losing their importance as energy sources to oil derivatives, although they will remain a strategic raw material for a few dozen or so years. Data concerning the amount and structure of raw energy use are depicted in Table 2.5.

Table 2.4. GDP in Poland in the years 2000–2007

Specification	Years							
	2000	2001	2002	2003	2004	2005	2006	2007
GDP [million PLN, current prices]	744622	779205	807859	842120	922157	983302	1060194	1167796
GDP per capita [PLN, current prices]	19464	20371	21130	22048	24153	25698	27803	30638
GDP dynamics [constant prices, previous year = 100]	104.2	101.1	101.4	103.8	105.3	103.6	106.2	106.7
GDP structure [%, current prices]								
Total GDP	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Taxes from products discounted by donations to products	12.5	12.3	12.6	13.0	11.5	11.5	12.5	12.5
Gross value added	87.5	87.7	87.4	87.0	88.5	88.1	87.8	87.5
Agriculture, hunting and forestry	3.0	3.2	2.7	2.6	4.5	4.1	3.7	4.3
Fishing and fisheries	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Industry	22.1	20.8	21.0	21.3	22.5	21.9	21.7	24.5
Construction	7.1	6.2	5.8	5.3	4.9	5.3	5.7	7.3
Services	55.3	57.5	57.9	57.8	56.6	56.6	56.7	63.9

Source: GUS.

Table 2.5. Volume and structure of primary energy consumption in Poland in 1999 and in the years 2003–2007

Specification	Years					
	1999	2003	2004	2005	2006	2007
Total primary energy consumption [PJ]	3770.1	3939.8	3884.5	3927.1	4166.6	4137.1
Share of individual sources [%]						
Hard coal	52.39	52.20	48.49	47.49	48.06	48.27
Lignite	13.83	13.12	13.92	13.71	12.74	12.24
Petroleum oil	18.85	18.83	19.77	19.65	20.44	20.66
Natural gas	10.29	12.93	12.80	13.89	13.23	13.35
Other[1)]	4.64	2.91	5.02	5.25	5.53	5.48

[1)] Wood, peat, waste fuels, water energy and other renewable carriers.

Source: GUS.

The prevalence of oil derivatives as an energy source is apparent in the final energy use. The role of gas fuels also has increased, but hard coal is still an important energy source in individual heating systems. In the structure of final energy use in economic sectors changes occur, corresponding with the development of individual sectors. First of all, there has been a decrease of energy consumption in the industry and, to a small extent, in households. Energy consumption increase applies to developing services and transport.

Final energy consumption in the main industry sectors was depicted in Fig. 2.1. Most energy is consumed by the following types of industry: food industry, chemical industry, iron and steel industry and paper industry (77.8% of the total energy consumption in this sector in 2007); the chemical industry consumed 3,685 ktoe of energy in 2007 and the mineral and iron and steel industry consumed 2,844 and 2,515 ktoe, respectively. An increase of share in consumption structure was also observed in the chemical and paper industry; a decrease is observed in the food, textile, machinery and devices industry. A significant decrease in energy consumption also was observed in the steel industry. However, structural changes are small and do not exceed several percent.

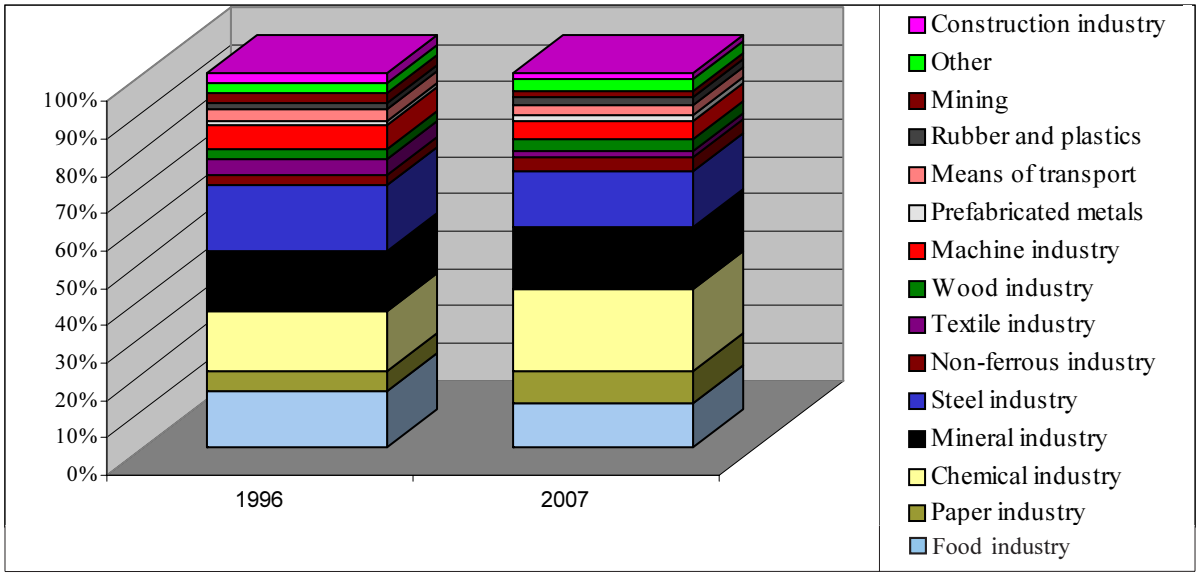

Figure 2.1. Energy consumption structure in the Polish industry in 1996 i 2007, source: ODDYSSE database, GUS 2009

Consumption of final energy rose significantly in the transport industry – from 10.2 Mtoe in 2003 to 14.8 Mtoe in 2007. In the household sector, there was a systematic increase of energy consumption until 2006, when the value of 19.5 Mtoe was reached; then, in 2007, consumption decreased to the value from 2003. In the period in question, in the agricultural sector, a constant decrease of energy consumption was visible; in the services sector, that value remained at a similar level (Fig. 2.2).

In Poland, the currently used sources of renewable energy, which constitutes more than 5% of primary energy in total, include, first of all, biomass (especially wood and wood waste) and water energy; to a significantly lower extent wind energy and geothermal and solar energy. In 2007, installed power of power plants generating electrical energy from renewable energy sources amounted to 1,524 MW and energy generated by them reached the level of 5229 GWh. Despite certain fluctuations, production of electrical energy from renewable sources has been increasing every year; in 2006, it constituted 6.5% of the total energy production and 5.1% of the total electrical energy consumption.

The intense economic transformations that resulted in a decrease of consumption of the primary and final energy with the growing GDP caused the GDP energy consumption to drop. It applies both to the primary and final energy. Since 2000, the GDP energy consumption decrease rate is at the level of 2% a year (Table 2.6).

The energy sector in Poland comprises the following subsectors: electrical power engineering, heating, gas and oil.

Electrical power engineering sub-sector. Power industry in Poland is based, to a significant degree, on public power plants. Installed power of all power plants (utility, industrial and renewable energy sources) by the end of 2007 amounted to 35,850 MW and production amounted to 159,292 GWh.

Causes of the low efficiency of the Polish power system and its high CO_2 emissivity include:

- very high share of high-emissivity coal technologies in electrical energy generation, not found in other countries;
- low efficiency of electricity generation processes in coal technologies;
- high energy demand for internal use in the power industry;
- high losses connected with electricity transport (transmission and distribution).

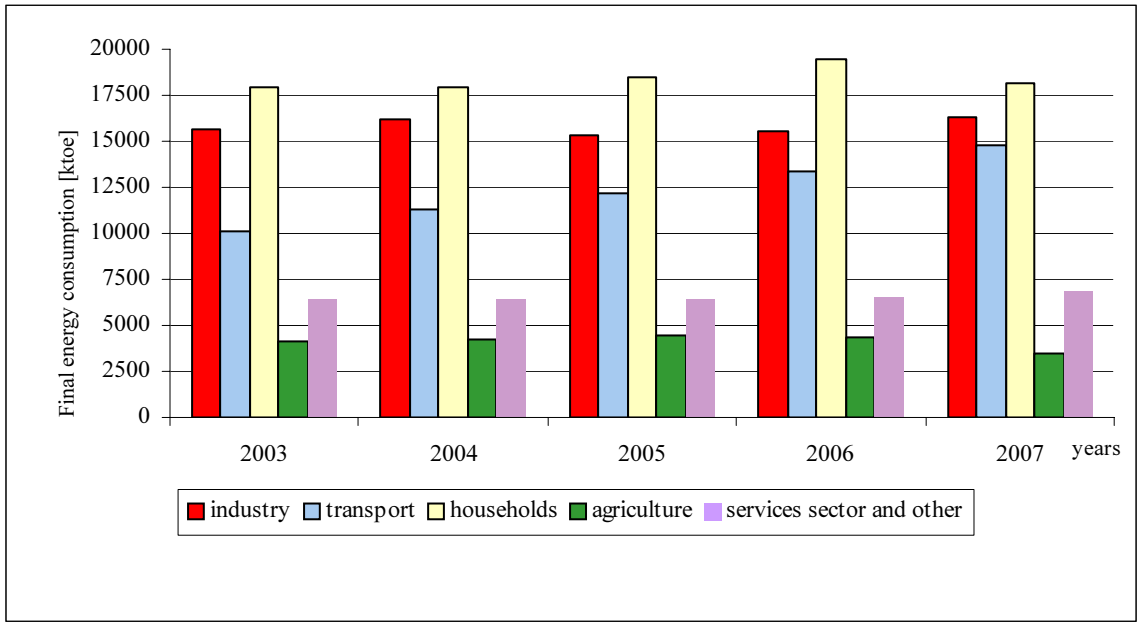

Figure 2.2. Final energy consumption by sectors in the years 2003–2007, source: ODDYSSE database, GUS 2009

Table 2.6. GDP energy consumption and primary energy consumption in Poland in relation to population number in 2000–2007

Specification	Years							
	2000	2001	2002	2003	2004	2005	2006	2007
GDP energy consumption [PJ/PLN 1,000]	5.2	5.0	4.7	4.7	4.2	4.0	3.9	3.5
Primary energy consumption per capita [PJ per capita]	101.2	102.4	99.1	103.2	101.8	102.9	109.3	108.5

Source: GUS and MŚ.

Evaluating the structure of use and losses, one should pay attention to two items which are alarmingly high internal use in the power industry amounting to 9.0% and losses (total) 9.1%. Both items should be recognized as significantly differing from European standards (Table 2.7).

Low quality of power transmission and distribution networks constitutes an important problem in the electrical power engineering sector. Electrical energy losses constitute almost 10% of gross generated energy. Power transmission and distribution systems, even though they ensure safety of electrical energy delivery to recipients in Poland, require modernisation. However, transborder connections, despite investments implemented in recent years, are not sufficient and do not ensure efficient operation of the electrical energy market.

Since 2006, Poland has been implementing the new *Programme for the Electrical Power Industry*, the purpose of which is to lower the cost of generation, transmission and distribution of electricity, improvement of energy safety and reliability of delivery as well as limitation of the impact of the power industry on the environment. One of the actions taken for that purpose is creation of strong entities capable of ensuring energy safety. In 2007, another stage of supplier consolidation was completed, thanks to which four producers operate in Poland now: PGE – Polska Grupa Energetyczna S.A., Tauron Polska Energia S.A., ENERGA S.A. and ENEA S.A. Operator of the power transmission system in Poland is Polskie Sieci Elektroenergetyczne OPERATOR S.A.

The electricity use increase rate in Poland in the years 1995–2007 is characterised by a constant growth (Fig. 2.3.).

It is estimated that ca. 800–1000 MWe of new generating capacities should appear in Poland every year. However, modernisation works aimed at limitation of coal consumption and adaptation of boilers to fuels other than coal, as well as activities in the sphere of installation, expansion or modernisation of environmental protection devices bring some effects. Generation of electricity in hard coal- and lignite-powered power plants has been successively limited to the advantage of gas and biomass. In 2007, in public power plants 61.4% of energy was generated from hard coal combustion, 34.5% from lignite combustion, 3.0% from gas, whereas in 2006, these values were 61.9%, 35.6% and 1.7% respectively[6)].

Table 2.7. Total electricity consumption, electricity consumption for the needs of thermal power stations and losses and statistical differences of the utility electrical power engineering in Poland, in 2000, 2006 and 2007

Specification	Years		
	2000	2006	2007
Consumption [GWh]	141 631	158 670	159 568
Consumption for the needs of thermal power stations [GWh]	12 134	12 990	13 031
including: – consumption for electricity production [GWh]	10 242	11 162	11 155
– for heat production [GWh]	1892	1828	1876
Losses and statistical differences [GWh]	14 234	14 021	14 560

Source: Agencja Rynku Energii S.A.

Table 2.8. Electricity balance and heat production and sales in Poland, in 2000–2007

Specification	Years							
	2000	2001	2002	2003	2004	2005	2006	2007
Electrical energy [TWh]								
Production	145.2	145.6	144.1	151.6	154.2	156.9	161.7	159.3
Import	3.3	4.3	4.5	5.0	5.3	5.0	4.8	7.8
Domestic consumption	124.6	124.7	124.2	127.1	130.5	131.2	136.7	139.6
Export	9.7	11.0	11.5	15.1	14.6	16.2	15.8	13.1
Losses and statistical differences	14.2	14.2	12.9	14.4	14.3	14.6	14.0	14.4
Heat (in steam and hot water) [PJ]								
Production	558	578	564	577	560	x	x	x
Sales	340	420	352	–	–	–	–	–

Source: GUS and ARE S.A.

6) Energy Regulatory Office (Urząd Regulacji Energetyki).

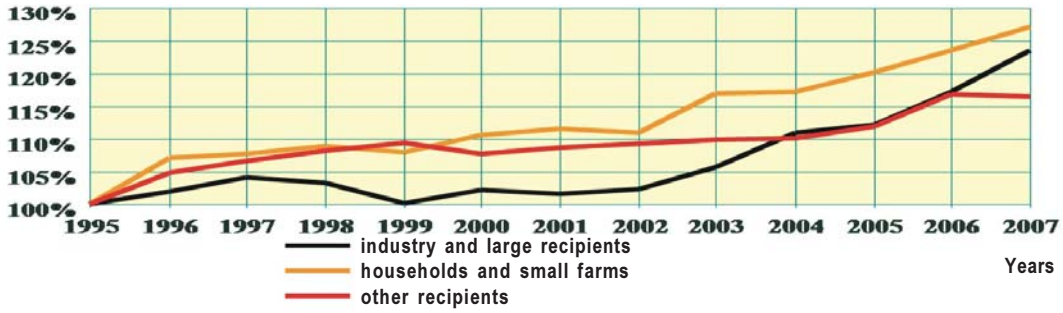

Figure 2.3. Electricity consumption dynamics in Poland, by individual recipient groups (1995 = 100%), source: Agencja Rynku Energii S.A.

Heating sub-sector. Heat supply covers production and distribution as well as marketing of thermal energy. Potential of the Polish heating industry is highly fragmented. Heating business is conducted by utility and industrial heat and power generating plants, utility and municipal heat generating plants and local production and distribution companies. Currently, more than 63% of heating companies belong to the public sector, almost 70% of which belong to local self-governments. The remaining entities are owned by the private sector, almost 28% of which is owned by foreign companies.

The basic fuel used for heat generation is hard coal (77.4%); however, also in this sub-sector investments are conducted consisting in replacing coal boilers with gas boilers, as well as various modernisation works connected with the environmental protection requirements. However, renewable fuels still had a very small share in the heat production structure. Share of heat obtained as a result of biomass combustion is rising very slowly. In the years 2002–2007, production of heat from biomass increased by more than 42% and its share in the total heat production increased to 1.6%.

Ca. 30% of the heat produced is used by the producers for satisfying their own heat needs, the remaining part is transmitted to the heat distribution networks. Recipients connected to the network, on account of heat losses during transmission receive not much more than 60% of the produced heat.

Technical potential of licensed heat engineering companies is characterised by high fragmentation and geographical spread. In 2007, installed power of licensed heat engineering companies amounted to 62,752.3 MW (in 2002: 70,952.8 MW) and the attainable power: 60,530.5 MW (in 2002: 67,285.4 MW). More than 1/3 of the heating industry production potential was concentrated, like in the previous years, in two voivodships: the Śląskie and Mazowieckie Voivodships.

The highest attainable power, almost 60% of share on the national level, belong to typical heat engineering companies. The share ranges in individual voivodships, from ca. 25% in the Lubuskie and Podkarpackie Voivodship to 90% in the Dolnośląskie Voivodship.

In the years 2002–2007, ca. 90% of licensed heat engineering companies produced heat. In 2007, they generated (including recovery) almost 435,000 TJ of heat, i.e. 11.7% less than in 2002. Some of these companies (17.7%), generated heat in combination with electricity. In the year in question, 62% of the generated heat (251.3 TJ) was cogenerated in power plants and heat and power generation plants belonging to utility electrical power sector, utility heat engineering sector and industry. More than 55% of the total national heat production in 2007 was generated by utility heat engineering companies. Definitely the most heat was generated by companies that combined heat production with its transmission and distribution.

Assessment of energy use changes in the Industry sector. Changes in the use of energy in the most energy-consuming sectors of the processing industry in the years 2003–2007 were depicted in Fig. 2.4. There are practically no sectors with visible trends of changes in the use of energy. Small energy consumption changes are mostly caused by production limitations, not modernisation. As compared to 2003, a small increase in energy use took place in the paper industry; whereas in chemical industry and non-ferrous metal smelting industry, there are no significant changes of use.

However, there is a distinct trend of increase of energy efficiency of production in most industrial sectors, especially those, where efficiency was lowest (Fig. 2.5 and 2.6), which has a direct influence on the decrease of GHGs emissions.

Energy intensity of cement production has been stable since 2003. In that industry, the technology of wet cement production method, which was very energy-consuming is no longer used as a result of which, energy intensity dropped below 0.1 toe/t, i.e. value that is close to the European average. In the period in question, energy intensity of steel production also was constantly reduced. After privatisation, the paper industry also underwent a thorough technological modernisation, thanks to which the energy intensity dropped to the lowest level of 0.55 toe/t in 2006. However, in 2007 that value

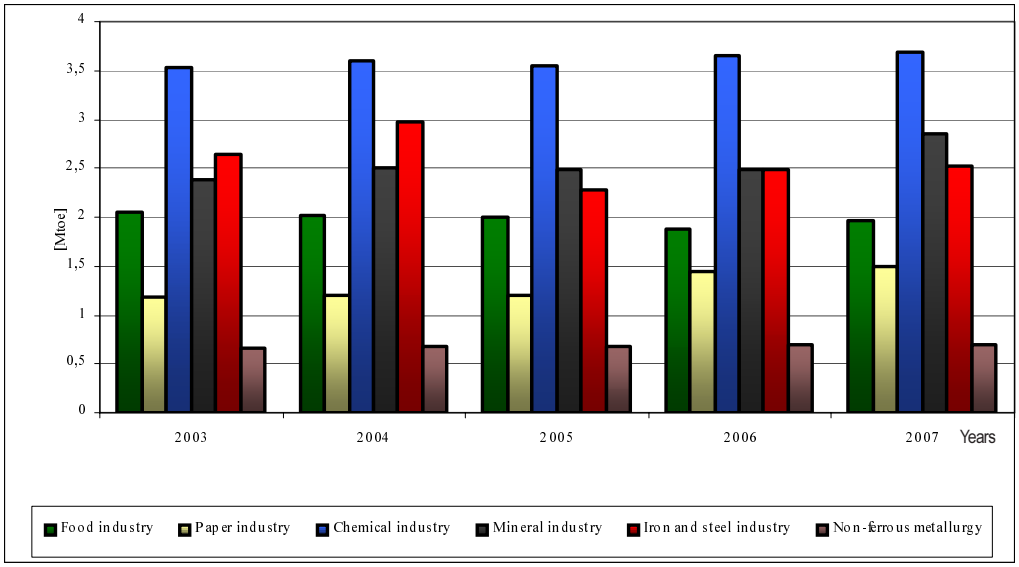

Figure 2.4. Final energy consumption by the most energy-consuming processing industry sectors in Poland in the years 2003–2007, source: ODDYSSE database, GUS 2009

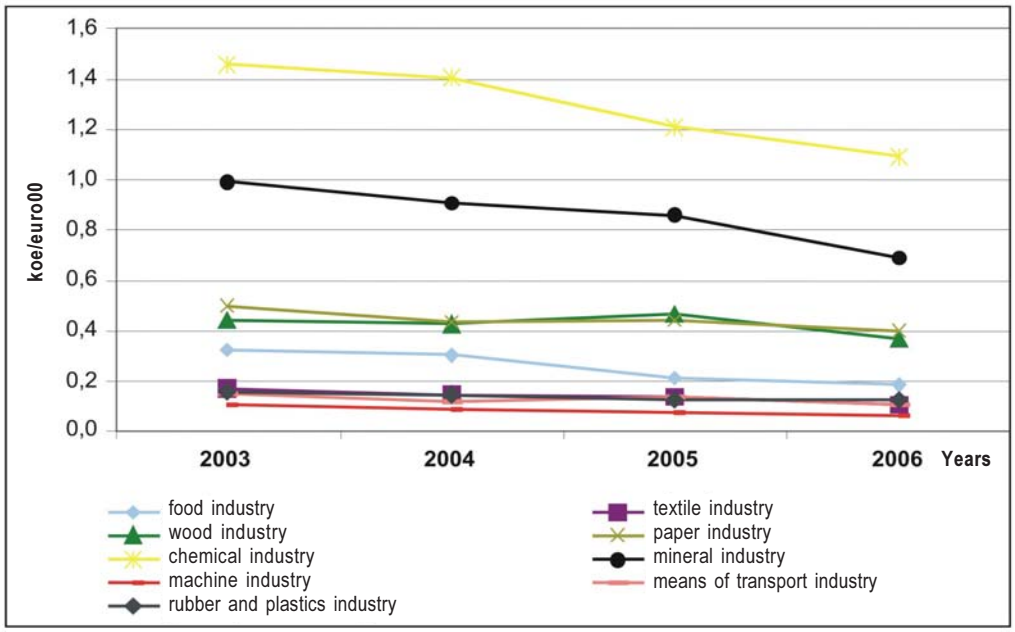

Figure 2.5. Changes of the final energy consumption index in selected industry sectors in Poland, in the years 2003–2006, source: ODDYSSE database, GUS 2009

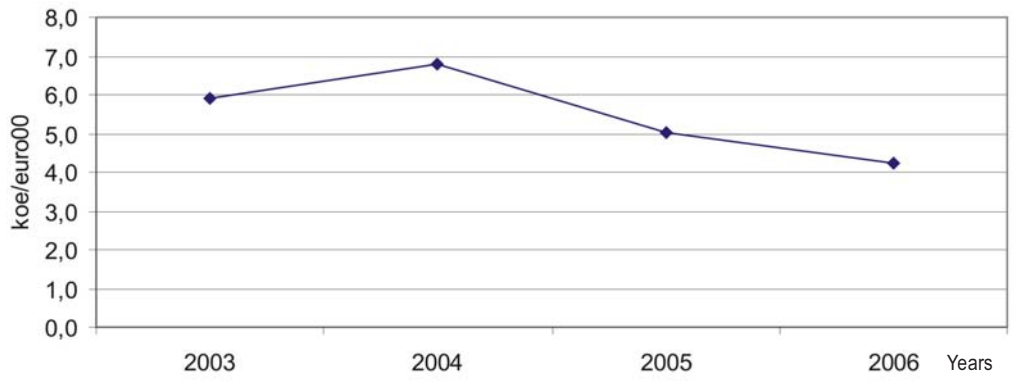

Figure 2.6. Changes of the final energy consumption index in the steel industry in Poland, in the years 2003–2006, source: ODDYSSE database, GUS 2009

increased slightly to 0.66 toe/t. Glass production energy intensity increased steeply from 6.3 toe/t in 2003 to 10.7 toe/t in 2007 (Fig. 2.7).

Assessment of changes of energy consumption in the Services sector. Since 2005, an increase in the consumption of final energy in the services sector has been observed. In the years 2003–2005, consumption remained at a medium level amounting to 6,500 ktoe. However, in 2007 it reached the value of 7,400 ktoe. The final energy consumption index in the services sector in the period in question remains at a similar level with a small decreasing trend (0.06–0.05 koe/euro00).

Assessment of changes of energy consumption in the Transport sector. Since 2003, the transport sector has been observing a systematic increase in the consumption of final energy, reaching the value of 14,800 ktoe in 2007. Road transport still plays a dominant role in consumption, constituting more than 90% (Fig. 2.8).

The final energy consumption index in the transport sector in the years 2003–2007 is at a similar level, with a small increasing trend (0.05–0.06 ktoe/euro00). The role of the dominant energy carrier in the transport sector has been played in recent years by diesel oil, reaching the value of 7,600 ktoe. Petrol consumption remains at a constant level of 4,200 ktoe, whereas biofuels consumption is marginal.

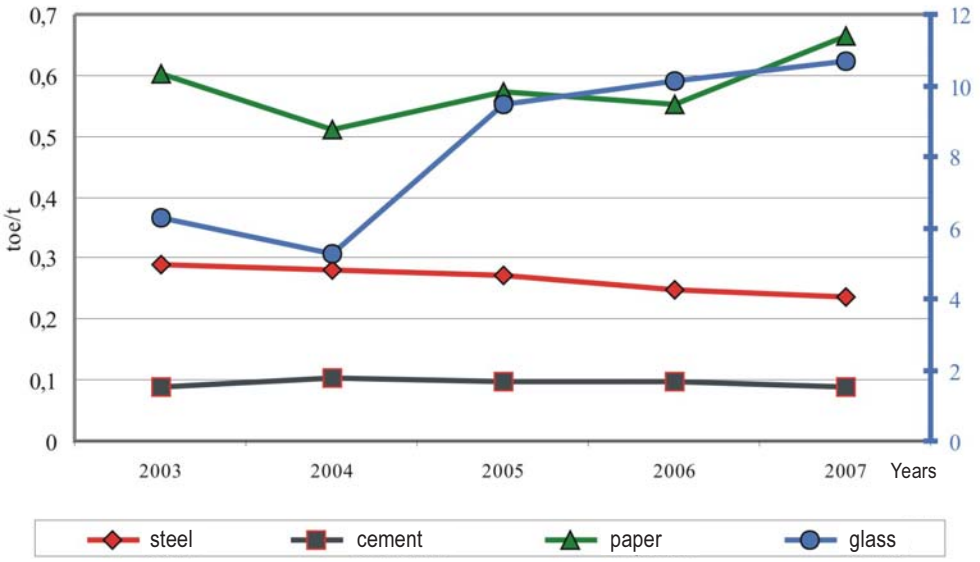

Figure 2.7. Unit energy consumption in production of selected industrial products in Poland, in the years 2003–2007, source: ODDYSSE database, GUS 2009

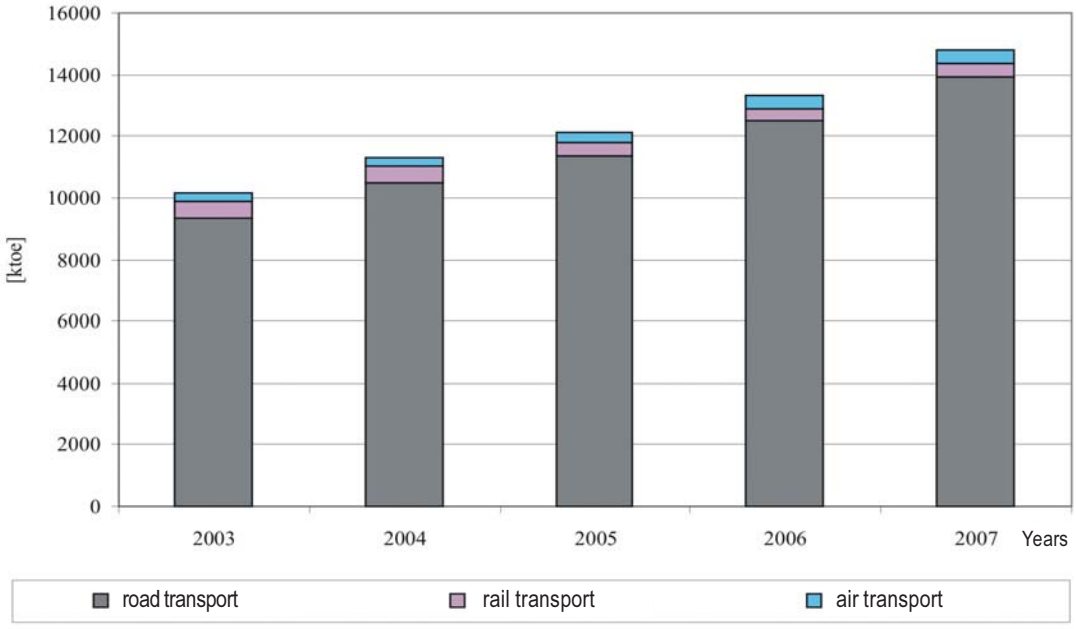

Figure 2.8. Final energy consumption in transport, in Poland in the years 2003–2007, source: ODDYSSE database, GUS 2009

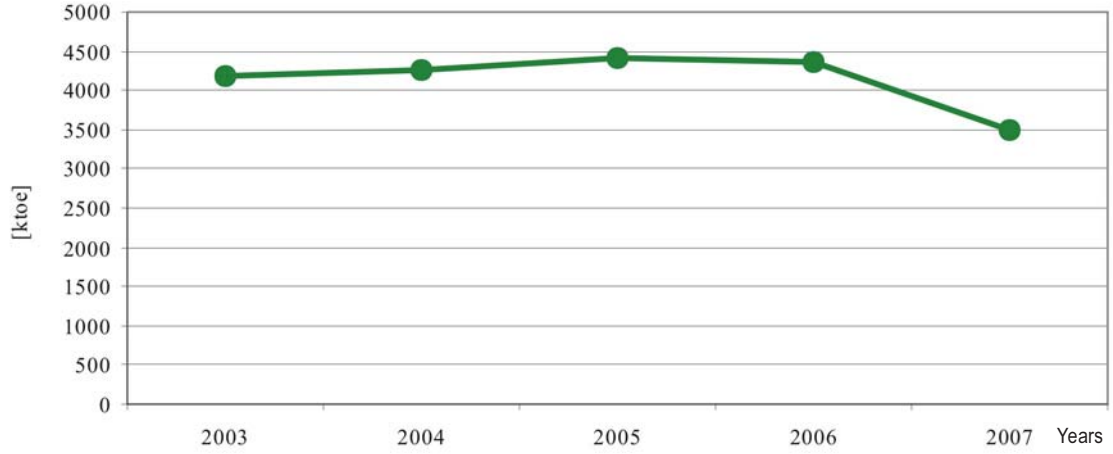

Figure 2.9. Energy consumption in agriculture in Poland, in the years 2003–2007, source: ODDYSSE database, GUS 2009

Assessment of changes of energy consumption in the Agriculture and Fishing sector. Since 2005, energy consumption in agriculture has been showing a decreasing trend. In 2007, that value reached the level of 3,500 ktoe. The cause of these changes is rather in a decrease of the number of farms followed by a decrease in agricultural production than in activities aimed at energy efficiency improvement.

2.5.3. Industry

Poland as a member of European Union is implementing community policy, based on a horizontal approach to the industry[7]. However, the specific nature of the Polish economic system, especially of some industrial sectors, still requires actions aimed at restructuring of individual sectors; such actions are taken apart from horizontal initiatives. The industry remains the dominant factor that generates economic growth, even though its share in GDP decreases every year. The sold industry production has been increasing successively. The sold production dynamics is differentiated. In the years 2004–2007, it ranged from 3.7% to 12.6% annually. In 2007, the sold production was more than 80% higher than in 2000.

Trends concerning industrial production dynamics that are present in Poland are compliant with those in developed countries. The fastest development takes place in the processing industry, which determines the dynamics in the whole industry. A positive phenomenon is observed in a form of more rapid than in other sectors growth in industrial production sectors and groups considered as the driving forces of technical progress, e.g. in the mining industry, production decrease occurs in the long run. Another important trend is visible in the structure of industrial sectors and consists in an increase of the importance of the private sector, whose share in the total sold production of industry was in 2007 almost 85%. Trends present in the industry are depicted in Table 2.9.

Transformations of the industry ownership structure and sectoral production structure are accompanied by organisational and technical and technological changes in manufacturing processes, contributing at the same time to energy efficiency improvement and therefore to a decrease in energy intensity of industrial production and GHGs emissions. Processing industry energy intensity was improving fastest in the years 1996–2000; improvement dynamics amounted then to 13.6%. After 2000, efficient energy use improvement dynamics decreased to 9.5%. Since 2004, the highest energy efficiency improvement dynamics has been observed in the machinery and means of transport industry. Energy efficiency improvement of the most energy-consuming branches of industry: iron and steel, chemical, wood and paper industry is progressing the most slowly.

2.5.4. Transport

Due to its geopolitical location, Poland may play an important role in transit services between Western Europe and Baltic countries, Ukraine, Belarus and Russia and Asia, as well as the Scandinavian countries and the South of Europe.

[7] Implementation of the EC Lisbon Programme. Political Framework for Reinforcement of EU Industry – Towards a More Integrated Approach to Industrial Policy (COM (2005) 474) and Medium-term Review of the Industrial Policy. A Contribution to the European Employment Growth Strategy.

Table 2.9. Sold production of industry in Poland in 2000–2007

Specification	Years							
	2000	2001	2002	2003	2004	2005	2006	2007
Total sold production (million PLN) [1)]	488801	500781	527908	582663	678521	698711	784721	897975
Sold production per capita (PLN) [1)]	12777	12960	13374	14783	17772	18309	20579	23559
Sold production per 1 employed person (PLN) [1)]	151658	161539	174000	194552	231994	239347	265573	
Sold production by ownership sectors (%)								
Public sector	28.7	24.7	23.7	22.0	19.1	17.5	16.4	15.1
Private sector	71.3	75.3	76.3	78.0	80.9	82.5	83.6	84.9
Dynamics of sold production (%) [2)]	6.7	0.6	1.1	8.3	12.6	3.7	11.2	9.5
Sold production by sections and divisions (%) [1)]								
Mining and quarrying	x	x	5.0	4.5	4.9	5.0	4.9	4.3
Industrial processing including:	x	x	83.2	84.1	85.0	84.5	85.0	86.5
Production of food and beverages	x	x	19.9	18.9	16.7	17.2	16.1	17.0
Production of clothes and fur products	x	x	1.9	1.6	1.4	1.2	1.1	1.0
Production of wood and wooden products	x	x	3.1	3.0	3.1	3.0	2.8	3.0
Production of coke and oil refining products	x	x	4.0	4.2	5.0	4.6	5.1	5.2
Production of chemical products	x	x	5.9	6.2	6.0	5.9	6.0	5.6
Production or rubber and plastic products	x	x	4.4	4.8	4.7	4.9	4.8	5.0
Production of metals	x	x	3.5	3.6	4.8	4.1	4.7	4.7
Production of metal products	x	x	5.3	5.6	5.8	6.0	6.6	6.9
Production of machinery and devices	x	x	4.3	4.6	4.6	5.4	5.4	5.7
Production of vehicles and transport equipment	x	x	7.0	8.1	10.3	9.8	10.7	10.5
Production of furniture and other production activities	x	x	3.7	4.2	4.1	3.9	3.7	3.7
Production and supply of energy, gas and water	x	x	11.8	11.4	10.1	10.5	10.1	9.2

1) Current prices.
2) Constant prices.

Source: GUS.

Despite the location, transport in Poland is still a falling-behind sector. The fact that this potential is not used to the full extent results from the poor condition of the existing routes, mostly in the sphere of the basic components of transport infrastructure.

In Poland, since the beginning of economic transitions, income from sales of services of all transport units in total has been increasing. The highest income is generated by the private sector, whose share in the sales of transport and storage services has been increasing since the beginning of the 1990s and in 2007 it amounted to 79%.

Changes in the structure of types of transport, both as regards passenger transport and cargo transport took place in 2004, but they were not as dynamic as at the turn of the 20th and 21st century. The most important change in the structure of individual types of transport is the decrease of importance of railroads in favour of road transport (Table 2.10).

The decreasing share of the railroad transport in cargo transport is caused mainly by the low competitiveness of this type of transport, especially in relation to road transport, decreasing transport intensity of the Polish economic system and decreasing demand for hard coal and steel mill products, which predominate in the railroad-transported goods structure. In the passenger transport structure, railway transport has also been successively losing its market share. In the years 1990–2004, there was a breakdown in the passenger transport market, but since 2006, increase in the share of railway transport in passenger transport has been observed.

In recent years, air transport has been the most dynamically developing branch of transport in Poland; the main cause of the fact is Poland's accession to EU. Poland has one central airport (Warszawa–Okęcie) and 11 regional airports, eight of which constitute part of the TEN-T European transport network. In connection with an abrupt rise of demand for air transport, investment needs as regards infrastructure have increased significantly. It applies both to development of airports and ensuring fast and efficient road and railway access to airports.

In recent years, an increase in the amount of goods transported by sea has been observed in Poland. Poland has four ports of essential importance for the national economy: Gdańsk, Gdynia, Szczecin and Świnoujście. In 2007, almost

Table 2.10. Volume and structure of cargo and passenger transport in Poland, 2000–2007

Specification	Years							
	2000	2001	2002	2003	2004	2005	2006	2007
Cargo transport (thousands, tons)								
Total	1271529 (100%)	1241382 (100%)	1233209 (100%)	1238842 (100%)	1324511 (100%)	1422576 (100%)	1480259 (100%)	1532728 (100%)
Rail transport	187247 (14.7%)	166856 (13.4%)	222908 (18.1%)	241629 (19.5%)	282919 (21.4%)	269553 (18.9%)	291420 (19.7%)	245346 (16%)
Car transport	1006705 (79.2%)	996517 (80.3%)	931190 (75.5%)	911997 (73.6%)	956939 (72.2%)	1079761 (75.9%)	1113880 (75.2%)	1213246 (79.2%)
Pipeline transport	44342 (3.5%)	45301 (3.6%)	46132 (3.7%)	51782 (4.2%)	53378 (4%)	54259 (3.8%)	55631 (3.8%)	52866 (3.4%)
Sea transport	22774 (1.8%)	22426 (1.8%)	25222 (2%)	25435 (2.1%)	22499 (1.7%)	9362 (0.7%)	10021 (0.7%)	11432 (0.7%)
Water transport: inland transport[1)]	10433 (0.8%)	10255 (0.8%)	7729 (0.6%)	7968 (0.6%)	8747 (0.7%)	9607 (0.7%)	9271 (0.6%)	9792 (0.6%)
Air transport	28 (0.0%)	27 (0.0%)	28 (0.0%)	31 (0.0%)	29 (0.0%)	34 (0.0%)	36 (0.0%)	46 (0.0%)
Passenger transport (thousands, persons)								
Total	1319972 (100%)	1236583 (100%)	1124940 (100%)	1112533 (100%)	1085509 (100%)	1046930 (100%)	1024413 (100%)	1004691 (100%)
Rail transport	360687 (27.3%)	332218 (26.9%)	304025 (27%)	283359 (25.5%)	272162 (25.1%)	258110 (24.7%)	265323 (25.9%)	278249 (27.7%)
Car transport[2)]	954515 (72.3%)	898710 (72.7%)	815041 (72.3%)	822875 (74%)	807281 (74.3%)	782025 (74.7%)	751470 (73.4%)	718274 (71.5%)
Sea transport	625 (0.0%)	582 (0.0%)	559 (0.0%)	526 (0.0%)	626 (0.1%)	714 (0.1%)	741 (0.1%)	754 (0.1%)
Water transport: inland transport[1)]	1265 (0.1%)	1637 (0.1%)	1648 (0.1%)	1795 (0.2%)	1396 (0.1%)	1444 (0.1%)	1550 (0.1%)	1490 (0.1%)
Air transport	2880 (0.2%)	3436 (0.3%)	3667 (0.3%)	3978 (0.4%)	4044 (0.4%)	4637 (0.4%)	5329 (0.5%)	6194 (0.6%)

1) Including coastal transport.
2) Without public transport.

Source: GUS.

11.4 million tons of cargo were transported by sea, i.e. 14.1% more than a year before, with a simultaneous decrease of shipping work by 10.3%. The total increase of transit is influenced by, first of all, transit between foreign ports (by 18%) and Polish ports (by 14%). The number of passengers transported by sea has also increased slightly, which is mostly generated by ferry shipping. Polish shipping faces many problems, the most important of which are decapitalisation of fixed assets and lack of good access to ports, especially from the land.

Inland water transport in Poland plays a marginal role and situation in this respect is difficult. Inland shipping in relation to the most favourable period has decreased by 10 million tons. The main obstacle to development of maritime transport in Poland is the condition of waterways. The length of actually used waterways has decreased dramatically, also as a result of floods (mostly floods in 1997 and 1998).

Share of the transport sector in the final energy consumption structure has been constantly increasing. In 1996, its level was below 15%, now it amounts to more than 20%. The increasing trend concerning the share of transport in the national energy consumption is influenced, first of all, by the development of road transport. Almost 94% of energy used in transport is used in road transport and ca. 3% in railway transport. The remaining 3% is used in air transport and by inland and coastal shipping. In road transport, there has been an increase in fuel consumption and number of cars (table 2.11). In 2000, fuel consumption amounted to 0.648 toe/vehicle, in 2004: 0.686 toe/vehicle and in 2006: 0.751 toe/vehicle. A constant positive trend observed in the transport sector is a decrease in means of transport energy consumption indexes. The ODEX energy efficiency index in 2000 amounted to 100, in 2004: 71.5 and in 2006: 71.3.

2.5.5. Construction and housing

Dynamisation of investment activities, among others thanks to the inflow of aid funds from European Union, resulted in an increase of trends and dynamics of gross expenditures for tangible assets. This tendency has been observed in Poland since 2004 and correlated with added value of the building industry, which increased by a dozen or so percent in 2006 and 2007. Since 2004, share of the building industry in GDP creation has been increasing. In the ownership structu-

Table 2.11. Registered automotive vehicles and tractors in Poland, in 2000–2007

Vehicles	Years							
	2000	2001	2002	2003	2004	2005	2006	2007
	thousands, pieces							
Total	14 106	14 724	15 525	15 899	16 701	16 816	18 035	19 472
Passenger cars	9991	10 503	11 029	11 244	11 975	12 339	13 384	14 589
Buses	82	82	83	83	83	80	83	88
Trucks and truck-tractors	1879	1979	2163	2313	2392	2305	2393	2521
Ballast and farm tractors	1253	1257	1294	1322	1319	1243	1288	1339
Motorcycles	803	803	869	845	836	754	784	825

Source: GUS.

re in the building industry, the public sector has a small share. The increase of building industry indexes applies to, first of all, the developers sector. In 2007, more than 133,000 dwellings were put into use, i.e. 16.0% more than in the previous year. Housing construction despite its intense development during last few years, remains a social problem in Poland.

At the end of 2007, housing stock in Poland constituted 13.0 million dwellings, consisting of 48.0 million rooms of usable area of 907.2 million m^2. In 2007, flat number index per 1,000 inhabitants was 341, i.e. the lowest in European Union.

The housing problem in Poland concerns, among others, dwelling standard, including sanitary and technical systems. The highest number of dwellings is equipped with water supply systems (95.3%), fewer are equipped with a lavatory and bathroom (87.8% and 86.7%, respectively). However, in 2007, gas system was connected in every second dwelling (55.6%). Dwellings in rural areas are definitely worse equipped with the abovementioned devices than dwellings in cities (water supply system: 88.8%, lavatory: 74.2%, bathroom: 75.6%, gas: 18.6%, central heating: 64%). In 2007, 35,200 dwellings were modernised as regards connection to new sanitary and technical systems.

In recent years, a decrease of individual energy consumption in dwellings has been observed, as a result of the implementation of a program of thermal modernisation of buildings, reduction of losses in heating networks and improvement of efficiency of newly installed equipment. Despite that fact, in households (which are the biggest energy consumer, ca. 32–22%, total final energy consumption have a slight increasing tendency), as much as 71.2% of energy used is used for heating of rooms and almost 15.1% for warm water production. For lighting purposes, meal preparation and supplying household appliances with electricity, almost 13.4% of consumed energy is used.

2.5.6. Agriculture

Polish agriculture is characterised by large soil resources with a high share of poor and acidified soils, high fragmentation of farms and preservation of traditional production methods.

In 2007, farm area in Poland amounted to 18.7 million ha and constituted more than 59.7% of the total area of Poland.

Table 2.12. Sold production of the building industry in Poland and buildings completed in 2000–2007

Specification	Years							
	2000	2001	2002	2003	2004	2005	2006	2007
Sold production total (million PLN)	107177.5 (100%)	104197.8 (100%)	99543.5 (100%)	92315.7 (100%)	97449.4 (100%)	114671.9 (100%)	135759 (100%)	164446 (100%)
Public sector	4421.0 (4.1%)	3604.4 (3.5%)	3226.7 (3.2%)	3289.1 (3.6%)	3144.0 (3.2%)	2788.7 (2.4%)	2785 (2.1%)	2796 (1.7%)
Private sector	102756.5 (95.9%)	100593.4 (96.5%)	96316.8 (96.8%)	89026.6 (96.4%)	94305.4 (96.8%)	111883.2 (97.6%)	132974 (97.9%)	161650 (98.3%)
Buildings completed (pcs.)	50205	54219	66321	139702	80756	80118	78089	95876
Urban areas	28429	30275	34283	59380	37385	37105	23893	37484
Rural areas	21776	23944	32038	80322	43371	43013	45196	58392
Cubic volume of buildings completed (dam^3)	80795	97275	92877	145856	110144	119532	128820	162495
Urban areas	57812	68119	60888	76349	64355	72657	73494	94291
Rural areas	22983	29156	31989	69507	45789	46875	55326	68204

Source: GUS.

Total area of soils belonging to farms, as compared to 2006, increased by 319,000 ha, whereas area of cultivated land used by farms in 2007 amounted to 16.1 million ha, which constitutes 51.7% of the area of Poland. In the users group structure, private sector predominates: 96.5% of cultivated land area, 89.1% of which constitute individual farms. In 2007 there were 1,804,000 individual farms of an area exceeding 1 ha. Among individual farms, small farms of an area of up to 5 ha predominate, (they constitute more than 57% of the total number of individual farms) and cultivate 2,603,200 ha of land, which constitutes 18.4% of individual farms area. Farms exceeding 15 ha of cultivated lands, including the biggest ones, constitute 11.2% and they cultivate 6,628,100 ha, which constitutes 47.1% of cultivated lands area. Area of cultivated land per one farm, as compared to two previous years, has increased (Table 2.13).

Apart from fragmentation of farms, traditionalism of Polish agriculture is manifested in still moderate (according to European standards) level of use of mineral fertilisers and chemical plant protection products. In 2007, the use of mineral and chemical fertilisers for harvest amounted to 1,970,700 tons in total, which constitutes 122 kg per 1 ha of cultivated land (Table 2.14). An apparent decreasing trend has been visible in the use of lime fertilisers, which has a detrimental effect on the condition of soils, resulting in their acidification.

Agricultural production in Poland is carried out on agricultural land with predominance of light soils which are poor in nutrient elements. In Poland, share of light soils amounts to 60.8%; these soils are characterised by high sand content. At the same time, the coarseness of light soils results in a low retention capacity, which, in the event of low precipitation in the growing season affects hydrographic conditions (especially on the Polish Lowland, where in the growing season, water deficit reaches the level of 250 mm).

In Polish agriculture, plant and animal production are balanced; however in the gross agricultural production value, plant production prevails (in 2007: 55.6%) and in the market production value: animal production prevails (in 2007: 56.6%). In the animal production, the most important is cattle, swine and poultry (Table 2.15).

In the agriculture structure, cereal production predominates (72.9% in the area under crop structure), root crops, mostly potatoes (despite the fact that their crop area decreases every year) and vegetables and fruits. Cultivation of non-food plants, including energetic plants, is getting more and more important. Area of cultivated lands meant for energetic plants cultivation and biomass production increases every year: in 2005, it amounted to 5,966 ha, in 2006: 6,991.5 ha. Taking into account support of financial instruments in order to establish plantations of multi-year plants for energy purpo-

Table 2.13. Private farms in Poland, in 2000–2007

Specification	Years							
	2000	2001	2002	2003	2004	2005	2006	2007
Number of farms (thousands)	1881	1882	1952	1850	1852	1782	1806	1804
Average cultivated land area per farm (ha)	7.2	7.1	7.4	7.4	7.5	7.6	7.7	7.8
Percentage of farms by cultivated land area								
1.01–1.99 ha	23.8	22.8	26.5	25.8	26.1	25.1	23.2	23.4
2.00–4.99	32.6	33.8	32.2	33.0	32.1	32.8	33.8	34.0
5.00–9.99 ha	23.8	24.3	21.9	22.1	21.8	21.8	23.0	22.2
10.00–14.99 ha	9.9	9.7	9.3	9.2	9.6	9.4	9.4	9.2
15.00–19.99 ha	4.5	4.4	4.3	4.2	4.3	4.3	4.3	4.3
20.00–49.99 ha	4.7	4.4	4.9	4.7	5.1	5.5	5.2	5.7
50.00 ha and more	0.7	0.6	0.9	1.0	1.0	1.1	1.1	1.2

Source: GUS.

Table 2.14. Consumption of mineral and lime fertilisers in Poland in 2000–2007 (in kg of pure ingredient per 1 ha of cultivated land)

Specification	Years							
	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007
Mineral or chemical fertilisers total, including:	85.8	90.8	93.2	93.6	99.3	102.4	123.3	122.0
Nitrogenous fert.	48.4	50.3	51.0	51.5	54.8	56.3	62.5	65.0
Phosphatic fert.	16.7	17.9	18.9	18.7	19.7	20.4	27.7	26.0
Potassic fert.	20.7	22.6	23.3	23.4	24.8	25.7	33.1	31.0
Lime fertilisers	95.1	94.2	94.1	94.6	93.5	91.5	54.8	37.0

Source: GUS.

Table 2.15. Gross and market agricultural output in Poland, in 2000–2007

Specification	Years							
	2000	2001	2002	2003	2004	2005	2006	2007
Total production								
Total (million PLN) including:	55985.4	60319.5	55706.0	56263.6	66985.4	63337.2	65081.7	81757.0
Plant production (%)	53.2	52.4	52.8	52.8	53.5	48.6	50.3	55.6
Animal production (%)	46.8	47.6	47.2	47.2	46.5	51.4	49.7	44.4
including private farms (%)	90.0	90.1	90.1	89.6	89.0	89.3	89.4	89.6
Commodity production								
Total (million PLN) including:	33491.4	35933.8	34739.3	36542.9	43465.0	42907.0	45897.2	52593.0
Plant production (%)	37.4	36.8	38.7	40.0	40.4	38.7	41.9	43.7
Animal production (%)	62.6	63.2	61.3	60.0	59.6	61.3	58.1	56.3
including private farms (%)	86.4	86.9	87.1	86.3	86.0	86.6	86.9	86.1
Share of commodity production in the total production (%)								
Total	59.8	59.6	62.4	64.9	64.9	67.7	70.5	64.3
Plant production	42.1	41.9	45.8	49.2	49.0	53.9	58.9	50.6
Animal production	80.0	79.0	80.9	82.6	83.2	80.8	82.3	81.6
Production per 1 ha of cultivated land (PLN)								
Total	x	x	3296	3480	4103	4054	4068	5054
Commodity	x	x	2056	2260	2662	2781	2864	3251

Source: GUS.

ses, one may assume that this sector will develop dynamically in Poland.

Preservation of traditional methods of agriculture made it possible for local varieties of plants and livestock breeds to survive. The mountainous region, i.e. the area of Southern Poland is the region where especially old varieties of plants and animals have been preserved. In genetic resources of livestock, Poland has 215 native animal breeds.

2.5.7. Forestry

The area of forests in Poland is increasing and in 2007, it amounted to 9,049,000 ha, which constitutes 28.9% of the area of Poland (recorded forests and wooded land, including forests, wooded lands and shrub lands occupied in that year the area of 9,255,000 ha, which constitutes 30.2% of the land area of Poland). In the period from 1946 to 2007, the forest cover index increased from 20.8% to the current level, but it is still lower than the target index for Poland, i.e. 33–34%. The forest cover index is differentiated regionally, ranking from 20.9% in the Łódzkie Voivodship (Central Poland) to 48.8% in the Lubuskie Voivodship (Western Poland). In Poland, the forestland area per capita is almost 0.25 ha. In the forest structure, public forests predominate: 82%, 98.9% of which belongs to the State Treasury and 1.1% to communes (Table 2.16).

Increase of forest area was obtained as a result of forest planting on non-forest lands, agricultural lands or wasteland through artificial afforestation and classifying other lands covered by forest vegetation (natural succession) as forests. In the years 2004–2007, in total 55,800 ha of lands that were not owned by the State Treasury were afforested. The volume of forest area is also slightly influenced has exclusion of forest lands for non-agricultural and non-forest purposes; in 2007, 597 ha were excluded (Table 2.17).

In Poland, there are 26 habitat types of forests, coniferous habitats predominate, occupying 55.1% of the total forest area; forest habitats occupy 44.9%, of which 3.4% is occupied by alder swamps and marshy meadows. As regards species structure, coniferous trees prevail; their share in the total forest area amounts to almost 76.5%, 69% of which is covered by pine trees. Share of deciduous trees in the total forest area has been increasing since the 1950s (in the years 1945–2007, deciduous tree stands area has increased from 13 to 24%). The current afforestation, thanks to administrative and financial instruments and the way of forest management, gradually move towards restructuring of tree stands structure, so that they were compliant with natural conditions.

As regards forests age structure, III (41–60 years) and IV (61–80 years) age class predominate; they occupy 25% and 19% of the area, respectively. Index of tree stands age structure changes is the constant increase of share of tree stands,

Table 2.16. Forestland area and forest treestands in Poland in 2000–2007

Specification	Years							
	2000	2001	2002	2003	2004	2005	2006	2007
Forestland area (thousand ha) [1]								
Total	8865	8894	8918	8942	8973	9000	9026	9049
Public forests, including:	7341	7349	7363	7379	7400	7410	7419	7426
Forests managed by the State Forests	6953	6968	6987	7006	7030	7042	7053	7060
Private forests	1524	1545	1555	1563	1573	1590	1607	1623
Forest area by treestand species (thousand ha, forests managed by the State Forests) [2]								
Forest cover index (%)	28.4	28.4	28.5	28.6	28.7	28.8	28.9	28.9
Coniferous trees, including:	x	x	5364	5366	5371	5378	5383	5393.3
pine and larch	x	x	4842	4844	4850	4854	4858	4869.1
Deciduous trees	x	x	1604	1621	1635	1652	1659	1659.8
Growing stock of standing wood (hm^3, forests managed by the State Forests)								
Total	1466	1480	1500	1523	1555	1586.3	1629.3	1646.4
Coniferous trees	x	x	1181	1199	1227	1252.5	1286.4	1298.5
Deciduous trees	x	x	319	324	328	333.8	342.9	347.9
Timber removal (dam^3)								
Total	26025	25017	27137	28737	30427	29725	30228	34146
Coniferous removals	19540	18047	19828	20838	22348	21919	22326	26375
Deciduous removals	6485	6970	7309	7899	8079	7806	7902	7771
Total removals in forests managed by the State Forests	24097	23471	25595	27134	28699	28164	28700	32314

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

Table 2.17. Forestland exclusions for other purposes and the level of renewals and afforestations in Poland 2000–2007

Specification	Years							
	2000	2001	2002	2003	2004	2005	2006	2007
Exclusions (thousand ha)	0.7	0.5	0.4	0.7	0.7	0.5	0.6	0.6
Renewals and afforestations (thousand ha)	68.9	65.4	56.8	66.1	61.7	62.0	65.7	60.8

Source: GUS.

the age of which exceeds 80 years. However, the average age of tree stands in the State Forests remains unchanged and for a few years, it has amounted to 60 years. The problem is the decrease of area of the youngest tree stands (I and II age class), which may endanger forest stability in the future.

The dominant function of forests is the economic function (almost 52%). Area of forests performing protective functions amounts to 36%, they are mainly water protective forests: 1,398,000 ha, forests surrounding cities (665,000 ha), forests in the industry impact zone (510,000 ha) as well as soil-protecting forests (345,000 ha). The highest number of protective forests can be found in mountainous areas. The area of forests in national parks amounts to 194,900 ha and constitutes 61.4% of the total area subject to protection, in reservations: 103,100 ha and 61% and in landscape parks: 1,331,000 ha and 51.1%, respectively.

As a result of afforestation that has been conducted for many years and adherence to the principles of sustainable forest management in Poland, there is an increase of forest resources in Poland. In the forests managed by the State Forests, tree resources as standing amounted to 1,646,400 m^3 in 2007 (1,466,000 m^3 in 2000). The current annual gross wood thickness growth in the last five years has amounted to ca. 9 m^3/ha in State Forests and the expected additional tree mass growth in the next 30 years amounts to 11,455,207 m^3, which corresponds to growth of 9.59 m^3/ha/year. For two decades, an increase in wood harvesting has been observed, expressed in net thickness per one ha of forest area: in 1998 – 3.11 m^3/ha, in 2000 – 3.47 m^3/ha, in 2005 – 4.00 m^3/ha and

in 2007 – 4.58 m^3/ha. The use of wood for energy purposes, remains at a constant level and amounts to 500,000 m^3 a year. However, the acquisition level does not exceed the permissible types of use, i.e. the current level of growth of tree stand thickness.

Polish forests are constantly endangered by abiotic, biotic and anthropogenic factors. In 2007, in the State Forests, losses caused by abiotic factors were detected on area of 365,000 ha of forests stands of age exceeding 20 years, more than 273,000 ha of forests stands were damaged by wind. On almost 65,000 ha there were losses connected with fluctuations of ground water level, on 17,000 ha with snowfall, on 9,000 ha resulting from low and high temperatures. Biotic factors endangering the forests include, first of all, insects. In 2007, rescue actions limiting the population of almost 60 species of insects were carried out on total area of almost 118,500 ha. Biotic factors also include fungal infectious diseases; in 2007, infectious diseases were detected on the total area of 505,100 ha of forest stands, which, as compared to 2006, was an 8-percent growth and mammals, which in 2007 damaged trees on the total area of 154,743 ha, damage decreased by 20% as compared to 2006. The most important anthropogenic factor are fires. In 2007, 7,049 forest fires occurred, as a result of which, 2,455 ha of forests burnt.

2.5.8. Waste management

The amount of waste produced in Poland in the years 2000–2007 remained at the level of 133,000,000 Mg a year. The largest amount of waste is generated by industry. In the years 2000–2007, the amount of waste generated as a result of industrial activities ranged from 123 million to 124 million Mg, more than 62% of industrial waste is generated by the mining and metallurgical (ore melting) industry and ca. 18% in the power industry. In industrial waste management, an increase in the amount of waste subject to recycling is observed, which is connected with the use of less material-consuming types of activities and with the use of cleaner manufacturing processes. In 2007, more than 76.4% of industrial waste generated was subject to recycling processes and only 24.6% were neutralised, of which ca. 15.6% was neutralised through landfilling. Also industrial waste deposited on landfills are subject to modification and economic use. Thanks to it, in the years 2000–2007, the amount of industrial waste deposited on landfills was systematically declining. The dominating method of industrial waste treatment is its use for energy recovery purposes, for production of construction materials and for ground surface levelling and hardening.

Municipal waste is mainly waste from households, service facilities (trade, services, crafts, education, „social" section of the industry, etc.) and open areas, such as roads and parks. In 2007, 10,083,000 Mg of municipal waste was collected, i.e. 9.2% less than in 2001 and 2.0% more than in 2006. In 2007, 319,000 Mg (in 2000 – 248,000 Mg and in 2005 – 362,000 Mg) were subject to biological and thermal processing (without selectively collected biodegradable waste). Currently, more than 90% of municipal waste in Poland is deposited on landfills, ca. 48% of which constitute biodegradable waste. In Poland, there are 764 landfills other than dangerous and neutral waste, where municipal waste is deposited (as of 31 December 2005, according to the National Waste Management Programme, KPGO 2010). The average amount of municipal waste per 1 inhabitant in 2007 amounted to 264.5 kg (value for mixed and selectively collected waste). The amount of municipal waste per capita in Poland is much lower than the average amount in the European Union (517 per one inhabitant in 2006); however, as regards municipal waste management, Poland faces various problems (Table 2.18).

A significant progress is visible in biological waste treatment, mostly in the increased share of highly efficient treatment (based, to a significant extent, on BAT). It applies to PUB waste treatment plants, with an increased degree of removal of biogenic substances (nitrogen and phosphorus). Construction of new waste treatment plants as well as modernisation and expansion of old ones made it possible to increase the percentage of highly efficient treatment in biological waste treatment plants from ca. 30% in 2000 to more than 64% in 2007 (Table 2.19).

In the last ten years, energy consumption of waste treatment plants has decreased, mostly as a result of:

– changes in the waste treatment plants technology and introduction of BAT,
– use of energy-saving devices and introduction of systems controlling their operation, adapted to the actual charge of impurities in the waste water subject to treatment,
– use of biogas from sludge fermentation processes for production of thermal and electrical energy for the needs of waste treatment plants.

Table 2.18. Generation and management of industrial and municipal waste in Poland in 2000–2007

Specification	Years							
	2000	2001	2002	2003	2004	2005	2006	2007
Industrial waste (thousand tons)								
Generated	125 484	123 810	117 894	120 551	124 030	124 602	123 463	124 414
Subject to recovery processes	96 489	96 771	93 176	95 415	97 415	98 756	94 853	95 026
Neutralised	25 118	23 857	20 768	21 658	22 578	21 890	23 807	24 963
Temporarily stored	3898	3182	3951	3479	4037	3956	4804	4425
Municipal waste (thousand tons)								
Collected	12 226	11 109	10 509	9925	9759	9354	9877	10 083
Collected selectively	13	147	116	145	243	295	403	666
Neutralised (combustion and composting plants)	248	323	251	171	322	362	342	319
Neutralised through storage	11 965	10 638	10 142	9609	9194	8623	8987	9098
Sewage sludge from wastewater treatment plants (thousand tons of dry matter)*								
Generated	1063.1	1046.8	1083.7	1008.7	1087.2	1124.3	1064.7	1088.8
Thermally transformed	34.1	46.6	31.5	47.0	39.9	37.4	39.3	33.7
Landfilled	474.5	475.4	469.5	453.1	453.3	399.1	381.3	297.2
Accumulated at the premises of wastewater treatment plants	14 084.6	11 660.8	1 0714.2	10 364.6	10 150.6	9342.8	8710.5	8295.2

* Sewage sludge from waste water treatment plants is included in the amount of generated industrial waste.

Source: GUS.

Table 2.19. Treated and untreated municipal waste water

Waste water	Years							
	2000		2001		2002		2003	
	million m^3/year	%	million m^3/year	%	million m^3/year	%	million m^3/year	%
Total	**1494.0**	**100.0**	**1425.3**	**100.0**	**1190.9**	**100.0**	**1323.7**	**100.0**
Treated	1243.4	83.2	1227.4	86.1	1353.1	88.0	1159.1	87.6
Mechanically	84.8	5.6	74.0	5.1	61.1	4.5	59.5	4.5
Biologically	1158.6	77.6	1153.4	81.0	1129.9	83.5	1099.6	83.1
Incl. PUB	450.5	30.2	501.4	35.2	546.3	40.4	608.7	46.0
Untreated	250.6	16.8	197.9	13.9	162.2	12.0	164.8	12.4
Waste water	**Years**							
	2004		**2005**		**2006**		**2007**	
	million m^3/year	%	million m^3/year	%	million m^3/year	%	million m^3/year	%
Total	**1293.6**	**100.0**	**1273.6**	**100.0**	**1265.2**	**100.0**	**1265.5**	**100.0**
Treated	1152.3	89.1	1140.0	89.5	1155.5	91.3	1174.1	92.8
Mechanically	54.2	4.2	49.8	3.9	48.2	3.8	10.9	0.9
Biologically	1098.0	84.9	1090.2	85.6	1107.3	87.6	1163.1	91.9
Incl. PUB	650.8	50.3	723.0	56.8	765.9	60.5	811.9	64.2
Untreated	141.3	10.9	133.6	10.5	109.7	8.7	91.4	7.2

Source: GUS.

2.5.9. The state of the environment

In Poland, the state of the environment is influenced by many factors, some of which are related to the situation from before the political system and economic transformation. The consequences of the centrally-planned economy, which existed until 1989, are wastage of natural resources and carelessness as regards its quality, but also low ecological awareness of the Poles until today. In Poland restructuring of the economy and modernisation processes being implemented that reduce the pressure on the environment are of utmost importance for the condition of the environment. Currently, the National Ecological Policy[8)], is being carried out in Poland; its implementation results in constant improvement of

[8)] In 2003, the Parliament (Sejm) of the Republic of Poland approved a document entitled *National Environmental Policy for the years 2003–2006, considering perspectives for the years 2007–2010*. Since 2008, Poland has been implementing „*National* Environmental Policy" for 2009–2012 and its 2016 outlook.

individual environmental components and ecological awareness of the public. Polish legal, administrative and financial institutions play an important role favouring responsible use of the environment and catching up with the environmental protection.

In 2007, expenditures for environmental protection amounted to PLN 7,500,000,000 and expenditures for water management: PLN 2,000,000,000. In recent years, their share in investment expenditures in the national economy remains at the level of 3.9% and 1.2%, and in GDP: 0.64% and 0.19%, respectively. Despite many investments concerning waste water management in Poland, the quality of water in rivers in which waste is dumped is still unsatisfactory. More than 40% of river waters are classified to quality class IV. The quality of water in lakes, which is affected mainly by the agriculture, is similarly bad.

Poland is a country of relatively high natural and landscape diversity. As compared to the rest of Europe, especially valuable landscape components are dense, large forest complexes and valleys of large rivers, whose natural character has been preserved. Factors that contribute to the preservation of animate natural resources are extensive agriculture, which has been preserved on large areas as well as non-uniform degree of urban and industrial development.

2.6. Special circumstances for fulfilling obligations by the Republic of 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[9)]. 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.

Additional information required in line with Art. 7.2 of the Kyoto Protocol was presented in various chapters of the Communication; a detailed list can be found in Annex 2.

9) A detailed justification why Poland adopted 1988 as the base year can be found in the 1st National Communication for the Conference of the Parties of the Convention (1994).

3. INFORMATION ON GREENHOUSE GAS INVENTORY AND REMOVALS

3.1 Information on GHG inventory

Preparation of the national inventory of greenhouse gas and other air pollutions emissions and removals for the needs of the United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Long-Range Transboundary Air Pollution (CLRTAP) is the responsibility of the National Emission Centre (KCIE) established in 2000 at the Institute for Environmental Protection in Warsaw. Since 2006, KCIE has been performing its tasks within the confines of the National Administrator of the Emissions Trading Scheme, established also at the Institute for Environmental Protection.

Inventory of greenhouse gases and their precursors is compiled in cooperation with individual experts and institutions, including, first of all: the Central Statistical Office (GUS), Energy Market Agency (ARE SA), Institute for Ecology of Industrial Areas (IETU), Motor Transport Institute (ITS) and Office for Forest Planning and Management (BULiGL).

Greenhouse gas emission and removals inventory is prepared on the basis of the Intergovernmental Panel on Climate Change (IPCC) following guidelines:

– *Good Practice Guidance and Uncertainty Management in National GHG Inventories*. IPCC 2000,
– *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*. IPCC 1997,
– *Good Practice Guidance for Land Use, Land use Change and Forestry*. IPCC 2003.

As regards emission sources for which there are no emission factors in the guidelines from 2000 and 1997, data available in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* were used. For the majority of main emission sectors, national emission factors and inventory methodology at a higher detail level have been established. In the 2005–2007 inventory, data from national installations subject to the European Union Greenhouse Gas Emission Trading System (EU ETS) were taken into account.

The most important features of the inventory preparation process can be described as follows:

– data on emission sources activities come mainly from official statistical publications of the Central Statistical Office; if there are no such data, findings of expert studies or assessments ordered by the Ministry of the Environment are used.
– emission factors for the main emission categories are mostly adopted on the basis of national research; default IPCC data are used if there is a large uncertainty as regards own emission factors or if the share of a given source in the national emission is small;
– all data on activities, emission factors and findings are stored in the KCIE database, which is constantly expanded in order to meet the ever-increasing requirements concerning emission data reporting for the needs of both the UNFCCC and CLRTAP conventions and their protocols.

Detailed results of the GHGs emission and CO_2 removal inventory are published every year in the current CRF format (Common Reporting Format) and described in the NIR (National Inventory Report). These reports are subject to periodic reviews carried out by a team of international experts appointed by the UNFCCC Secretariat. The last inventory review took place on 7–12 September 2009 and included the Polish inventory data for the year 2007. In the inventory results presented below, experts' recommendations resulting from reviews carried out earlier were taken into account and an emission recalculation was accomplished for some sectors, which caused in a change of emissions for the 1988–2007 series, in order to preserve their consistency.

Poland has adopted 1988 as the base year for commitments resulting from the UNFCCC convention and its Kyoto Protocol as regards emissions of three basic gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) and within the obligations of the Kyoto Protocol, 1995 as the base year for industrial gases: HFCs, PFCs and sulphur hexafluoride (SF_6).

3.2. 2007 inventory results and emission trends

In 2007, aggregated emission of all the assessed GHGs amounted to 398,905 Gg of CO_2 equivalent (excluding Sector 5. Land use, land use change and forestry). However, GHGs emissions and carbon dioxide removal in sector 5 was negative and amounted to -40497 Gg of CO_2 equivalent, of which CO_2 removal (mainly by forest lands) was estimated as -54,399 Gg CO_2 and greenhouse gases emission was estimated as 13,902 Gg of CO_2 equivalent.

Economic sectors (according to IPCC classification) responsible for the majority of GHGs emissions (expressed as CO_2 equivalent) in Poland in 2007 are as follows:

1.A. Fuels combustion – 77%, of which:
- **1.A.1.** Power industries – 45.8%
- **1.A.2.** Manufacturing and construction industry – 8.8%
- **1.A.3.** Transport – 9.7%
- **1.A.4.** Other sectors – 12.7%

4. Agriculture – 8.8%

2. Industrial processes – 8.3%

6. Waste – 2.2%

In 2007, in the total greenhouse gases emission, carbon dioxide predominated, whose share in emission total amounted to 82.3%, methane constituted 9.3% of the aggregate greenhouse gases emission and nitrous oxide: 7.5%. Industrial gases accounted for 0.9% of the aggregate greenhouse gases emission. The aggregate emission shares presented above and shares of individual gases described below were given without taking into account the GHGs balance in sector 5. Land use, land use change and forestry.

According to inventory results, in the years 1988–2007, greenhouse gases emission decreased by 29.3%; emission decrease amounted to, respectively: (as regards) carbon dioxide – 30.1%, methane – 31.5% and nitrous oxide – 26.1%. A particularly visible decrease in emission of greenhouse gases can be seen in the years 1988–1990, which was caused by significant changes in the Polish economy, especially in the heavy industry. It was a result of political transformations and change from centrally-planned economy to free-market economy. Emission decrease lasted until 1993 and then emission values started to increase, reaching the local maximum in 1996, which was caused, among others, by modernisation of the heavy industry as well as the dynamic economic growth. The following years were characterised by a slow emission decrease lasting until 2002, accompanied by programmes and activities aimed at efficient energy use. After 2002, a slight emission increase took place, lasting until 2007, stimulated by the speeded up economic growth (Table 3.1). Detailed results of GHGs emission and removals inventory for the years 1988–2007, according to IPCC sectors were presented in Annex 1.

Carbon dioxide. In 2007, the basic source of carbon dioxide was fuel combustion in Sector 1. Energy, constituting 92.3% of emissions, including: energy industries: 55.5%, manufacturing industries and construction: 10.6%, transport: 11.6%, other sectors: 14.6%. Industrial processes account for 7.4% of CO_2 emissions; sector 2 (Fig. 3.1). However, CO_2 emission and removal balance in Sector 5. Land use, land use changes and forestry was negative and amounted to: -42885 Gg CO_2.

In the years 1988–2007, carbon dioxide emission decreased by as much as 30.1% (including carbon dioxide removal: by 34.7%). The highest decrease, exceeding 20%, took place in the years 1988–1990. However, in the years 2002–2007 CO_2 emission increased by 7.4% along with stimulation of economic growth, resulting in an increase of energy demand.

Methane. The most important source of methane is sector 1. Energy, whose share in total CH_4 emission in 2007 was 43.5%. Here, the largest contribution came from fugitive emissions resulting mainly in extraction of hard coal (ca. 23% of the national total). From sector 4. Agriculture come 35% of the total methane emission; the dominating subsector here was the enteric fermentation, 25.1% of emission total. The third important emission source is waste, constituting ca. 20.3% of CH_4 emission. The highest share in this sector has solid waste disposal on land, ca. 17.5% of emission total (Fig. 3.2).

Methane emission in 2007 was lower by 31.5% as compared to 1988. A significant emission decrease occurred in sectors: 1. Energy – by 39.9% and 4. Agriculture – o 32.2%. In the first of the sectors, it resulted from the decrease of fugitive emission from hard coal mines (53.9%) as a result of restructuring of the mining industry and coal extraction decrease. However, emissions in agriculture decreased, following a systematic decrease of livestock population, resulting in decreasing emissions from enteric fermentation, by 40.8%.

Nitrous oxide. The largest source category of nitrous oxide was agriculture, which constituted 74.7% of the national total; emission from agricultural soils constitutes 53.2% and emission from animal manure management: ca. 20% of the total. Another important source of emissions are industrial processes (16%), in which chemical industry predominates. The remaining two sectors: 1. Energy and 6. Waste (waste management) – constitute 6.4% and 3.7% of emission total, respectively (Fig. 3.3).

In 2007, total nitrous oxide emission was lower by 26.1% than that in 1988. The highest reduction was noted in agricul-

Table 3.1. Changes in carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) emissions in 1988–2007 expressed in carbon dioxide equivalent [Gg CO_2 eq.]

Greenhouse gases	Years									
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
CO_2 including sector 5	436 669.74	411 866.24	343 541.84	336 788.16	329 218.48	342 204.56	337 862.55	343 259.51	350 895.95	343 289.11
CO_2 excluding sector 5	469 604.46	447 358.34	368 728.98	368 208.64	359 633.22	366 078.93	361 582.72	366 185.88	375 228.11	369 176.40
CH_4 including sector 5	54 143.10	53 113.54	49 870.69	48 295.03	46 097.90	45 854.85	46 004.37	45 847.60	45 326.43	45 512.05
CH_4 excluding sector 5	54 135.62	53 109.66	47 715.24	46 133.78	43 911.90	43 673.15	43 812.15	43 649.19	43 117.11	43 280.56
N_2O including sector 5	40 665.57	42 083.39	37 876.70	32 430.34	30 203.78	29 881.37	30 018.12	30 824.76	30 221.85	30 415.17
N_2O excluding sector 5	40 664.81	42 083.00	37 869.65	32 424.21	30 194.28	29 875.64	30 012.77	30 820.24	30 216.94	30 411.45
HFCs	–	–	–	–	–	–	–	15.72	37.67	114.56
PFCs	–	–	–	–	–	–	–	252.24	235.68	248.92
SF_6	–	–	–	–	–	–	–	30.53	24.93	24.02
Total (including sector 5)	**531 478.41**	**507 063.17**	**431 289.23**	**417 513.53**	**405 520.16**	**417 940.78**	**413 885.03**	**420 230.35**	**426 742.52**	**419 603.82**
Total (excluding sector 5)	**564 404.89**	**542 551.00**	**454 313.88**	**446 766.63**	**433 739.40**	**439 627.72**	**435 407.64**	**440 953.79**	**448 860.44**	**443 255.91**
Greenhouse gases	**Years**									
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
CO_2 including sector 5	315 437.52	302 785.36	294 090.92	291 029.51	273 628.21	283 831.81	280 860.94	280 490.89	286 716.67	285 287.30
CO_2 excluding sector 5	341 255.10	329 445.66	320 588.24	317 216.50	305 692.58	317 003.44	317 296.81	318 215.84	329 599.11	328 172.10
CH_4 including sector 5	44 582.96	44 191.29	41 261.39	39 885.21	39 107.27	39 567.48	39 171.00	39 411.28	39 604.66	39 450.99
CH_4 excluding sector 5	42 360.78	41 952.25	39 003.81	37 608.87	36 823.22	37 247.75	36 838.83	37 062.73	37 229.82	37 065.69
N_2O including sector 5	30 018.30	29 070.04	28 891.98	29 007.16	27 515.30	27 659.78	27 699.12	28 255.27	29 474.60	30 034.50
N_2O excluding sector 5	30 015.29	29 067.05	28 889.12	29 004.67	27 512.62	27 655.30	27 696.58	28 252.48	29 471.79	30 032.08
HFCs	172.01	217.52	603.40	1 018.17	1 486.04	1 912.03	2 146.66	3 018.32	2 844.22	3 327.01
PFCs	251.26	239.74	248.87	269.93	286.59	278.39	285.08	259.95	269.75	276.65
SF_6	25.08	24.64	24.18	23.96	24.42	21.72	23.43	28.09	30.02	31.92
Total (including sector 5)	**390 487.13**	**376 528.58**	**365 120.74**	**361 233.95**	**342 047.83**	**353 271.21**	**350 186.24**	**351 463.81**	**358 939.92**	**358 408.37**
Total (excluding sector 5)	**414 079.52**	**400 946.86**	**389 357.63**	**385 142.10**	**371 825.47**	**384 118.63**	**384 287.40**	**386 837.42**	**399 444.72**	**398 905.45**

Source: GUS.

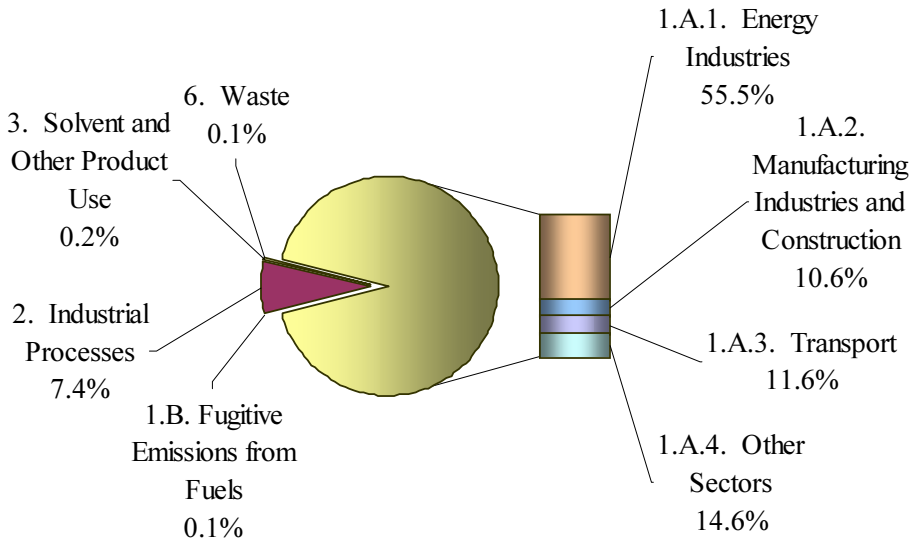

Figure 3.1. Carbon dioxide emissions share in 2007, source: GUS

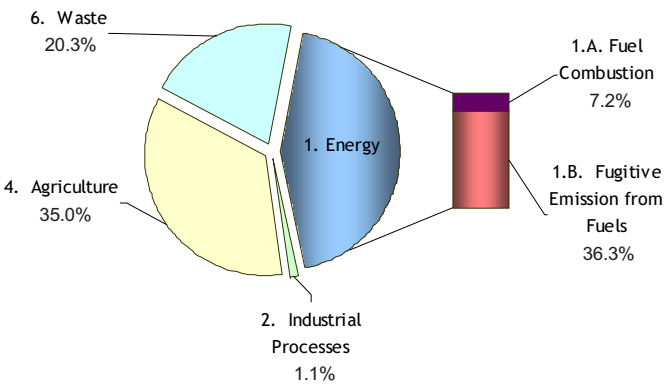

Figure 3.2. Methane emissions share in 2007, source: GUS

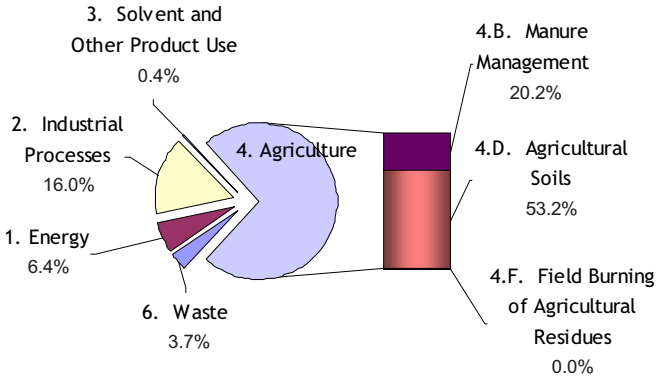

Figure 3.3. Nitrous oxide emissions share in 2007, source: GUS

ture, by 31.2% in the period 1988–2007, which was caused mainly by a decrease in livestock population and use of mineral fertilisers. However, since 2003, N_2O emission in agriculture has increased by ca. 9%, mostly due to the ever-increasing use of nitrogen fertilisers.

Industrial gases. Within the period from the base year (1995) to 2007, there was an increase in industrial gases emission, from almost 300 Gg to 3636 Gg of CO_2 equivalent, these changes were very different in individual gas groups. There is a clear increasing emission trend of hydrofluorocarbons (HFCs). HFC emissions grew from 15.7 Gg to 3,327 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. Emissions of perfluorocarbons (PFCs) changed by ca. 10% in the years 1995–2004, following the trend of aluminium production – the main source of PFC emissions. PFC emissions increase was also caused by increased use of perfluorobuthane (C_4F_{10}) in production of fire extinguishers. The increase of sulphur hexafluoride (SF_6) emissions by 4.6% was caused by the increased emissions of that gas from electrical appliances.

Uncertainty evaluation of GHG emission data. Uncertainty analysis of GHG emission estimates was carried out in accordance with the guidelines *Good Practice Guidance* (IPCC 2000) using the Tier 1 method. During the analysis, recommendations of experts reviewing the GHGs inventory in Poland in 2005–2008 were taken into account.

The uncertainty analysis for the year 2007 brought the following total uncertainties for individual greenhouse gases:

CO_2 – 3.7%	CH_4 – 24.2%	N_2O – 48.2%
HFC – 44.7%	PFC – 20.0%	SF_6 – 100.0%

Analysing the results obtained one may say that they correspond to results obtained abroad, where CO_2 emission uncertainties range from 0.2 to 10%, CH_4 emission: from 5 to 50% and N_2O emissions: from 5 to 300%.

The relatively low uncertainty values for total CO_2 emissions (3.7%) are caused by the fact that most of CO_2 emissions are generated in sector 1.A in which activity data are relatively precise (1–4%) as well as CO_2 emission factors (1–3%). Higher uncertainty estimate for CH_4 (24.2%) is due to the fact that significant parts of CH_4 emissions come from agriculture, 4.A and 4.B, where emission factors are quite uncertain (ca. 50%). Like in other countries, large uncertainty of total emissions was estimated in case of N_2O (48.2%). The main cause is the large uncertainty of the respective emission factors in dominating source categories including animal manure management, 4.B.11 and 4.B.12 (150%).

Large uncertainties of emission factors are caused by, among others, 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 the highest.

Key sources in greenhouse gases emissions. In the emission level assessment, 16 sources were classified as the key sources of GHGs emissions in 2007. The most important of them are: stationary fuel combustion plants (solid, liquid and gas fuels) and road transport. Emission of CO_2 from these sources amounted to 75% of the total emission of GHGs in Poland, expressed in CO_2 equivalent, whereas emissions from combustion of solid fuels in stationary sources only amounted to 55.6% of the total emission of GHGs in Poland (Table 3.2).

Table 3.2. GHGs emission level assessment in 2007

Source categories according to IPCC	Greenhouse gas	Emission in 2007	Share in total emission	Accumulated share in total emission
1.A.1. 2. 4. Solid fuel combustion – stationary sources	CO_2	221 721.91	0.5558	0.56
1.A.3.b. Road transport	CO_2	36 274.54	0.0909	0.65
1.A.1. 2. 4. Gas fuel combustion – stationary sources	CO_2	23 435.44	0.0587	0.71
1.A.1. 2. 4. Liquid fuel combustion – stationary sources	CO_2	19 256.02	0.0483	0.75
4.D.1. Direct emission from soils	N_2O	11 015.12	0.0276	0.78
4.A. Enteric fermentation	CH_4	9305.67	0.0233	0.80
1.B.1 a. Hard coal mining	CH_4	8518.41	0.0214	0.83
2.C.1. Iron and steel production	CO_2	8341.75	0.0209	0.85
2.A.1. Cement production	CO_2	7050.41	0.0177	0.86
6.A. Solid waste storage	CH_4	6471.52	0.0162	0.88
4.B. Animal manure	N_2O	6077.80	0.0152	0.90
1.B.2.b. Natural gas	CH_4	4782.73	0.0120	0.91
4.D.3. Indirect emission from soils	N_2O	4559.39	0.0114	0.92
2.B.2. Nitric acid production	N_2O	4552.69	0.0114	0.93
2.B.1. Ammonia production	CO_2	4208.63	0.0106	0.94
4.B. Animal manure	CH_4	3649.41	0.0091	0.95

Source: GUS.

4. POLICIES AND MEASURES

4.1. Introduction

This chapter is an update of the information given in the Fourth National Communication, as the majority of climate protection-related enterprises mentioned in that Report is still valid.

The key governmental document formulating the national environmental policy is the *National Environmental Policy for 2009–2012 and its 2016 outlook*, approved by the Parliament (Sejm) on 22 May 2009. That document contains the objectives, priorities, challenges and tasks as well as major priorities of the ecological policies of the Republic of Poland, also including climate protection in the next 4–8 years.

4.2. Instruments

In the ecological policy for the years 2009–2012, further development of activities taken so far is planned, including, among others:

– use of the "green procurement" system in public procurement procedures organised by all institutions using public resources;
– elimination of products that are harmful to the environment from the market;
– promotion of creation of the so-called "green work places" with the use of EU funds;
– promotion of transfer of the latest technologies for environmental protection to Poland through financing of projects within the confines of EU programmes;
– conducting a country-wide social campaign forming sustainable consumption patterns;
– supporting the use of low-emission and high energy efficiency vehicles with alternative driving systems and preparation of solutions that would hamper the import of foreign vehicles with unfavourable ecological and energy parameters.

Instruments supporting the implementation of the mentioned activities as regards climate protection include, among others:

– system of carbon dioxide emission allowance trading;
– emission standards for installations – permissible emission levels;
– an obligation to measure emissions of pollutants;
– environmental quality standards (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 in order to meet the parameters of permissible substances levels in the air;
– air quality assessment system;
– 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 management systems – voluntary commitments of organisations (manufacturing enterprises and service companies, financial, educational, health protection institutions, public administration bodies, etc.) to take measures aimed at systematic reduction of environmental impact connected with the type of activity involved;
– fees for release of gases or dusts (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 electricity produced from renewable energy sources);
– certificates of origin for agricultural biogas introduced into the distribution network; that mechanism has been introduced by an amendment to the Energy Law Act.

4.3. Major legislative acts and strategic documents

From the point of view of climate protection activities, of importance are legal acts compliant with European Union legal system, as well as other strategic documents approved by the Council of Ministers and Parliament of the Republic of Poland. Table 4.1 contains selected legal acts and strategic documents that came into force after 2004.

Table 4.1. Selected legal acts and strategic documents that came into force after 2004

No	Title of document	Information
	I. MULTI-SECTORAL ISSUES	
1	**National Environmental Policy for 2009–2012 and its 2016 outlook.** Resolution of the Parliament of the Republic of Poland of 22 May 2009 (M.P. Issue 34, item 501).	The document specifies objectives, priorities, challenges and tasks for the years 2009–2012 considering perspectives until 2016 as regards all natural components. The document takes into account, to a broader extent, issues mentioned in the Climate Convention and Kyoto Protocol, which results from the fact that climate protection has gained importance not only for environmental protection, but also for economic and social activities. For the purpose of ecological policies implementation, environmental protection programmes are prepared.
2	**Poland 2025 – Long-term Strategy for Sustainable Development** approved 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 fulfilment of commitments of the Kyoto Protocol.
3	**Act of 27 April 2001** – Environmental Protection Law (Dz.U. Of 2008, Issue 25, item 150, as amended).	The Act contains regulations concerning air protection so as to ensure possibly the best air quality.
4	**Poland's Climate Policy. Strategies for greenhouse gas emissions reduction in Poland until 2020.**	The document specifies the state climate policy, specifies the basic objectives, priorities and tasks concerning economic sectors that are responsible for the majority of the national GHGs emissions.
5	**Act of 20 April 2004 on substances that deplete the ozone layer** (Dz.U. Issue 121 item 1263).	The Act sets out mainly the provisions for using and marketing ozone depleting substances and products, equipment and installations containing these substances.
6	**Act of 20 July 1991 on the Inspection for Environmental Protection** (Dz.U. Of 2007, Issue 44, item 287 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).
7	**Act of 27 March 2003 on spatial planning and management** (Dz.U. Issue 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.
8	**Act of 22 December 2004 on emission allowance trading of greenhouse gases and other substances** (Dz.U. of 2004, Issue 281, item 2784 and of 2008, Issue 199, item 1227). **Act of 17 July 2009 on greenhouse gases and other substances emission management system** (Dz.U. Issue 130, item 1070).	Flexibility mechanism, i.e. the emission allowance trading system, according to Directive 2003/87/WE establishing the greenhouse gases allowance trading in the European Community and amending Directive of the Council 96/61/WE has been transposed to Polish law by way of the Act of 22nd December, 2004 on emission allowance trading of greenhouse gases and other substances. The Act specifies: responsibilities of the National Centre for Emissions Balancing and Management, principles of operation of the national emission balancing and forecasting system, principles of management of emissions of greenhouse gases and other substances, principles of operation of the national Kyoto units register, principles of Kyoto units trading and management, principles of operation of the national system of green investments and Climate Account, conditions and principles of implementation of joint implementations projects within the territory of Poland, conditions and principles of implementation (outside the territory of Poland) of: a) Joint Implementations projects, b) Clean Development Mechanism projects.
9	**State Development Strategy for 2007–2015**. Document approved by the Council of Ministers on 27 June 2006.	State Development Strategy for the years 2007–2015 is the overriding social and economic plan, which takes into account development strategy: regional strategies, major sector strategies (agriculture, power industry, housing, transport) and horizontal strategies (education, innovation).
10	**Water Management Strategy**, elaborated by the Minister of the Environment. Document approved by the Council of Ministers on 13 September 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, protection of water resources in soils, building and modernising flood control facilities.
11	**Strategy for changing the production and consumption patterns to those favouring implementation of the principles of sustainable development**. Document approved 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".

12	**National Strategy for biodiversity preservation and reasonable use with an action programme**. Document approved by the Council of Ministers on 25 February 2003.	The ultimate goal of the Strategy is to preserve all natural environmental values and ensure sustainability in the development at all organizational levels. 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	
13	**Act of 10 April 1997 – Energy Law** (Dz.U. of 2006, Issue 89, item 625 as amended).	The Act lays down the principles for energy management and saving energy resources, as well as supports the use of renewable energy sources, an important role is played by the so-called "green certificates". Of great significance is the requirement to develop consistent development plans for enterprises and communes, which must include, among others, undertakings related to the use of renewable energy sources. It also establishes "Red certificates" – certificates of origin of CHP*.
14	**Energy Policy of Poland until 2025,** approved by the Council of Ministers on 4 January 2005. **Energy Policy of Poland until 2030** approved on 22 October 2009 by the Committee of the Council of Ministers.	The document specifies actions aimed at ensuring energy safety, competitiveness of the economic system, its energy efficiency and environmental protection. Energy policy is based on: harmonious energy management in conditions of social market economy, full integration of the Polish power industry with the European and global power industry and according to the principle of competitive market, support of renewable energy sources. It also formulates priorities and tasks such as: monitoring of the energy safety level, reduction of costs of operation of the power industry and improvement of energy efficiency as well as strengthening of the self-government position in relation to power companies. The main directions of the Polish energy policy contained in the document are as follows: enhancing the energy efficiency, increasing security of fuel and energy supplies, diversification of structure of electricity generation by introducing nuclear power, development of renewable energy sources use, including biofuels, development of competitive fuel and energy markets, limiting the impact of the energy sector on the environment. While implementing measures in line with those directions energy policy shall strive to increase the national energy security in line with preserving sustainable development principles.
15	**Strategy for renewable energy development approved by the Council of Ministers on 5 October 2000 and by the Parliament on 23 August 2001. Regulation of the Minister of Economy on detailed scope of duties concerning obtaining and submitting certificates of origin for cancellation, payment of replacement fee, purchase of electrical energy and heat generated from renewable energy sources and obligation to confirm data concerning the amount of electrical energy generated by a renewable energy source.**	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.
16	**Act of 25 August 2006 on biocomponents anf liquid biofuels** (Dz.U. Issue169, item 1199 as amended).	• Making it possible for farmers to produce liquid biofuels for their own use; the fuels should meet only minimum quality requirements that are important from the point of view of environmental protection (annual limit of permissible production for own use is 110 l/h of cultivated land area owned by the farmer). • On 1st January, 2008, an obligation to ensure certain share of biocomponents in the transport fuels market was introduced. It was imposed on entrepreneurs performing economic activity as regards production, import and intra-community purchase of liquid fuels or biofuels, who sell them or use for their own needs. • Introduction of solutions permitting generation of financial resources for support of production of biocomponents and liquid biofuels (income from fines awarded on the basis of that Act is the income of the National Fund for Environmental Protection and Water Management, the sole purpose of which is to support activities connected with production of biocomponents and liquid biofuels).
17	**Act of 25 August 2006 on fuel quality monitoring and control system** (Dz.U. Issue 169, item 1200, as amended).	The Act came into force on 1st January, 2007 and makes it possible to use biofuels of increased share of biocomponents in vehicles and machinery (group of at least 10 vehicles).
18	**Regulation of the Council of Ministers of 15 June 2007 on National Index Targets for 2008–2013 (NCW)** (Dz.U. of 2007, Issue 110, item 757).	The regulation specifies the minimum amount of biocomponents and other renewable fuels in the total amount of liquid fuels and biofuels consumed in a calendar year.
19	**Regulation of the Minister of Economy of 22 January 2009 on quality requirements for liquid biofuels (**Dz.U. of 2009, Issue 18, item 98).	The regulation specifies requirements for methyl ester, diesel oil and engine petroleums.

* High-efficiency cogeneration is joint generation of electrical or mechanical energy and useful heat, which ensures primary energy saving.

20	**Act of 6 December 2008 on excise duty** (Dz.U. of 2009, Issue 3, item 11, as amended).	The Act specifies excise duty fees for engine petroleum and diesel oil and application of the decreased excise duty fee for biocomponents.
21	**Long-term programme of promotion of biofuels or other renewable fuels for the years 2008–2014,** approved on 24 July 2007 by the Council of Ministers.	The programme is execution of Art. 37 of the Act on biocomponents and liquid biofuels, the purpose of which is to create conditions that would make it profitable to produce and use biofuels in Poland. The programme covers, first of all, two types of actions: actions concerning support for production of liquid biocomponents and biofuels and actions aimed at stimulating demand in this regard.
22	**Regulation of the Council of Ministers of 14 October, 2008 on environmental fees** (Dz.U. Issue 196, item 1217).	The regulation takes in to account a discount for use of the environment due to combustion of fuels containing biocomponents.
23	**Act of 21 November, 2008 on supporting thermo-modernisation and repairs** (Dz.U. Issue 223, item 1459).	The Act introduces simpler methods of granting assistance from the state budget resources. Like before, the assistance may be used by real estate owners and managers (except budget companies and entities) and natural persons. In line with the new Act, BGK will also grant repair and compensation bonus. Maximum amount of thermo-modernisation bonus will not exceed 16% of the total investment expenditures. Repair bonus will be granted for repayment of part of credit taken for this purpose in the amount of 20% of the used credit amount, not exceeding 15% of the repair enterprise. Compensation bonus if a form of specific compensation for owners of residential buildings with the so-called quartering premises. Credits for the execution of therm-omodernisation and repair enterprises are granted by 15 banks that signed a cooperation agreement with BGK.
24	**Act of 7 July, 1994 – Building Law** (Dz.U. of 2006, Issue 156, item 1118 as amended).	Through an alteration and change of executive regulations to it, a building energy assessment system has been introduced, which follows from the regulations of Directive 2002/91/WE of the European Parliament and Council on energy characteristics of buildings. It includes: – obligation to carry out energy assessment of buildings in the form of a building energy characteristics certificate on the basis of a uniform methodology of energy charactristics assessment, – obligation to regularly carry out inspections of non-renewable fuel powered boilers and cooling devices in air conditioning systems, – introduction of minimum requirements concerning energy characteristics of new buildings and large existing buildings, subject to earlier renovation, – introduction of minimum requirements concerning energy characteristics of large existing buildings, subject to earlier renovation, – recommendations concerning consideration of profitability of use, in newly erected buildings of usable area exceeding 1,000 m^2, of the most energy efficient alternative systems (energy supply systems based on renewable sources, CHP generation, heat pumps). The purpose of the regulations introduced is promoting improvement of building energy standard through limiting the demand for energy connected with heating, ventilation, preparation of warm water and lighting, as well as creation of social awareness as regards energy consumption rationalisation. These actions will result in a decrease of the global energy consumption and decrease of the level of emission of greenhouse gases.
25	**Regulation of the Minister of Infrastructure of 12 April 2002 on technical conditions that should be met by buildings and their location** (Dz. U. Issue 75, item 690 as amended).	In the regulation on technical conditions that should be met by buildings and their location, introduced were: 1) more strict conditions of energy consumption rationalisation policy in the construction resources sector with simultaneous ensuring appropriate quality of internal environment, 2) creation of building energy assessment conditions through introduction of a reference building model as the building that meets the requirements of technical and building regulations, 3) ensuring appropriate quality of certificates of building energy characteristics and possibility to verify them if necessary.
26	**Regulation of the Minister of Infrastructure of 3 July, 2003 on detailed scope and form of building design** (Dz. U. Issue 120, item 1133 as amended).	Changes to the regulation on detailed scope and form of building design ensures implementation of the requirement contained in Art. 5 of Directive 2002/91/WE of the European Parlament and Council of 16th December, 2002 on building energy characteristics, as regards the obligation of analysis of the possibility to use alternative energy sources for the needs of heating or cooling or preparation of warm tap water, in case of newly-erected buildings whose area exceeds 1,000 m^2 within the confines of design work and prepares for building energy assessment.
	III. INDUSTRY	
27	See item 9. **Regulation of the Minister of Infrastructure of 6 November 2008 amending the regulation on technical conditions that should be met by buildings and their location** (Dz.U. Issue 201, item 1238).	Sectoral strategies are incorporated in the State Development Strategy for the years 2007–2015.

IV. TRANSPORT		
28	**State transport policy for the years 2006–2025 (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. State transport policy for the years 2006–2025, mentioned in the Communication, is in the implementation phase. The main goals of the policy are implemented, among others, through the Infrastructure and Environment Operational Programme (POiŚ), which was approved by the Polish Government in 2008.
29	**National road construction programme for the years 2008–2012.**	Poland is implementing programmes for development of road and railroad infrastructure. The programme is taken into account in the new perspective, i.e. 2008–2011 of the National Reforms Programme for the years 2008–2011 in order to implement the Lisbon Strategy, which is listed as one of the basic legal regulations and strategic documents mentioned in the Communication. The road programme is treated as medium-term financial plan that constitutes financial framework for the planned investments.
V. AGRICULTURE		
30	**Act of 3 February 1995 on protection of agricultural and forest lands** (Dz.U. of 2004, Issue 121, item 1266 asamended).	The Act regulates the principles of protection of agricultural and forest lands, reclamation and improvement of land use value. It specifies permissible transformations of forest areas for non-forest purposes.
31	**Rural Development Programme for the years 2007–2013.**	The Programme sets out objectives, priorities and principles for supporting sustainable development in the rural areas.
32	**Rural Development Plan for the years 2004–2006.**	Within the confines of which activities aimed at sustainable development of rural areas in those years were supported.
VI. FORESTRY		
33	**Act of 28 September 1991 on forests** (Dz.U. of 2005, Issue 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.
34	**"State forest policy", hereinafter referred to as "PLP", approved by the Council of Ministers in 1997**, specified nine basic priorities which should be successively implemented. In their basic scope, they meet the objectives and principles specified in Art. 7 and 8 of the Act on forests.	In the initial years of PLP implementation, one of the tasks was development or alteration of the existing principles and guidelines concerning forest management. For that purpose, the following were developed and introduced into the forest management practice: Forest cultivation principles (2002), Forest protection manual (2004), Forest habitats marking and mapping manual (2003) and Forest organisation manual (2003). In 2005, Large-area forest inventory preparation manual was approved.
35	**National Programme for the Augmentation of Forest Cover (KPZL),** approved 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.
36	**Act of 16 April 2004 on natural protection** (Dz.U. of 2009, Issue 151, item 1220 as amended).	The act corrects and expands the regulations setting out the scope of protection plan, which was necessary for the effective Natura 2000 areas protection. Preparation of the protection plan and protective actions plan for the Natura 2000 area and its subsequent implementation will a manner of meeting the obligation resulting from Art. 6(1) of the Habitat Directive and Art. 4 of the Bird Directive and implementation of the directive goal in an appropriate scope – maintenance or restoration of the proper condition of protection of protection subjects in the Natura 2000 network. An important purpose of amendment of the Act of 16th April, 2004 on environmental protection (that was made in 2008) was improvement of principles of protection planning for the Natura 2000 areas in a way that would make it faster and more flexible to implement planning procedures. Protection activities plan will be developed for the Natura 2000 areas for the period of 10 years.
37	**Act of 3 October 2008 on making available information on the environment and its protection, social participation in environmental protection and on environmental impact assessments** (Dz.U. Issue 199, item 1227 as amended).	The act regulates principles and modalities during making available information on the environment and its protection, environmental impact assessments and principles of social participation in environmental protection. It also establishes the General Directorate for Environmental Protection, the purpose of which will be to make the environment management process more efficient. The act introduces a provision according to which enterprises that may significantly or potentially significantly affect the environment and the Natura 2000 areas will require carrying out an assessment within the confines of which specified were: environment, health and living conditions of the people, property, historical monuments, availability of minerals, methods of prevention and limitation of environmental impact of planned investments as well as the scope of monitoring of the enterprise. The act also applies to forestry, in particular the basic forest document, i.e. the forest organisation plan, which may be treated as one of the strategic documents. Forest organisation plans, the scope of which includes the Natura 2000 areas are subject to environmental impact assessment through preparation of a Natura 2000 area impact forecast.

	VII. WASTE	
38	**National Waste Management Plan 2010** approved by the Council of Ministers on 29th December, 2006.	The plan covers the full range of tasks necessary for ensuring integrated waste management in Poland in a manner that would ensure environmental protection, taking into account the present and future possibilities and economic conditions and technological level of the existing infrastructure. The waste management plan applies both to waste generated in Poland, in particular municipal waste, dangerous waste, packaging waste, municipal sewage sludge and waste shipped to Poland. The goals and tasks described in the plan apply to the period 2007–2010 and, in perspective, 2011–2018.
39	**Act of 27 April 2001 on waste** (Dz.U. of 2007, Issue 39, item 251, 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.
40	**Act of 11 May, 2001 on packaging and packaging waste** (Dz.U. Issue 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.
41	**Act of 20 January, 2005 on recycling of vehicles withdrawn from use** (Dz.U. Issue 25, item 202, as amended).	The Act lays down the principles of handling vehicles withdrawn from use in a manner that would ensure protection of health and safety of personnel as well as environmental protection in accordance with the principle of sustainable development and applies to vehicles manufactured in Poland, imported to Poland (import from a non-EU member state) or intra-community purchase (import from an EU-member state other than Poland) and waste generated from vehicles.
42	**Act of 29 July 2005 on used electrical and electronic equipment** (Dz.U. Issue 180, item 1495 as amended).	The main purpose of the Act is to create a used electrical and electronic equipment management system through limiting the amount and negative influence of waste in the form of used electrical and electronic equipment on the environment through the obligation of selective collection and recycling of waste.
43	**Act of 24 April 2009 on batteries** (Dz.U. Issue 79, item 666).	The Act specifies requirements for products in the form of batteries, waste generated from that products as well as equipment which is partially or wholly powered by batteries or can be battery-powered.
44	**Act of 10 July 2008 on mining waste** (Dz.U. Issue 138, item 865).	The purpose of the Act is to prevent generation of mining waste in the mining industry and limit their negative impact on the environment and health and safety of people.

Source: Ministry of the Environment.

4.4. Domestic policy and measures

4.4.1. National reduction targets

The national GHG emission reduction target pursuant to Annex B to the Kyoto Protocol (6% in relation to 1988) remains unchanged and is going to be achieved in Poland. Poland is also obligated to fulfil the obligation of reducing greenhouse gas emission adopted within the European activity packet related to energy and climate.

4.4.2. Complex measures aimed at reduction of greenhouse gas emission

Complex measures for greenhouse gas emission reduction comprise the following:

The European Union Emission Trading System – CO_2 emission allowances are allocated to enterprises covered by the system for a settlement period that includes a few years (the first period comprised the years 2005–2007, and the subsequent one the years 2008–2012) and denote a certain type of permissible emission threshold in the scale of the entire system. The emission trading system encompasses the following sectors of the economy: public power plants, public heat and power generation plants, public heating plants, refinery industry, coke industry, iron and steel industry, cement industry, lime industry, glass-making industry, ceramic industry, paper industry, sugar industry, chemical industry and the remaining industries.

Application of the Joint Implementation (JI) mechanism and the Green Investment Scheme (GIS). Requirements concerning projects of Joint Implementation and Clean Development Mechanism projects were defined in the Act of 17 July 2009 on the Management System of Greenhouse Gas Emission and Other Substances (Dz.U. No. 130, item 1070). The act defines:
- requirements and rules for Joint Implementation projects on the territory of the Republic of Poland;
- requirements and rules for Joint Implementation projects outside the territory of the Republic of Poland;
- requirements and rules for Clean Development Mechanism projects outside the territory of the Republic of Poland.

In the discussed act the **National Green Investment Scheme** was established, under which means obtained in the years 2009–2012 from the sale of allocated emission allowances are designated for co-financing projects on the territory of the Republic of Poland:
- programmes or projects related to environment protection, especially with limitation or avoidance of domestic greenhouse gas emission, capture or sequestration of carbon dioxide;
- adaptation measures to climate changes;
- other measures related to air protection.

The act on the management system of greenhouse gas emission or other substances regulates issues of joint implementation in Poland, providing the legal framework for approval and execution of projects. The act transposes regulations of the so-called linking directive (2004/101/EC), and introduces into the Polish law procedures and principles related to Joint Implementation projects, forming a legible framework to facilitate the execution of this type of projects.

Having met criteria (the so-called eligibility requirements) contained in paragraph 21 of the so-called JI guidelines (JI guidelines – Decision 9/CMP.1), Poland can execute Joint Implementation projects also under Track I, which allows approval of projects under national procedures, without the necessity of participation of the Joint Implementation Supervisory Committee (JISC) as is the case for Track II. Poland has adopted the procedure of approval of Joint Implementation projects under Track I, and notified the Secretariat of the Climate Convention of the fact on 5 September 2008.

Full information concerning estimated amount of anticipated and achieved emission reduction by the end of 2007 as a result of completion of 11 Joint Implementation projects, approved in Poland until the end of 2008, was presented in table 4.2.

4.4.3. Monitoring the emission and implementation of provisions of the Kyoto Protocol

Monitoring greenhouse gas emission is executed on an ongoing way and the obtained results are presented in National Inventory Reports. Implementing provisions of the *Kyoto Protocol* is subject to periodical analyses, and is presented in

Table 4.2. Amount of the greenhouse gas emission reduction achieved until the end of 2007 in 11 Joint Implementation (JI) projects approved by the end of 2008

Period	Amount of greenhouse gas emission reduction [Gg CO_2 equivalent]		
	Expected (according to PDD)	**Achieved** (according to KASHUE reports drawn by initiators, but excluding verification)	**Verified** (by Accredited Independent Entities)
Total until the end of 2007	746.458	406.287	350.047

Source: IOŚ.

National Communications to the Conference of the Parties. In Poland the implementation of policies and measures aimed at reducing greenhouse gas emission are not being monitored in a versatile way. It only includes measures in the financing of which public means were involved or those of the European Union.

4.4.4. Financial mechanisms supporting measures related to greenhouse gas emission reductions

The basic institutional and financial mechanism that supports the implementation of the climatic policy, especially with respect to improving the efficiency of energy use, development of renewable energy sources and modernisation of energy generation processes, is the system of financing measures in support of the environment based on Funds for Environment Protection and Water Management, EcoFund and European Funds. The general rule of financing projects allowing reduction of greenhouse gas emission comprises granting credits at low interest and granting subsidies to enterprises, self-government bodies and institutions of the budgetary sector.

The most frequently co-financed projects comprise the following:

- modernisation and construction of heating networks,
- modernisation of boiler plants,
- thermo-modernisation of public utility facilities,
- limiting low emissions,
- investments related to installations based on the use of renewable energy sources,
- energy savings in municipal heat supply systems (only under competitions for energy savings in heating systems),
- use of biomass for energy needs in the municipal and household sector and in industrial plants,
- technical use of biogas from the agricultural sector, from municipal waste landfills and from sewage treatment plants and waste gas from industrial processes,
- use of solar energy (photovoltaic panels and solar collectors under the subsidy system),
- use of shallow geothermic properties (heat pumps),
- promoting the technology of fuel cells,
- use of waste energy from industrial processes and from the combustion processes.

One of the most intense common reduction measures was thermo-modernisation, under which 9181 projects were implemented in the years 2004–2007, allowing a reduction in energy consumption by 7 889 022 GJ/year.

Sample values of CO_2 reduction achieved in two basic categories of measures co-financed by the EcoFund were presented in table 4.3. The total value of CO_2 emission reduction achieved in the years 2004–2007 through implementation of projects co-financed by the Environment Protection Fund system were given in table 4.4.

Table 4.3. Amount of CO_2 emission achieved in the years 2005–2009 through implementation of projects co-financed by EcoFund

Project category	Amount of CO_2 emission reduction [Mg/year]
Modernisation of the heating system	744 529.74
Renewable energy sources	449 764.23
Total	1 194 293.97

Source: EcoFund.

Table 4.4. Projects financed by the Environmental Protection Fund system

Years	Number of projects	Reduction of CO_2 emission [Mg/year]	Energy savings [GJ/year]
2004	1344	512 396.4	497 032.96
2005	1832	446 712.5	239 489.11
2006	756	653 476.9	614 577.52
2007	662	1 783 004.6	419 374.43
Total	4594	3 395 590.4	1 770 474.02

Source: Own study of KAPE S.A on the basis of annual reports and information obtained directly from the Funds.

4.5. Energy sector

The policy and measures defined in the Fourth National Communication are still being implemented. The effects of those measures have been presented in Annex 3.

4.5.1. The energy policy of Poland until 2030

Priority directions of Poland's measures with respect to the energy policy were presented in ***the Energy Policy of Poland until 2030*** (adopted on 22 October 2009 by the Committee of the Council of Ministers), developed by the Ministry of the Economy, they are as follows:

- improvement of energy efficiency,
- enhanced security of fuel and energy supplies,
- diversification of the electric energy generation structure by introducing nuclear power industry,
- development of the use of renewable energy sources, including biofuels,
- development of competitive fuel and energy markets,
- limiting the impact of the energy industry on the environment.

4.5.2. Implementation tools for the energy policy

The main tools for implementation of the energy policy comprise:

- legal regulations that define operating rules for the fuel and energy sector and that set up relevant technical standards,
- effective use of ownership supervision by the State Treasury, under the assigned competencies, to implement objectives of the energy policy,
- ongoing regulation measures of the President of the Energy Regulatory Office, which comprise verification and approval of tariffs and application of a benchmarking type analysis with respect to regulated energy markets,
- system support mechanisms for implementation of measures aimed at achievement of basic objectives of the energy policy, which at present are not commercially viable (e.g. the market of "certificates", tax reliefs and exemptions),
- ongoing monitoring of the current situation on the fuel and energy markets by the President of the Office of Consumer and Competition Protection and President of the Energy Regulatory Office, and taking up intervention measures according to the assigned competencies,
- measures on the European Union forum, especially those aimed at creation of the EU energy policy and Community requirements related to environment protection so that they allow for considerations relevant for the Polish energy sector and lead to an increase in Poland's energy security,
- Poland's active membership in such international organisations as the International Energy Agency,
- statutory measures of territorial self-government units, which take into account priorities of the state energy policy, including by application of public-private partnership (PPP),
- hierarchy based spatial planning, which is to assure the implementation of the energy policy priorities, plans of electric energy, heating and gaseous fuel supply in gminas and development plans of energy enterprises,
- information activities carried out by governmental bodies and cooperating research and development institutes,
- support from public means, including European funds, for implementation of projects of particular significance for Poland with respect to the energy industry (e.g. investment projects or research and development projects).

4.5.3. Measures

Improvement of energy efficiency is one of the priorities of the EU energy policy, and the objective set out until 2020 is reducing the energy consumption by 20% as compared to the *"business as usual"* scenario. Poland has managed to achieve a considerable advancement in this respect. In the last 10 years the GDP energy intensity fell by 30%, yet the effectiveness of the Polish economy, estimated as GDP (according to the euro rate) per energy unit, continues to be twice lower than the European average. Economic development, which arises from the application of new technologies, indicates a significant increase in electricity consumption at a relative fall in consumption of other energy forms. The issue of energy efficiency has a priority rank assigned in the energy policy, and progress in this field would be of key importance for implementation of all its objectives. Consequently all feasible measures would be undertaken aiming at increase in energy efficiency.

Specific objectives related to improvement of energy efficiency in the economy are as follows:

- improving the effectiveness of electricity generation by building highly effective generation units,
- two-fold increase until 2020 of electricity generation in highly efficient cogeneration technology as compared to generation in 2006,
- lowering the indicator of network losses in transmission and distribution, inter alia by modernisation of the present networks and construction of new sections, replacement of low efficiency transformers and development of dispersed generation, increasing the efficiency of final energy consumption,
- increasing the relation of annual demand for electricity to the maximum demand for power at peak load periods, which would be conducive to reducing total costs of meeting the demand for electricity.

The following measures are going to be undertaken to allow implementation of determined objectives aimed at improvement of energy efficiency:

- determination of national objective for increase in energy efficiency,
- introduction of a system support mechanism for measures leading to implementation of the national objective of increase in energy efficiency,
- stimulating the development of cogeneration by support mechanisms, allowing for cogeneration from generation units below 1 MW, and by introduction of required policy in the gminas,
- application of mandatory energy performance certificates for buildings and dwellings during their introduction into trade or for their rental,
- determination of energy intensity for equipment and products that use energy and introduction of minimum stan-

dard thresholds for products that consume energy,
- commitment of the public sector to fulfilling a model role in economical energy consumption and management,
- supporting investments related to energy savings by way of granting preferential credits and donations from national and European means, including under the Act on *Support of Thermo-Modernisation and Overhauls*, Operational Programme *Infrastructure and Environment*, regional operational programmes, resources of the National Fund for Environmental Protection and Water Management,
- supporting research and development works related to new solutions and technologies that reduce energy consumption in all directions of its generation and consumption,
- application of demand management techniques (Demand Side Management) stimulated by daily diversification in electricity prices arising from the introduction of the present day market and transmission of price signals to customers via remote bilateral communication systems with electronic counters,
- information and education campaigns promoting rational energy consumption.

Enhancing the security of fuel and energy supply, i.e. assuring stable supplies of fuels and energy on a level that guarantees satisfying domestic needs and at prices approved by the economy and the society, on the assumption of optimum usage of domestic energy material resources and by diversification of sources and directions of supplies of crude oil, liquid and gaseous fuels, is the subsequent direction of measures.

Poland has considerable coal resources, which are going to serve as a vital stabiliser in national energy security, which acquires special importance with view to the dependence of the Polish economy on the import of gas (in over 70%) and crude oil (in over 95%). The energy policy will be focused on diversification of supplies of raw materials and fuels, which is to be understood as diversification of the technology, and not merely a differentiation in directions of supplies. Furthermore, the support of technologies allowing obtaining liquid and gaseous fuels from domestic materials would be supported.

As the present hard coal and brown coal (lignite) resources in operating deposits are being gradually depleted, preparation works are to be started in the time perspective until 2030 related to taking up mining in new deposits. For this reason it is vital that access to strategic coal resources be assured, inert alia by protecting the areas where they occur from further infrastructure development not directly connected with the power industry, and having them included in national spatial development concept, local spatial development plans and long-term development strategy. It is also necessary that the cited documents allow correlation of deposit usage plans with investment plans in other sectors, e.g. those related to the road infrastructure. This concerns especially hard coal deposits: "Bzie-Dębina", "Śmiłowice", "Brzezinka" and brown coal (lignite) deposits: "Legnica", "Gubin" and satellite deposits of operating mines.

As regards the sectors of natural gas and crude oil, there is a need of increasing the flow capacity of gas transmission systems and storage facilities, and of petroleum and fuel pipelines along with the accompanying reloading and storage infrastructure, including caverns in salt structures. An increase of the domestic natural gas mining capacity should not only help cover the present needs, but also provide security should particularly unfavourable atmospheric conditions or external interferences occur.

The previous forecasts which concerned possibilities of covering the future demand for electricity in Poland indicate the necessity of developing the existing generation capacity. Commitments concerning limiting greenhouse gas emission force Poland to seek low emission solutions with respect to electricity generation. Use will be made in the first place of all available technologies of coal based energy generation on the assumption that they would allow reducing air pollution.

Electricity is being generated in the national system at insignificant available possibilities – currently being below 10% – of international exchange. For this reason apart from development of electricity generation capacity, and transmission and distribution capacity of power networks, the main directions of the energy policy comprise also increasing possibilities of electricity exchange with the neighbouring countries. For this purpose appropriate statutory regulations would be developed and set up, which are to eliminate any barriers which might exist in this respect.

An important element of the energy policy will also be the creation of appropriate conditions for enhancing the competitive position of Polish energy enterprises to enable their competing on European energy markets.

Apart from correlating plans of brown coal (lignite) deposits mining with investment plans, it is also necessary to carry out a concurrent analysis of all programmes and policies. Giving preference to energy related issues may give rise to the necessity of giving up tasks covered in the "National Roads Construction Programme for the years 2008–2012", and consequently to limited transport possibilities on the analysed area. Such analysis is necessary among others for the area of brown coal deposit "Legnica" indicated in the analysed project. On this territory will be the planned expressway S-3, which shall run in the vicinity of in the corridor of the existing National Road No. 3. Potential mining of the deposits would entail elimination of the existing National Road No. 3, which is the main road link of the Lower Silesian Voivodship with the Lubelskie and Zachodniopomorskie voivodships, and with the road border crossing in Jakuszyce (the Czech Republic). The course of expressway S-3 outside the "Legnica" and "Ścina-

wa" coal deposit area would pass by the towns of Lublin and Legnica. Those are important municipal and industrial centres, which generate considerable traffic on this route. Their passing by would put into question the justification of building such a road.

Diversification of the electricity generation structure by introducing nuclear energy industry. Poland's energy security requires that the required amounts of electricity supplied be assured at acceptable prices, concurrently meeting binding environment protection requirements. Climate protection under the climate and energy packet adopted by the EU gives rise to the necessity of reorienting the energy generation onto low CO_2 emission technologies. In such a situation particular importance is being assigned to the use of all available technologies with parallel raising the energy security and lowering the pollution emission, preserving the economic effectiveness.

With view to the present trends in the European energy policy, nuclear energy is becoming one of the most desirable sources, as apart from having no CO_2 emission it also guarantees independence from typical directions of obtaining energy resources. By resolution of 13 January 2009 the Council of Ministers committed all participants to the process to undertake intensified measures aimed at development of appropriate conditions for implementation of the Polish nuclear power industry programme in a way consistent with requirements and guidelines provided in documents of the International Atomic Energy Agency. Maintaining the planned date for start up of the first nuclear power plant by 2020 requires assuring an extensive involvement of the state bodies and involving budgetary means, providing staff with the required qualifications and efficient institutions in the preparatory stage to undertaking the final decision about implementation of nuclear power industry development, as well as during preparations to the bid procedure.

Preparatory works connected with introduction of nuclear energy in Poland are going to comprise in particular extensive social consultation, as well as identification and minimising the potential hazards. It is also necessary to assure long-lasting access to all elements of the fuel cycle. Uranium may be obtained from regions that are politically stable, and competition among producers is considerable, which provides the necessary protection from potential price dictate. Issues of fuel purchases by EU member states are coordinated by the European Supply Agency[10)] which has been specially established for the purpose by Euratom.

Increasing the usage of renewable energy sources, including biofuels, is crucial for implementation of elementary objectives under the energy policy. The increased share in the usage of those sources allows a bigger degree of independence from energy supplies coming from import. Promoting the use of RES allows increasing the diversification degree of supply sources and creates possibilities of establishing appropriate conditions for development of dispersed power systems based on locally available raw materials. Renewable energy industry comprises as a rule small generation plants situated close to clients, which allows enhancing the local energy security, and to reduce transmission losses. Power generation from renewable sources is characterised by low or zero pollution emission, which guarantees advantageous ecological effects. The development of renewable energy is also going to contribute to development of less developed regions, which have abundant renewable energy resources.

The main objectives of the energy policy in this respect comprise:

– increasing the share of renewable energy sources in final energy consumption at least to the level of 15% in 2020 and further growth of this indicator in the forthcoming years,
– achieving a 10% share of biofuels in the market of transport fuels in 2020, and increasing the use of II generation biofuels,
– protection of forests from excessive exploitation to obtain biomass and sustainable use of arable lands for needs of RES, including also biofuels, to prevent competition between renewable energy and agriculture and to allow preserving the biological diversity,
– making use of the existing damming facilities being property of the State Treasury for generation of electricity,
– increasing the diversification degree of supply sources and creation of optimum conditions for further development of dispersed energy industry based on locally available raw materials.

The following measures are going to be undertaken to implement the adopted objectives for development of the use of renewable energy sources:

– working out a way to achieve a share of 15% of RES in consumption of final energy in a balanced way, in a division by particular energy types: electricity, heating and cooling, and renewable energy in transport,
– keeping up support mechanisms for producers of electricity from renewable sources, e.g. by a system of certificates of origin,
– maintaining the obligation of gradual increasing the share of biocomponents in transport fuels to allow achievement of the intended goals,

[10)] Euroatom Supply Agency.

- introduction of additional support instruments which entice to more extensive generation of heating and cooling based on renewable energy sources,
- implementation of construction of agricultural bio-gasworks on the assumption of assuring on average one bio-gasworks in each gmina (commune) up to 2020,
- creation of conditions to facilitate taking of investment decisions concerning construction of wind farms in the open sea,
- maintaining the principle of releasing energy generated from RES of excise tax,
- direct support for construction of new RES units and electricity grids, allowing their connection with the use of European funds and environmental protection fund means, including means coming from the substitute fee and from fines,
- stimulating the development of the potential available in the Polish industry, which manufactures equipment for renewable energy industry, including also with the use of European funds,
- supporting the development of technologies and construction of installations designated to capture renewable energy from waste that contains degradable materials (e.g. municipal waste containing fractions subject to biodegradation),
- evaluating the possibility of using the existing damming facilities owned by the State Treasury in the energy industry, by having them inventoried, and by working out rules of impact on the environment and devising rules for allowing access to them.

Furthermore, according to plans implementation of the *Long-term National Program for Promotion of Biofuels and other Renewable Fuels in Poland 2008–2014*, adopted by the Council of Ministers on 24 July 2007, is going to be continued. One of the assumed measures is obliging the government administration to the use of liquid biofuels. The government administration would be encouraged to purchase vehicles equipped with engines adapted to liquid biofuels and the use of liquid biofuels to drive vehicles, as well as the obligation of visible marking of such vehicles to promote the use of liquid biofuels.

The planned measures will allow achieving the expected share of RES, including biofuels. This in turn will allow achieving sustained development of RES, including biofuels without adverse impact on agriculture, forestry, the food processing sector and biological diversity. A positive effect of RES development will be reduction of CO_2 emission and enhancing Poland's energy security, inter alia by increasing the diversification of the *energy mix*.

Development of competitive fuel and energy markets will be conducive to reducing production costs, and consequently also to limit the rise in fuel and energy prices.

To limit the impact of the power industry on the environment, plans assume launching of the following measures:

- establishment of a management system of domestic threshold values for greenhouse gas emission and other substances,
- introduction of admissible product emission indicators in generation of electricity and heat as a tool which allows reduction of the SO_2 and NO_x emission levels, including the achievement of threshold values determined in the Accession Treaty for Poland,
- implementation of commitments arising from the new ETS directive[11] for the electricity industry and heating systems,
- the use of receipts obtained from CO_2 emission allowances to support measures that limit the emission of greenhouse gas,
- introducing construction standards for new power plants in the preparation system for capturing CO_2 and determination of national capacity for geological carbon dioxide storage, for example in explored crude oil and natural gas deposits at the bottom of the Baltic Sea,
- active participation in implementation of a European Commission initiative related to the construction of large scale demonstrative facilities for capture and storage of carbon dioxide (CCS),
- using the CCS technology to assist crude oil and natural gas mining,
- intensification of scientific research and development works on the CCS technology and new technologies which allow the usage of captured CO_2 as raw material in other industrial branches,
- technical usage of coal wastes,
- increasing the usage of combustion side products,
- application of highly efficient closed cooling circuits in power plants and power and heat generating plants,
- diagnosing possibilities of occurrence in the energy sector of unintended production of permanent organic pollutants (dioxins and furans),

[11] Directive of the European Parliament and Council No. 2009/29/EC of 23 April 2009 amending Directive 2003/87/EC to improve and extend the scheme for greenhouse gas emission allowance trading within the Community (OJEU of 5 June 2009, pp. 63–87).

– supporting measures related to environment protection with the use of inter alia European funds.

Apart from the above indicated measures, of particular importance for achievement of the adopted energy policy objectives would be the implementation of the *"National Environment Policy for 2009–2012 and its 2016 outlook"*, especially with respect to lowering dust emissions, waste utilisation and protection of surface and ground water.

The planned measures will allow limiting the emission of SO_2, NO_x and dusts pursuant to commitments adopted by Poland. Measures aimed at limiting CO_2 emission should significantly reduce the emission value per unit of generated energy. Climate protection together with the climate and energy packet adopted by the EU make it necessary to reorient energy generation onto technologies with low CO_2 emission.

With view to the present European energy policy trends, the nuclear power industry has become one of the most desirable sources, because apart from not generating any CO_2 emission it also assures independence from typical directions for obtaining raw materials for the energy industry. The Resolution of the Council of Ministers of 13 January 2009 on measures undertaken with respect to the nuclear power industry assumes construction of at least two nuclear power plants. Works on them would be executed concurrently, and at least one of them should start operating by the end of 2020. The resolution bound all participants to the process to undertake intense measures aimed at preparation of appropriate conditions for deployment of a nuclear power industry programme in Poland pursuant to requirements and guidelines provided in documents of the International Atomic Energy Agency. The assumed date for start up of the first nuclear power units by 2020 can be kept provided that an extensive share of the state bodies and involving budgetary means is assured, providing staff with the required qualifications and efficient institutions both in the preparatory stage to undertaking the final decision about implementation of nuclear power industry development, as well as during preparations to the bid procedure.

The second new direction is implementation of experimental projects related to carbon dioxide capture and storage (CCS). At present two projects are in the preparation stage in the brown coal mine in Bełchatów and in Zakłady Azotowe in Kędzierzyn Koźle together with Południowy Koncern Energetyczny. The novelty of the technology to be applied in Kędzierzyn comprises the coal gasification technology for energy and methanol production (applying CCS technology and the chemical separation of CO_2 in the form of methanol).

Synthetic information on changes in energy effectiveness in the years 2004–2007 was contained in Table 4.5.

Table 4.5. Changes in energy efficiency in Poland

Measures	Yes	No	Partly
Institutional measures			X
Energy prices			X
Legal acts and technical standards			
Technical standards			X
Mandatory regulations			X
Voluntary/special purpose commitments		X	
Energy efficiency labels			X
Energy audits			X
Energy management		X	
Reports on energy consumption		X	
Energy saving plans		X	
Keeping equipment in a state of high energy efficiency			X
Metering of heating installations	X		
Economic and fiscal measures			
Economic incentives		X	
Investment reliefs, subsidies		X	
Preferential credits			X
Co-financing of audits		X	
Fiscal incentives			
Tax reliefs		X	
Hastened depreciation		X	
Tax reliefs for purchase of energy saving equipment		X	
Other			
Information campaigns			X
Sectoral agreements		X	
Co-financing research and development			X

Source: Own study of KAPE S.A.

4.6. Industry

4.6.1. Policy

A priority for the industry is restructuring of industrial sectors, such as for example mining of hard coal, zinc and lead, iron and steel industry, sulphur mining and processing as well as the cement and chemical industries. Furthermore, priorities in the entire industrial sector also include privatisation and restructuring of business entities and entire industrial sectors, and also consolidation of entities to enhance their economic viability, research and development activity, innovativeness and implementation of decisions arising from the amended Lisbon Strategy, inflow of direct foreign investments, public aid and its appropriate orientation and also elimination of barriers for the development of entrepreneurship.

Industrial sectors

Hard coal mining. Hard coal mining in Poland comprises a few dozen mines grouped in commercial law companies (Kompania Węglowa S.A., Katowicki Holding Węglowy S.A., Jastrzębska Spółka Węglowa S.A., Południowy Koncern Węglowy S.A., LW "Bogdanka" S.A. and ZG "Siltech" Sp. z o.o.). In the years 2005–2008 the restructuring process of this industry sector, which comprised reducing the mining capacity and employment, has practically been completed. The number of operating mines was reduced from 39 to 31, and the average annual mining fell by 15 million tonnes.

The mined raw materials are first of all assigned for use in the energy industry and coke production, and to satisfy needs of individual users (households, local heat generation plants). In the period from 2005 to 2008 the Polish hard coal mining managed to reduce to a considerable extent the degree of its adverse impact on the environment, inter alia the volume of dust and gas emission was reduced from 1.15 million tonnes in 2005 to 0.98 million tonnes in 2008 (15%).

Chemical industry. This industry sector demonstrates constant gradual increase in production and sale. Implementation of restructuring measures led to a change in the ownership structure in the chemical industry, especially in larger enterprises. Small and medium-size plants almost entirely belong to the private sector. Production technologies have undergone intensive modernisation. A vital role in modernisation and restructuring of the chemical industry is played by direct foreign investments. The chemical industry is highly capital intensive and strongly dependent on raw material sources. It is also characterised by very high production of semi-products, which are subsequently processed by other industrial 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 varnish 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% as compared with the level achieved in the early 1990s. Consequently 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 classifying the cement industry to the leading industries in Europe with view to technical and organizational aspects. All these measures have led to the minimisation of the impact of cement industry on the environment in Poland. As compared with the late 1980s carbon dioxide emissions dropped by over 25%. The cement industry 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 material supply for the general construction industry, road, water, energy and municipal industries. It provides basic materials for the electro machinery, 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, the aim of which is to reduce the emission of certain greenhouse gases containing fluorine[12)] by launching 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.

[12)] 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).

4.6.2. Measures

Priority directions for measures in industry with respect to limiting greenhouse gas emission comprise:

- implementation of the best available technologies (integrated permits are granted to installations and establishments that deploy BAT/BEP),
- supporting the development of environmentally friendly and technically profitable methods for greenhouse gas emission reduction,
- identification of priorities for research and development works oriented at modern pro-ecological and also material and energy saving production technologies and assuring their financing,
- technological modernisation in industrial plants.

Legislative and organisational measures comprised:

- **improvement of technical standards for equipment and facilities** – such measures allow improving the energy effectiveness of industrial production[13] (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[14]. 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 approx. 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[15];
- **development of a set of measures supporting the activity of small and medium enterprises, mainly with respect to introducing innovation and capacity improvement** – mechanisms supporting the activity are 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 have been published, which disseminate information on best available techniques for different production areas (for instance, guidebooks for brickyards and titanium white and soda production plants);
- **setting up of priorities for research and development targeted at sophisticated ecological and material- and energy-saving production technologies and provision of their financing** – several 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 into account the European Union standards and 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, with the same production level maintained. 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

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[13] Implemented Council Directive 92/42/EEC on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels of 21 May 1992 (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).

[14] 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).

[15] 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).

using 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.

4.7. Transport

4.7.1. Transport policy

The State Transport Policy for the years 2006–2025, which has been mentioned in the Communication, is still being implemented. Its main objectives are being applied inter alia by the Operational Programme Infrastructure and Environment (OPI&E) adopted by the Polish government in 2008. OPI&E is one of the operational programmes forming a basic tool for achievement of objectives specified in the National Strategic Reference Network for use of resources from the Cohesion Fund and the European Regional Development Fund. Objectives of OPI&E comprise inter alia:

– establishment of the basic motorway and expressway network,
– fundamental improvement of railway transport,
– sustainable development of the municipal transport system.

Railway transport. In 2008 the Polish government adopted a Master Plan for railway transport in Poland up to 2030. The Master Plan is the basic governmental document, which combines all aspects of railway transport until 2030. The main objective of this plan is to transform railway transport into a competitive segment of the transport market based on cooperation of central and local authorities, railway enterprises and infrastructure administrators. In 2008 a very important reform was finalised concerning the railway sector. Under this reform voivodship marshals are to take over shares in one of the companies in the PKP Group, which is responsible for regional trains. In 2007 the Polish government also adopted the National Plan of the European Railway Traffic Management System (ERTMS) Deployment, which supports infrastructure administrator in more effective railway traffic management.

Road transport. Regulations related to emissions coming from air conditioning systems in motor vehicles, which have been specified in Directive 2006/40/ EC, of 17 May 2006, of the European Parliament and Council, have been deployed in the Polish legal system by regulation of the Minister of Infrastructure on official type certification of vehicles and trailers.

Emission tests carried out during technical control of vehicles in pursuance of the Council Directive 96/96/EC of 20 December 1996 on the approximation of the laws of the Member States relating to measures to be taken against air pollution by gases from positive-ignition engines of motor vehicles, have also been introduced to the Polish legal system. Provisions of those directives are an element of periodical technical control of vehicles.

Public transport and biofuels. Works have been under way in the Ministry of Infrastructure since 2008 on a bill on public collective transport. An obligation was set up of preparing the so-called Development plan of integrated public transport. This commitment is to concern gmina level self-government bodies if on the territory relevant to them a minimum of 50,000 people reside. It is assumed that one of the elements of that plan is to be setting up city zones available only to ecological public transport means (these could be vehicles fuelled by biofuels).

Promotion of bicycle transport. The General Directorate of Public Roads and Motorways has developed and is implementing a special programme of bicycle routes construction along main national roads.

Furthermore, new information and educational campaigns are being carried out to achieve certain behavioural changes, such as “Cycling as safer means of transport” and “Cycling licence – my first driving licence”. Furthermore, the Secretariat of the National Road Safety Council (SNRSC) improves safety under measures to be implemented on roads (National Road Safety Programme 2005–2007–2013 GAMBIT 2005) and supports the development of technical infrastructure for cyclists and pedestrians. Together with the Ministry of Science and Higher Education the Secretariat is also working in an initiative the aim of which is to assure that each child graduating from primary school can obtain a cycling license.

Pursuant to provisions contained in the Fourth National Communication, Poland is implementing subsequent development programmes of road and railway infrastructure (with respect to roads this is the “Construction of National Roads for the years 2008–2012” programme). This programme has been included in provisions of the National Reform Programme for the years 2008–2011 in favour of implementation of the Lisbon Strategy, hence there is no need as adding another programme for the road sector as a separate item. The above mentioned road programme is treated as a medium-term financial plan forming a financial framework for the planned projects.

4.7.2. Measures

Measures of a legal and financial nature comprised:

– **energy efficiency changes in road transport** – differentiated fee rates for driving on domestic roads have been introduced depending on the level of exhaust gas emis-

sions from vehicles, which is to promote the usage on roads of 'cleaner' vehicles;

- **use of alternate fuels and introduction of an 'environmental' tax on fuels** – one of the highest taxes in Europe have been imposed on engine fuels (over 60% of the retail price) which does not allow much possibility for introduction of further loads without causing an adverse impact on economic activity and costs borne by the society; taxes on fuels are differentiated in a way that promotes both alternate fuels (including renewable ones), and those less noxious for the environment; an additional instrument are fees for environment use, which are generally borne for the use of engine fuels, generated from non-renewable sources;
- **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;
- **promotion of LPG and bio-diesel** – through tax reliefs for LPG and biocomponents for fuel engines (dehydrated alcohols, ethers and esters) introduced since the end of 1990s; this gives promotional prices for gaseous fuels, and also increases the interest in introducing biocomponents to fuels; recently mechanisms have been introduced which support the construction of installations for production of biocomponents and biofuels, as well as new mechanisms that promote the use of such fuels (production of biofuels for own use, selected fleets, excise tax);
- **introduction of a road tax** – system changes were worked out in 2007 with respect to road fees, which comprise abolishing flat rate and introduction of an electronic fee charged for the driven distance; this will allow introducing in 2011 a charge for heavy vehicles, which depends on the covered distance and is based on the vehicle weight; it is also planned that the electronic fee could be diversified depending on the EURO emission class, which would be conducive for reducing air pollution caused by heavy road transport.

Measures of a technical nature comprised:

- **construction of motorways, by-pass roads and express roads** – in the years 2005–2008 an intensification took place of works which resulted in commissioning of 230 km of motorways, 210 km of express roads, and 38 by-pass roads, which improved road traffic flow capacity and reduced energy losses resulting from congestion; in the subsequent period of implementation of the National Roads Construction Programme (2009–2012) intense road works are planned; the objective is to assure by 2012 a complex network of motorways and fast traffic roads along the basic trans-European transport corridors and providing links for the major economic centres in Poland; this would be conducive to enhancing the effectiveness of transport and of traffic flow smoothness, which in turn would allow decreasing energy losses connected with congestions on the roads;
- **changes in energy efficiency of railway transport** by execution of several measures, such as for example modernisation of non-traction energy equipment and replacement with energy saving installations, modernisation of the rolling stock, railway infrastructure, railway buildings, thermo-modernisation of railway buildings, energy saving use of the rolling stock; to increase non-traction energy equipment efficiency the installations in question have been replaced by energy saving ones; the electrical installations were adapted to current needs allowing for reduction in energy consumption, electric power equipment with unused capacity have been adapted to current needs; intense modernisation works of railway infrastructure carried out in the period of the past few years comprised: modernisation of the track permanent way including the road bed and drainage on tracks and stations, modernisation of the traction and powering systems, modernisation of automatic lighting signalling system and road paving on railway crossings, modernisation of engineering structures, modernisation of telecommunication facilities and railway interlocking system, construction of environment friendly facilities; thermo-modernisation works were continued for railway buildings in which heating substations, heaters, windows, boilers for solid fuels were replaced with new ones with better energy parameters; in deployment of energy saving operating technologies rational standards as regards heating of train sets were introduced, training courses were organised for train drivers with respect to economical energy consumption during handling of electrical traction units, measures aimed at savings have been undertaken related to operation of train engines and change in traffic organisation (the use of engine oil and electricity traction has been reduced by 34.62% and 6.3% respectively);
- **technical measures related to construction of vehicles** allow enhancing the effectiveness in fuel consumption in new vehicles, trucks, buses, track vehicles and aircraft introduced into operation in Poland; in particular the development of hybrid drive bus should be emphasised,

which has already been allowed in serial production; to limit CO_2 emission in the sector of navigation works are under way on the formula of the Energy Efficiency Design Index (EEDI) for new ships; this indicator is to become an instrument which is to allow supporting and promoting structural solutions aimed at better energy efficiency, and consequently reduced CO_2 emission during ship usage; light track vehicles, such as for example rail buses designated for local traffic that are currently being introduced into use, consume much less energy thanks to the application of light components for construction, installation of diesel engines with a lower fuel consumption and the use of heat from cooling of the engine and the transmission for warming up the vehicle; electric and diesel train engines are being modernised and self-drive network trains are being purchased with diesel engines, which meet requirements with respect to limiting emissions of gaseous pollution.

Measures of a legal and administrative nature comprised:

- **improvement of the infrastructure for cyclists and pedestrians** – the undertaken activities were focused on promoting bicycles as a means of transport and on building bicycle routes; the majority of new road projects and of rehabilitated roads allow for the need of providing bicycle paths; bicycle paths and pedestrian routes are being universally constructed or set out (for needs of everyday local and tourist transport) both in built-up areas and outside them; railway transport offers the general possibility of bicycle haulage (in the summer season the carriers tend to offer increasingly frequently the possibility of free of charge bicycle haulage);
- **introduction of more stringent emission standards for combastion engines** – as regards CO_2 emission new requirements were set up for new vehicles registered on the EU area at the turn of 2008/2009; progress in reducing the use of fuel and consequently of CO_2 emission arises from technological progress declared by passenger car producers and from decisions made by car buyers; monitoring studies carried out on the territory of Poland have shown that unit CO_2 emission for passenger cars fell from 177 g CO_2/km in 1998 to slightly over 152 g CO_2/km in 2008; in addition the system of technical testes of vehicles and their trailers, based on requirements the Council Directive No. 96/96/CE of 20 December 1996 assures that vehicles that are in an unsatisfactory technical condition or excessively used, which could have an adverse impact on the state of the natural environment, would be duly eliminated from traffic;
- **promotion of public transport** – an extensive assortment of incentives has been introduced to using railway transport by: establishing integrated tickets for railway, tramway and bus transport on designated routes, zonal tickets and propagating railway traffic instead of individual travelling with passenger cars; investment projects are being carried out as regards parking areas located in the vicinity of railway stations which comprise construction of new parking sites, as well as adaptation combined with modernisation of the already existent parking areas; depending on their situation parking sites would be operating in the formula of generally accessible parking sites or in the PARK & RIDE formula; in general users of passenger cars would be encouraged to leave their cars on a designated parking sites and to continue travelling by public transport means; there are various promotions connected with possibilities of cheaper railway travelling, such as for example free of charge bicycle haulage in the spring and summer seasons or the so-called "family fares" during summer and winter school holidays; all kinds of social campaigns are being launched, such as "Change Your Car into Bus", the European Mobility Week and the European Day without Cars, Public Transport Days (PTD), which are to encourage the drivers to leave their cars more frequently and change to increasingly modern and ever quicker public transport; there are cyclically organised Railway Technology Days which promotes rail based public transport with emphasis on railways; the public transport is promoted by such publications as: *Monster-trucks versus rail transport, the PKP Group Annual Report*; municipal public transport is being promoted all year round via web pages www.mi.gov.pl;
- **development of combined transport** – in the past years intermodal railway traffic has grown considerably; new links were established both in international and domestic transport, furthermore, new investments are being made in container terminals;
- **promotion of bicycle transport,** not only as means of active recreation, but also as means of transport; various activities are being undertaken in favour of universal use of bicycles; non-governmental organisations popularize guides for entities that design, implement and use the bicycle infrastructure, assisting implementation of the regulations that exist in this respect; a lot of actions are carried being out as regards promotion of safe cycling by the National Road Safety Council (NRSC), such as "Travel safely by bike" or "Safe trip. Bike pass – my first driving licence";
- **improving the quality of water transport** – appropriate conditions have been established for construction of "marine motorway" networks which are to combine Polish sea ports with ports in Baltic countries, and also with ports of Western Europe; the Inland Navigation Fund was established to support the development of inland navigation

offers to inland navigation ship operators means for measures that promote inland water transport as an environment friendly transport sector, and in particular means for measures aimed at environment protection (overhauls or replacement of old engines with new ones that are adapted to environment related requirements); owing to the very low share of river transport in Poland as compared to other forms of transport, in the first place with land transport, CO_2 emission from this source remains insignificant;

- **improvement of traffic flow and parking opportunities for heavy good vehicles in towns** – this is to be achieved by construction of ring roads (both around towns and the so-called city centre by-pass roads) and improvement of the state of road paving, as well as appropriate changes in traffic organisation (banning heavy vehicle traffic on certain streets or entire zones and similar bans within specified hours);
- **effective organisation of the railway and road transport systems** – to be achieved by adapting the size of train sets to actual transport needs, and for sections with lower passenger traffic flows replacing train sets by traditional light rail vehicles; monitoring the occupancy in particular trains is a factor that helps increasing the intensity of trains in peak hours, which is to enhance travelling comfort of the travellers, as well as their mobility; a system of transport and tariff offers is being developed that integrates a few collective transport operators, which allows more extensive use of public transport means offering pro-ecological transport forms; construction of railway overbridges to eliminate road and railway crossings, modernisation of tracks, modernisation of the railway siding will allow increasing travelling speed of trains; as regards cargo transport, measures are being undertaken to ensure effective organisation of railway transport;
- **information and educational activity concerning the need for behavioural changes –** this activity comprises basically execution of diverse social campaigns; the main objective of the campaign *Safe car academy – Don't wait for a breakdown – make your car safer by having it inspected* is making road traffic participants aware of the interdependence between the technical condition of a vehicle and their security; the campaign *Speed limits save lives* is to enhance social acceptance for rules of respecting speed limits and understanding the importance of speed differences in case of accidents; apart from obviously improving road safety both the usage of technically efficient vehicles and imposing speed limits for such vehicles have a direct impact on limiting environmental pollution, including also greenhouse gas emission;
- **measures aimed at reducing greenhouse gas emissions from air transport** – a modification was made of borders of six Aerodrome Traffic Zones (ATZ); the existing air space structures were reconstructed and new ones were introduced to allow flexible management, and namely: Temporary Segregated Area (TSA), Temporary Feeding Router (TFR), Temporary Reserved Airspace (TRA) and flight routes of military aircraft– Military Route (MRT); the Military Aerodrome Traffic Zone (MATZ) was restructured including changes in the course of horizontal and vertical borders; a data base of the air space management support system CAT (Common Airspace Tools) was established and started up; an agreement was concluded between the Polish Air Navigation Services Agency (PAŻP), Polish Airports State Enterprise (PPL), LOT Polish Airlines (PLL LOT) and handling agents deploying in the Okęcie Airport the Collaborative Decision Making System (CDM), which will be conducive to reducing the impact of the airport on the environment (inter alia lower pollution emission to the air); in 2005 cooperation with EUROCONTROL was continued with respect to modelling the dispersal of pollution around the Warsaw–Okęcie Airport, including in particular emissions from aviation; as of 2004 PLL LOT commenced the introduction of more economic Embraer 170 aircraft, with plans assuming having Boeing 737 aircraft replaced on shorter routes with fewer passengers;
- **measures aimed at reducing greenhouse gas emission from public transport** – those measures comprise in the first place introduction of modern rolling stock with more stringent emission parameters; new rail vehicles are characterised by lower energy consumption; one of the most effective solutions is to develop electrically powered rail traction systems (underground, tram and urban railway networks) and of the trolleybus traction, which are to take over tasks of individual and bus transport modes; as regards buses limiting the exhaust gas emission is executed by purchasing hybrid drive vehicles which allow saving the energy output of 30%, using CNG and LPG as propellants in buses, the use of biofuels, purchase of rolling stock with better emission parameters than the hitherto required ones under the so-called EURO standards, and on lines with low passenger flows – purchase of collective transport vehicles with lower capacities as compared to the ones in present use;
- **introduction of speed limits in towns** – a statutory duty was introduced of a speed limit on built-up areas to 50 km/h during the day and to 60 km/h between 23.00 hrs. – 5.00 hrs.[16)].

[16)] Act of 20 June 1997 – The Road Traffic Law (Dz.U. of 2005, Issue 108, item 908, with subsequent amendments).

4.8. Construction and housing

4.8.1. Policy

The housing policy is decentralised and subordinated to the decisions of the local self-governments[17]. The development of the housing sector for the poorest social groups is financially supported by gminas, which also provide financial aid for the poor. Also the housing cooperatives take advantage of the country's assistance in paying back housing credits.

4.8.2. Measures

Measures of a legal and organisational nature:

- **introduction of energy standards in the construction sector** aimed at improving the energy efficiency and rational use of energy by limiting its consumption, promoting the use of renewable energy sources and reducing the demand for non-renewable primary energy for new buildings and existing buildings subject to expansion, reconstruction and raising, and a change in the usage; modifications and amendments have been made in technical and building regulations concerning thermal protection of buildings with respect to the heat transfer coefficient through external partitions, efficiency of heating, ventilation and air-conditioning systems and provision of warm utility water; furthermore, implementation works have been completed with respect to evaluating energy performance of buildings arising from provisions of Directive 2002/91/CE of the European Parliament and Council on Energy Performance of Buildings. A commitment was imposed on providing an energy performance certificate for new buildings to be commissioned and buildings to be sold or rented on the secondary market, and the obligation of carrying out regular inspections of boilers fired by non-renewable liquid or solid fuel and the obligation of inspecting cooling equipment in air-conditioning systems;
- **thermo-modernisation of buildings** – changes were introduced that allow extending support measures for thermo-modernisation projects by the possibility of obtaining thermo-modernisation, renovation and compensation bonuses; as for the existing buildings which have gone through thermo-modernisation the demand for energy falls on average by 50%;
- **raising the awareness of users and owners of buildings in energy saving** by limiting its consumption and its rational use; an educational and information programme has been implemented, which is addressed to investors of new buildings, as well as administrators and owners of the existing buildings. Its role is to motivate the improvement of the technical standard in construction resources (building stock), the basic manifestation of which is reducing the demand for non-renewable primary energy and reducing the CO_2 emission; furthermore, a number of publications have been prepared and disseminated to promote energy-saving activities, such as: Energy-saving house, Thermo-modernisation of buildings.

4.9. Agriculture

4.9.1. Policy

The National Strategic Plan for Poland has been prepared pursuant to Council Regulation (EC) No. 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD).

The National Strategic Plan comprises the programming period of 2007–2013. On the basis of an analysis of the social, economic and environmental situation, conducted pursuant to the available statistical data, determined were priorities and development directions for rural development in Poland in relation to Community priorities.

The National Strategic Plan forms a basis for implementation of measures under the Rural Development Programme for the years 2007–2013, in line with the concept of multifunctional nature of agriculture and rural areas. It assumes economic support of farms and an increase in the competitiveness of the agricultural and food product sectors, concurrently assuring appropriate instruments to allow the required diversification of economic activity to achieve and establish alternative income sources for inhabitants of rural areas. This would be conducive to improve the quality of life on rural areas by developing the sector of elementary services for the population, and will also offer an alternative for the currently dominating role of rural areas, and namely food processing. Owing to the slow nature of structural changes taking place in the sector and taking into account the significant number of farms, taking into account needs diverse groups of farms in planning support instruments. Apart from economic functions and good conditions for social development, an aspect of equal importance for rural areas in Poland is their role in preserving and restoring landscape values and nature resources, i.e. preserving the good ecological state of water and soils, abundance of habitats and biodiversity, as well as cultural heritage of rural areas.

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

4.9.2. Measures

Measures of a legal and organisational nature comprised:

- **rational use of fertilisers, including nitrogenous fertilisers** – by enactment of the act that regulates the fertiliser use, doses of natural fertilisers have been limited to 170 kg N/ha·year in terms of pure ingredient, a ban was set up on the use of natural fertilisers from the end of November until the beginning of March, and training courses for farmers using fertilisers have become obligatory. Also the use of fertilisers in flooded soils, in soils covered with snow and in frozen soils, as well as on fields with a sloping > 10%. Moreover, a requirement for large commercial farms to have a fertilisation plan has been introduced. Those measures are to allow reducing the risk of agriculture exerting impact on the water resources and to limit losses of fertiliser components. To facilitate rational fertilisation a consultancy system has been introduced; free of charge programmes have been made available through the Internet that enable determining the amounts of natural fertilisers and composition of fertilisers produced in the farm, as well as a calculator of nutritional requirements of cultivated plants for nutrient components depending on the harvest, soil properties and the cultivated forecrops; also regular monitoring is being executed of the contents of mineral nitrogen in soils of arable lands and grasslands;
- **rational energy management in agriculture, including energy production from biomass side products, and from solid and liquid manure,** pursuant to the "Directions for construction of agricultural biogas plants in Poland up to 2020" the biogas production in 2020 is to be 2 billion m^3, and almost 700 thousand ha arable lands are to be taken up for this production; 8 biogas plants have been commissioned by now having a total capacity of 8.6 MW; the use of solid biomass has grown (from 170,056 TJ in 2004 to 189,586 TJ in 2007), bioethanol (from 1,589 TJ in 2005 to 3,356 TJ in 2007) and biodiesel (from 657 TJ in 2005 to 1,072 TJ in 2007); biogas obtaining grew in the years 2004–2007 from 1,941 TJ to 2,708 TJ; the share of energy from renewable sources in primary energy grew in the years 2004–2006 from 5.5% to 6.4%, of which over 91% was constituted by solid biomass; the adaptation process of local boiler plants to burning wood biomass and straw is being continued under rationalisation of the energy policy in agriculture; 500 wood fired boilers plants have been commissioned with an average capacity of 100 kW and 50 for straw with average capacity of 100 kW. CO_2 emission was reduced by 3.47424 Gg and CH_4 emission by 0.01302 Gg;
- **support for using other renewable energy sources in agricultural production** – thanks to various forms of support ca. 1200 m^2 of solar water collectors and ca. 200 m^2 of air collectors were established in agriculture, which caused a reduction in CO_2 emission by ca. 0.2108 Gg;
- **technical modernisation of farms** – modernisation measures were aimed in the first place at adapting farms to the binding EU standards; the only activity affecting reduction of methane emissions was the building of manure plates (gutters) for animal excrements and tanks for liquid fermented and unfermented manure;
- **improving the techniques of animal feeding and fodder policy** – implementation of breeding programmes and standards for precision animal feeding combined with enhanced output, and the consequent reduction in the number of livestock led to a reduction of CO_2 emission by 0.800 Gg and CH_4 emission by 0.100 Gg;
- **afforestations of arable lands and other lands** – forest cultivations made in the years 2004–2006 comprised 39,737 ha of arable lands with low agricultural suitability (0.22% arable lands), contributing to increasing the forest cover in Poland by 0.12%; the recently afforested areas store 122.788 Gg C/year, which comes up to almost 0.21% of the annual carbon capture potential by the forests in Poland.

As a result of a discussion completed on 20 November 2008 concerning functioning of CAP (Health Check) inter alia a decision was taken on abolishment as of 2010 of a fee system related to energy plants, which means that 2009 is the last year in which the farmers may apply for payments for cultivations of energy plants. Furthermore 2009 will also be the last year for assistance to be granted for establishment of permanent plantations (long-term energy plants). In this context Poland is one of few member states which under the ongoing discussion concerning an assessment of functioning of the Common Agricultural Policy has applied to maintain subsidies to plants cultivated for needs of the energy.

Measures of a legal and economic nature comprised:

- **preference to crops that remove CO_2** – subsidies from the EU are being provided to plantations of perennial and one-year plants cultivated for energy needs equal to 45 EUR/ha; domestic means granted via the Agricultural Market Agency were used to support the establishment of permanent plantations in the form of subsidies defined as percentage values in relation to lump costs for establishment of 1 ha of a plantation: energy willow (*Salix* sp.) – 50%, poplar (*Populus* sp.*)* – 30%, Miscanthus (*Miscanthus* sp.*)* – 40%, Pennsylvanian mallow *(Sida hermaphrodita)* – 40%. A factor of particular importance is co-financing research and implementation works for cultivations that remove CO_2; the CO_2 emission fell by 16.640 Gg; the

area of perennials cultivated for energy needs grew from 6,000 ha in 2004 to ca. 10,000 ha in 2008.

Research and development measures, as well as information and education measures comprise:

- **a change in the structure of fuels used to the benefit of hydrocarbon fuels and reduction of Diesel oil consumption –** to limit the consumption of engine fuels works are being carried out aimed at changing technologies of field works, including in the first place simplification of cultivation of arable lands, possibilities of aggregating machines, changes in harvesting technologies, especially sugar beets; however, despite a fall in the usage of fuel oil per production unit from ca. 450 GJ/JZ in 2005 to ca. 400 GJ/JZ in 2008 the consumption of this fuel per area unit remains on a constant level of 18 GJ/ha, and globally in agriculture ca. 1,800 thousand tonnes/year; however, the rapid growth of transport development in the rural areas, despite these measures, caused an increase in the total CO_2 emissions;
- **development of new technologies for growing and harvesting plant biomass intended for use as a renewable energy source and raw material for the industry –** advancements were made in the cultivation and harvesting technology of willow, miscanthus and Pennsylvanian mallow, and works were undertaken on the development of technology and introducing into cultivation of new species of energy plants: poplar, black locust, big bluestem, prairie cord-grass, switchgrass; the total area grown with these crops has been estimated at 10 thousand ha and is expected to grow; studies were conducted on developing a technology for establishment of plantations of willow and poplar on fallow grasslands in the system of "lignified willow branches", which rules out ploughing of those soils; in addition studies are being executed with respect to the technology of agricultural plant cultivations (corn, sorghum, sugar beets) which are designated for substrate for biogas production;
- **improvement of farm animal raising systems, reduction of methane from animal excrements –** research and implementation works were executed on development of new technological systems in buildings and on new methods of keeping livestock; a change in pig keeping techniques from traditional high emission to low emission type (emission per stand – 0.8 kg CH_4/year and 0.65 N_2O/year), which comprises providing partial coop grid and increasing the inclination angle of the floors (quicker drainage of waste) led to decreased emissivity of animal production by 15% as compared to 2004; progress in implementation of regulations concerning keeping and disposal of animal excrements had a significant impact on methane emission reduction; the applied measures allowed reducing CH_4 emission by 0.600 Gg and N_2O emission by 1.000 Gg;
- **elimination of gaseous pollution emitted from poultry processing buildings by using phytorementation and solar ventilation –** research works have been carried out on estimation and selection of plants that are most appropriate for this particular type of cultivations; additionally modified poultry houses with solar ventilation are to be developed; the level of CO_2 emission reduction has been determined to be 30–40%;
- **impeding the mineralization of organic soils used as meadows and pastures by their irrigation and limiting the groundwater outflow** – long-term research works on determination of the optimum groundwater table level necessary to impede losses of organic mass in peat soils allowed the development of guidelines in this respect; reconstruction and modernisation of land drainage systems restoring the required moisture content organic soils to limit their mineralization would lead to reducing CO_2 emission from those soils by 22%.

4.10. Forestry

4.10.1. 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.

4.10.2. Measures

Measures of legal and organisational nature comprised:

- **counteracting 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 and are insignificant;
- **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 fore-

sts (Dz.U. of 2005 Issue 45, item 435, as subsequently 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 2006 a total 16.9 thousand ha of agricultural land used for agricultural purposes have been afforested, including 4.5 thousand ha owned by the State Treasury, and in 2007 13.3 thousand ha and 3 thousand ha of soils respectively;

– **research on the level of carbon removal** – the total volume of carbon accumulated in the form of soil organic matter and tree biomass, within the time horizon up to 30 years equals to 4710234 tonnes, which accounts for 3.08 (t/ha/year); in 2007 two research projects were launched: "Carbon balance in tree biomass of the major forest forming species in Poland" and "Climate change versus forest ecosystems: CO_2 removal and change in forest structure and functions".

4.11. Waste and sewage

4.11.1. 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[18)] (NWMP 2010) covering the period of 2007–2010 and in perspective the period of 2011–2018.

The ultimate objective of establishment of national waste management plan is to achieve a waste management system that would be consistent with the sustainable development principle, which would allow full implementation of waste management rules. It is of utmost importance that waste be treated in compliance with the waste utilisation hierarchy, especially by preventing and minimising the volume of generated waste and by limiting their hazardous properties, and also making use of material and energy related properties of waste. If waste cannot be subjected to recovery processes, it shall be disposed of by landfilling. According to the above mentioned hierarchy landfilling is generally considered to be the least desirable way of waste utilisation. The implementation of this objective will allow achieving such goals, as limiting climate changes caused by waste management by way of minimising greenhouse gas emission form the waste disposal technology, or increasing the share of energy from renewable sources in the national energy balance by replacing incineration of fossil fuels by incineration of waste of plant and animal origin.

4.11.2. Measures

The extensive scope of measures necessary to assure an integrated waste management in Poland in a way which would guarantee environment protection, allowing for the present and future considerations and economic capacity and the technological level of the existing infrastructure has been determined in the "National Waste Management Plan 2010" adopted by the Council of Ministers in December 2006. The waste management plan concerns both waste generation in Poland, especially municipal waste, hazardous waste, packaging waste and municipal sewage sludge, as well as waste brought into Poland. The adopted objectives and tasks refer to the period 2007–2010 and in a perspective period until 2011–2018. Other means and detailed legal regulations related to waste management, i.e. the Act on Waste, have also been adopted, but they do not refer to issued concerning climate changes in a direct way.

[18)] Resolution no. 233 of the Council of Ministers of 29 December 2006 on the National Waste Management Plan (M.P. of 2006 No. 90, item 946).

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

5.1. Assumptions for the projections

Pursuant to guidelines on reporting for needs of the UNFCCC, the presented national projections have covered the anticipated volume of greenhouse gas emission up to 2030 (with a division into years: 2015, 2020 and 2030) in which currently implemented policies and measures aimed at limiting greenhouse gas emissions were accounted for. Those projections form the so-called scenario "with measures" hereinafter called "PEP'09", following adoption of provisions of *The Energy Policy of Poland until 2030* developed in 2009 by the Ministry of the Economy, necessary to estimate the forthcoming changes in greenhouse gas emissions in Poland.

The emission projections have been made for the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), HFCs (hydrofluorocarbons), PFCs (perfluorocarbons) and sulphur hexafluoride – SF_6 and for the following five sectors according to the IPCC classification: *Energy* (including *transport*), *Industrial processes*, *Solvent and other product use*, *Agriculture* and *Waste*. As regards the sector *Land use, land-use change and forestry* (LULUCF), only the value of the net CO_2 balance of emissions and removals has been assumed for activities Article 3.3 (afforestation, reforestation and deforestation) and additional activities selected by Poland under Article 3.4 (forest management) of the Kyoto Protocol, without assessing of such a balance for the entire sector 5. LULUCF, as was presented in the Fourth National Communication.

Determinant for the domestic carbon dioxide emission are data concerning the anticipated fuel consumption (92% of domestic CO_2 emission in 2007), which have been obtained on the basis of the Projection of demand for fuels and energy until 2030, which is a basis for the Energy Policy of Poland until 2030.

In the above mentioned projection basic directions for the energy policy in Poland have been adopted, allowing for requirements of the European Union:
- improvement of the energy efficiency;
- increased security of fuel and energy supplies;
- diversification of the electricity generation structure by introducing nuclear energy;
- development of the use of renewable energy sources, including biofuels;
- development of competitive fuel and energy markets;
- limiting the impact of the energy sector on the environment.

As regards energy efficiency the following energy policy objectives of particular importance for the forecast have been allowed for: striving at preservation of the zero energy economic increase, i.e. economic growth taking place without a growth of the demand for primary energy and determined reduction and of the energy intensity of the Polish economy to the level of EU-15.

Pursuant to the anticipated requirements of the European Union an increase is assumed in the share of renewable energy in the structure of final energy to 15% in 2020 and achievement in that year a share of 10% of biofuels in the market of transport fuels. Additionally there is assumed protection of forests from excessive biomass gaining and balanced use of arable lands for production of renewable energy, including biofuels, to prevent possible competition between renewable energy industry and agriculture.

The main assumptions of the macroeconomic forecast covered a projection for economic development up to 2030 which comprises an adjustment arising from the present financial crisis and the anticipated slowing down in the economy in the forthcoming years. Consequently a lower increase

Table 5.1. Synthesis of a projection of Gross Domestic Product and value added dynamics

Years	2007–2010	2011–2015	2016–2020	2021–2025	2026–2030	2007–2030
GDP	103.9	105.8	105.2	105.7	104.6	105.1
Value added	103.7	105.6	105.0	105.4	104.4	104.9

Source: IOŚ.

rate of GDP is considered in the years 2008–2011: 4.8% in 2008, 1.7% in 2009, 2.4% in 2010 and 3.0% in 2011 and gradually increasing growth after 2012 (table 5.1).

According to assumptions the economic sector which is to develop the most quickly in Poland during the forecast period are going to be the services, the share of which in value added would grow from 57.1% in 2006 to 65.8% in 2030. The share of industry in value added is expected to be reduced from 25.1% in 2006 to 19.3% in 2030. The building industry is projected to keep its share in that period at ca. 6%. There is expected a slight reduction in the share of transport, and the decrease from 4.2% to ca. 2.2% in share of agriculture.

In forecasting the energy demand the end-use model MAED was applied, i.e. bottom-up approach. In this model projections of energy demand were made for each energy use direction in each sector of the economy. The anticipated increase in consumption of final energy within the time horizon of the forecast (table 5.2) shall be ca. 29%, with the biggest increase of 90% anticipated in the sector of services. In the industry sector this growth is expected to be ca. 15%. In the time horizon of the forecast anticipated is an increase in final consumption of electricity by 55%, gas by 29%, district heating by 50%, oil products by 27%, and direct use renewable energy by 60% (table 5.3). Such a large increase in energy generation from renewable sources arises from the necessity of meeting requirements of the Climate and Energy Package within the European Union.

In addition an increase is anticipated during the analysed period in the demand for all energy carriers from renewable sources (almost ten-fold of electricity, almost two-fold of heat and twenty-fold of liquid fuels).

A moderate increase is anticipated in the final demand for electricity from ca. 111 TWh in 2006 to ca. 172 TWh in 2030, i.e. by ca. 55%, which is caused by the expected use of available reserves from market transformation and effectiveness measures carried out in the economy. The demand for peak load capacity is projected to grow from 23.5 MW in 2006 to ca. 34.5 MW in 2030. The gross demand for electricity is expected to grow from ca. 151 TWh in 2006 to ca. 217 TWh in 2030.

As a result of ecological requirements in the cost-wise optimum structure of electrical power sources nuclear power plants are going to appear, the rate of development of which is limited by organisational and technical reasons. According to assumptions the first nuclear power unit may be started up in 2020. Up to 2030 three nuclear power units with a net total power of 4500 MW (gross 4800 MW) should be already in operation.

Achievement of EU objectives with respect to the share of electricity from renewable sources will require gross production of electricity from RES in 2020 at the level of ca. 31 TWh, which accounts for 18.4% of total generation, and in 2030 at the level of 39.5 TWh, which accounts for ca. 18.2% of total generation. The wind power plants are expected to have the biggest share here – in 2030 ca. 18 TWh, which constitute ca. 8.2% of the anticipated gross electricity total production.

Table 5.2. Demand for final energy in a division into economic sectors

Sectors of the economy	Demand for final energy by years [Mtoe]					
	2006	2010	2015	2020	2025	2030
Industry	20.9	18.2	19.0	20.9	23.0	24.0
Transport	14.2	15.5	16.5	18.7	21.2	23.3
Agriculture	4.4	5.1	4.9	5.0	4.5	4.2
Services	6.7	6.6	7.7	8.8	10.7	12.8
Households	19.3	19.0	19.1	19.4	19.9	20.1
TOTAL	**65.5**	**64.4**	**67.3**	**72.7**	**79.3**	**84.4**

Source: IOŚ.

Table 5.3. Demand for final energy by carriers

Specification	Demand for final energy by years [Mtoe]					
	2006	2010	2015	2020	2025	2030
Coal	12.3	10.9	10.1	10.3	10.4	10.5
Oil products	21.9	22.4	23.1	24.3	26.3	27.9
Natural gas	10.0	9.5	10.3	11.1	12.2	12.9
Renewable energy	4.2	4.6	5.0	5.9	6.2	6.7
Electricity	9.5	9.0	9.9	11.2	13.1	14.8
Municipal heating	7.0	7.4	8.2	9.1	10.0	10.5
Remaining fuels	0.6	0.5	0.6	0.8	1.0	1.2
TOTAL	**65.5**	**64.4**	**67.3**	**72.7**	**79.3**	**84.4**

Source: IOŚ.

Electricity generation in highly efficient cogeneration is expected to keep growing from 24.4 TWh in 2006 to 47.9 TWh in 2030. The share of electricity generation in highly efficient cogeneration in gross domestic demand for electricity is projected to grow from 16.2% in 2006 to 22% in 2030. Changes in the anticipated net electricity generation by fuels are presented in table 5.4.

Detailed data for sector 1.A. *Fuel combustion* on the use of fuels determined according to the *Forecast of the demand for fuels and energy until 2030*, used to evaluate future changes of greenhouse gas emission, are presented in table 5.5.

The emission factors applied for evaluating greenhouse gas emission in the fuel combustion sector are three-year period average values in the years 2005–2007, calculated according to the most recent domestic greenhouse gas inventories for the years 2005–2007 for subcategories: 1.A.1.a, 1.A.1.b and c, 1.A.2 – stationary sources and 1.A.4 – stationary sources and for road transport (1.A.3) respectively. For the

Table 5.4. Net electricity generation by fuels

Specification	Net electricity generation by years [TWh]					
	2006	2010	2015	2020	2025	2030
Hard coal	86.1	68.2	62.9	62.7	58.4	71.8
Brown coal (lignite)	49.9	44.7	51.1	40.0	48.4	42.3
Natural gas	4.6	4.4	5.0	8.4	11.4	13.4
Petroleum products	1.6	1.9	2.5	2.8	2.9	3.0
Nuclear power	0.0	0.0	0.0	10.5	21.1	31.6
Renewable energy	3.9	8.0	17.0	30.1	36.5	38.0
Water pump energy	1.0	1.0	1.0	1.0	1.0	1.0
Waste	0.6	0.6	0.6	0.6	0.7	0.7
TOTAL	**147.7**	**128.7**	**140.1**	**156.1**	**180.3**	**201.8**
Share of energy from RES [%]	2.7	6.2	12.2	19.3	20.2	18.8

Source: IOŚ.

Table 5.5. Input data for sector 1.A *Fuel combustion*

Fuel	Fuel consumption by years [PJ]		
	2015	2020	2030
1.A.1.a			
Hard coal	907.95	849.55	891.52
Brown coal (lignite)	504.97	388.98	403.61
Natural gas	62.27	84.16	120.65
Fuel wood and wood waste	87.68	150.39	169.36
Biogas	19.89	41.30	66.99
Industrial waste	4.68	6.16	9.74
Coke and semi-coke (including gas coke)	1.00	1.16	1.50
Liquid petroleum gas	0.05	0.06	0.07
Diesel oil	1.38	1.21	1.13
Fuel oil	33.27	35.92	38.17
Coke-oven gas	15.26	15.44	16.38
Blast furnace gas	6.45	6.45	6.57
1.A.1.b and c			
Hard coal	14.76	14.40	14.00
Brown coal (lignite)	0.15	0.16	0.13
Natural gas	23.70	25.05	27.47
Industrial waste	0.28	0.29	0.32
Liquid petroleum gas	1.84	1.86	1.90
Diesel oil	0.56	0.59	0.65
Fuel oil	27.79	28.49	29.95
Refinery gas	17.46	19.57	19.57
Coke-oven gas	36.80	36.99	37.36
Blast furnace gas	1.33	1.37	1.38

Fuel	Fuel consumption by years [PJ]		
	2015	2020	2030
1.A.2			
Hard coal	93.42	100.68	106.63
Brown coal (lignite)	0.10	0.12	0.13
Natural gas	102.64	112.26	119.90
Fuel wood and wood waste	35.99	40.19	45.48
Industrial waste	18.85	21.26	25.19
Coke and semi-coke (including gas coke)	20.45	22.22	31.94
Liquid petroleum gas	5.13	4.95	4.33
Furnace oil	12.41	13.10	12.64
Refinery gas	26.47	29.66	29.66
Coke-oven gas	21.56	22.88	29.18
Blast furnace gas	14.71	14.44	17.60
1.A.4			
Hard coal	267.78	243.34	203.25
Brown coal (lignite)	3.84	3.73	3.13
Natural gas	240.77	261.84	310.55
Fuel wood and wood waste	133.94	141.94	161.01
Coke and semi-coke (including gas coke)	7.60	7.76	7.73
Liquid petroleum gas	23.69	21.18	17.05
Diesel oil	133.44	134.12	123.64
Fuel oil	2.88	2.73	1.87

Source: IOŚ.

remaining transport means assigned to category 1.A.3 (aviation, railways, navigation, off-road transport) and mobile sources from subcategory 1.A.2.f and 1.A.4.c, all emission factors come from IPCC guidelines.

A source for the remaining input data (apart from the use of fuels) used for projections of emissions was first of all official activity forecasts (e.g. on industrial products manufacture, agricultural production, volume of disposed sewage etc.) by years and by types of sources submitted to the Ministry of Environment by relevant ministries. In cases in which no input data on activities for a part of activity types were available, the trend in activity changes was evaluated on the basis of existing publications, studies, research works and evaluations of experts.

Input data for sector 2. *Industrial processes* (table 5.6) come first of all from the Ministry of the Economy (manufacture of sintered iron ores, pig iron, steel from converter furnaces and electric furnaces, coke and aluminium), as well as from forecasts developed by associations and industrial institutes (lime and cement production), and as regards sources, for which no forecasts were obtained for production in the years 2015–2030, use was made of activities for 2007 in domestic greenhouse gas emission inventory, coming from national statistics.

Emission factors used for the emission projections in sector 2. conform to average three-year values of emission factors in given subcategories applied in national greenhouse gas emission inventories for the years 2005–2007.

Projection of CO_2 emission from the Solvent and other product use has been based on a forecast of emission of non-methane volatile organic compounds (table 5.7) developed up to 2015. Due to lack of data for the consequent period, for the years 2020 and 2030 adopted were values anticipated for 2015.

Detailed data concerning the anticipated dynamics in activity changes in sector 4. *Agriculture* was obtained from the Ministry of Agriculture and Rural Development. Activities related to the goats livestock were adopted as the average value for the years 2005–2007 (table 5.8).

CH_4 and N_2O emission factors for the majority of subcategories in the sector of agriculture were obtained from inventory conducted in 2007. CH_4 factors from enteric fermentation and manure management of dairy cattle have been verified on the basis of data concerning the anticipated average annual milk production. The CH_4 and N_2O emission from combustion of plant waste has been adopted pursuant to the average value from the years 2005–2007.

Table 5.9 presents data on activities forming a basis for estimation of greenhouse gas emissions in sector 6 *Waste*. Based on data from the National Waste Management Plan 2010 (NWMP 2010) related to the projected volume of generated municipal waste, and on the basis of the share of municipal waste disposal on land and incineration in the total stream of waste generated in the years 2005–2007, calculations were made of the volume of incinerated and landfilled municipal waste for the years 2015–2030. Similarly calculations were carried out for incineration of sewage sludge, as well as incineration and disposal of industrial waste: in the first case data from NWMP 2010 were included, which concerned the forecast for the volume of generated municipal sewage slud-

Table 5.6. Input data for sector 2. *Industrial processes*

Industrial processes	Industrial production in years [Gg]		
	2015	2020	2030
A. Mineral products			
1. Cement production	14649.6	14649.6	14649.6
2. Lime production	2350.0	2350.0	2350.0
4. Soda ash – use	1191.7	1191.7	1191.7
B. Chemical industry			
1. Ammonia production	2417.5	2417.5	2417.5
2. Nitric acid production	2269.9	2269.9	2269.9
4. Carbide production	16.1	16.1	16.1
5. Other			
5.a Methanol	0.22	0.22	0.22
5.b Carbon black	38.16	38.16	38.16
5.c Styrene	114.61	114.61	114.61
5.e Ethylene	1300.00	1300.00	1300.00
5.j Caprolactam	157.60	157.60	157.60
C. Metal production			
1. Iron and steel production			
1.a Sinter	8500.00	8500.00	8500.00
1.c Steel cast	142.20	142.20	142.20
1.d Iron cast	1019.09	1019.09	1019.09
1.e Pig iron	6000.00	6000.00	6000.00
1.f Basic oxygen furnace steel	7500.00	7500.00	7500.00
1.g Electric furnace steel	4300.00	4300.00	4300.00
1.j Coke	11200.00	11680.00	11680.00
2. Ferroalloys production	58.54	58.54	58.54
3. Aluminium production	55.00	55.00	55.00
5. Other			
5.b Lead	80.06	80.06	80.06
5.c Zinc	64.50	64.50	64.50

Source: IOŚ.

Table 5.7. Input data for sector 3. *Solvent and other product use*

The use of solvents and other products	Emission of non-methane volatile organic compounds by years [Gg]		
	2015	2020	2030
A. Paint application	107.70	107.70	107.70
B. Degreasing and dry cleaning	47.64	47.64	47.64
C. Chemical products, manufacture and processing	24.72	24.72	24.72
D. Other	48.23	48.23	48.23

Source: IOŚ.

Table 5.8. Input data for sector 4. *Agriculture*

Agriculture	Unit	Years		
		2015	2020	2030
Area of agricultural lands	thousand ha	15 700	15 500	15 100
Total sown area	thousand ha	10 970	10 715	10 300
Average annual cows' milk production	kg/year	5 200	5 650	6 850
Use of nitrogen fertilizers	thousand tonnes	1 200	1 200	1 200
Cattle	thousand heads	5 600	5 800	6 200
including: dairy cattle	thousand heads	2 500	2 300	1 900
Sheep	thousand heads	320	320	320
Goats	thousand heads	139	139	139
Horses	thousand heads	340	350	350
Pigs	thousand heads	16 200	16 300	17 000
Poultry	thousand heads	150 000	160 000	171 000
Area of N-fixing crops	thousand ha	275	275	300
Area of other than N-fixing crops	thousand ha	10 695	10 440	10 000
Area of organic soils under cultivation	thousand ha	680	675	665

Source: IOŚ.

Table 5.9. Input data for sector 6. *Waste*

Specification	Unit	Years		
		2015	2020	2030
Population of Poland	million	38.02	37.83	36.80
Waste				
Volume of solid municipal waste deposited on landfills in the given year	Gg	11 412	11 874	11 874
Combustion of municipal waste	Gg	57	60	60
Combustion of industrial waste	Gg	153	150	150
Combustion of medical waste	Gg	27	29	32
Combustion of sewage sludge	Gg	84	88	88
Sewage				
Animal protein – consumption	[g/person/day]	51.04	51.04	51.04
Vegetable protein – consumption	[g/person/day]	48.84	48.84	48.84
Number of inhabitants using sewage treatment plants	thousand	27 224	29 055	32 083

Source: IOŚ.

ge, and in the second case the forecast of the volume of generated hazardous waste and waste other than municipal.

Moreover, pursuant to the increase in the number of medical consultation by 1% each year as anticipated in the NWMP 2010 a calculation was made of the volume of incinerated medical waste, and the values provided in national inventories were duly increased by 1% annually until 2030.

NWMP 2010 provided anticipated values for the years 2010, 2014 (2015 for sewage sludge) and 2018. So for the purpose of emission calculations, the values of 2014 were used for 2015, and the values of 2018 were applied for 2020 and 2030.

The forecast of the Polish population number has been based on data provided by the GUS Statistical Yearbook. The annual protein consumption in conversion of one inhabitant was adopted similarly as in 2007. The percentage of population using sewage treatment plants in the years 2015, 2020 and 2030, was estimated by the method of linear regression pursuant to statistical data for the past 5 years. The obtained results and data concerning the expected number of inhabitants in particular years covered by the projection were used to calculate the anticipated population number served by sewage treatment plants.

The greenhouse gas emission factors adopted in projections in the waste sector were applied in the national inventory for 2007.

Balance of CO_2 emission and removals connected with afforestation, reforestation and deforestation (as specified in Article 3.3 of the Kyoto Protocol) and with measure

conducted within forest management selected by Poland as an additional activities (Article 3.4 of the Kyoto Protocol), have been adopted as negative values as follows:
– 1000.00 Gg of CO_2 equivalent under Article 3.3,
– 3006.67 Gg of CO_2 equivalent under Article 3.4.

The amount of CO_2 removals under Article 3.3 of the Kyoto Protocol activities, related to afforestation, reforestation and deforestation since 1990 was adopted in an arbitrary way, highly conservatively. The actual value has not been assessed yet, and initial estimates allow to determine a range of this value as being from 1 to a few million tonnes of CO_2. In the last EU notification to the Secretariat of UNFCCC (Informal submission on forest data, September 2009) concerning Poland the value of CO_2 removals related to afforestation and reforestation has been assumed[19)] to be 1849–3240 Gg in the period 2001–2005. Those estimates are only approximate in nature, and are to be further verified in the forthcoming years.

It was also assumed that annual carbon removal arising from measures carried out in forest management would equal to 820 Gg C (3006.67 Gg CO_2), which is consistent with cap values set up for Poland for the period 2008–2012 (dec.11/CP.7). This limit conforms to 15% of CO_2 capture in 1990 (the estimate has been made before 2001). Owing to the temporary lack of available detailed data related to the balance of CO_2 emission and removal under the approved forest management system in Poland the same value has been adopted for the three years in the forecast, i.e. 2015, 2020 and 2030.

5.2. Results of emission projections

The projected greenhouse gas emission, and first of all CO_2 emission, in the PEP'09 scenario is going to decrease until 2020, and will subsequently start to grow in 2030 (table 5.10), which is consistent with the trend in the forecast of demand for fuels and energy, used as a basis for *The Energy Policy of Poland until 2030*. The biggest share in emission will concern carbon dioxide – over 81%, with the share of methane and nitrous oxide would account for ca. 10% and 8% respectively, and industrial gas will account for ca. 1% of emission.

The value of **projected total greenhouse gas emission** is first of all affected by sector 1. *Energy* (table 5.11), and a lower emission is anticipated in this sector as compared within the period of 1988–2007. Similarly a lower greenhouse gas emission is expected in *Agriculture*, with a slight increase in the years 2015–2020. Furthermore, emission from sectors *Industrial processes* and *Waste* would continue to grow systematically.

A comparison of emission in projected years 2015–2030 with data for the base year 1988 indicated a decrease in emission by over 30% for all sectors, with the most significant emission reduction in sectors *Energy* and *Agriculture*. *Industrial processes* and *Waste* are characterised by an emission increase starting in 2015 (table 5.11). The emission projected until 2030 is much lower than the domestic emission cap resulting from the adopted emission reduction target of the Kyoto Protocol – emission reduction by 6% in the years 2008–2012 in relation to base year 1988 (Fig. 5.1).

Changes in the greenhouse gas emission structure in 1988 and in 2030 by IPCC source categories (table 5.12) suggest a decrease in the share of the *Energy* sector from over 83% to 78.6% in favour of an increased share of *Industrial processes* and *Waste*.

Detailed results of **carbon dioxide emission projections** by IPCC source categories were presented in table 5.13. Hence CO_2 emission gets to the level of 307 274 Gg in 2015 and subsequently decreases by ca. 4% to 294 833 Gg in 2020. By 2030 emission is going to grow once again by ca.

Table 5.10. Collective results of projections of GHG emission by gases for the years: 2007, 2015, 2020 and 2030

Greenhouse gas	Greenhouse gas emission by years [Gg of CO_2 equivalent]			
	2007	**2015**	**2020**	**2030**
CO_2	328 172.10	307 273.58	294 833.04	314 690.16
CH_4	37 065.69	35 512.22	36 204.12	37 621.78
N_2O	30 032.08	31 263.42	31 435.00	32 073.56
HFCs	3327.01	3254.27	3265.85	3265.85
PFCs	276.65	265.82	260.92	260.92
SF_6	31.92	30.94	35.72	35.72
Total	**398 905.45**	**377 600.26**	**365 847.60**	**387 948.00**

The presented values did not include emission and removals from sector *5. Land use, land-use change and forestry.*
Source: IOŚ.

19) Values estimated by the European Union Joint Research Centre in Ispra, Italy.

Table 5.11. Projections for greenhouse gas emission and their comparison with the baseline year

Source category	Greenhouse gas emission by years [Gg of CO_2 equivalent]				Greenhouse gas emission as compared to the base year [%]		
	1988	2015	2020	2030	(2015–1988)/ 1988×100%	(2020–1988)/ 1988×100%	(2030–1988)/ 1988×100%
1. Energy	470 309.06	296 830.12	284 392.39	304 900.95	-36.89	-39.53	-35.17
2. Industrial processes	32 832.19	35 604.20	35 716.69	35 716.69	8.44	8.79	8.79
3. Use of solvents and other products	1006.46	835.53	835.53	835.53	-16.98	-16.98	-16.98
4. Agriculture	50 893.90	35 269.29	35 650.66	36 560.52	-30.70	-29.95	-28.16
5. Land use, land-use change and forestry	-32 926.48	-4006.67	-4006.67	-4006.67			
6. Waste	8401.16	9061.13	9439.39	9934.32	7.86	12.36	18.25
Total emission excluding sector 5	**563 442.77**	**377 600.26**	**366 034.66**	**387 948.00**	**-32.98**	**-35.04**	**-31.15**

Total emission does not include emission and removal from sector *5. Land use, land-use change and forestry.*

Source: IOŚ.

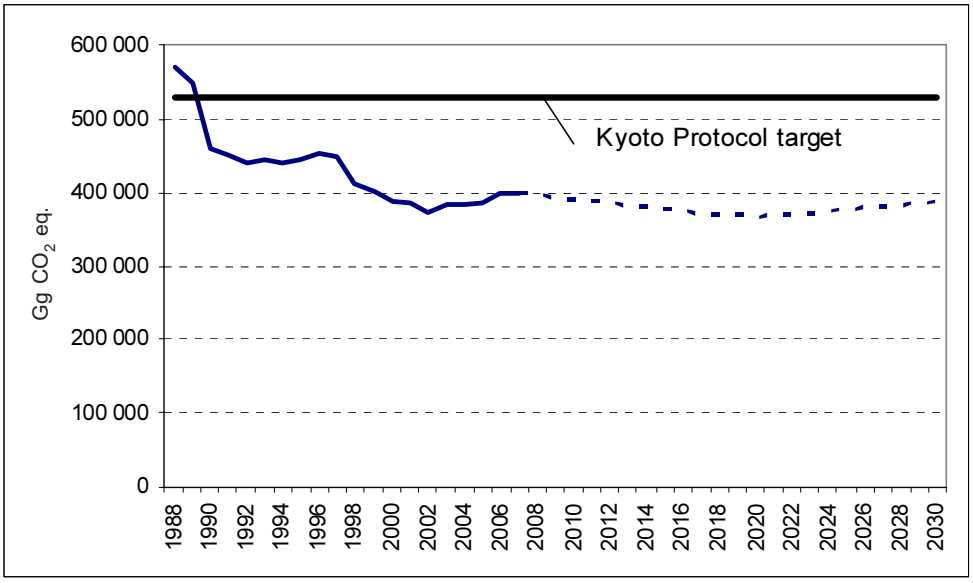

Figure 5.1. The present (1988–2007) and projected (2015, 2020 and 2030) greenhouse gas emission in Poland as compared to the domestic emission reduction target resulting from the Kyoto Protocol, source: IOŚ

Table 5.12. Structure of GHG emissions in 1988 and in 2030 for the scenario PEP'09

Source category	Structure of GHG emission [%]	
	1988	2030
1. Energy	83.47	78.59
2. Industrial processes	5.83	9.21
3. Solvent and other product use	0.18	0.22
4. Agriculture	9.03	9.42
6. Waste	1.49	2.56

Source: IOŚ.

6.7%. As compared to the base year of 1988 a significant emission decrease will take place: by 35% in 2015, by 37% in 2020 and by 33% in 2030. The biggest impact on fluctuations of emission will be exerted by sector 1. *Energy*.

Changes in the emission structure of carbon dioxide in 1988, 2007 and 2030 by IPCC source categories is presented in table 5.14. A decrease is visible in the share of the sector *Energy* in total emission with concurrent increase in the share of sectors: *Industrial processes* and *Waste*.

Detailed results of **carbon dioxide emission projections** by IPCC source categories were presented in table

Table 5.13. CO_2 emissions for the PEP'09 scenario by detailed IPCC source categories as compared with data for the years 1988 and 2007

Source category	Carbon dioxide emission by years [Gg]				
	1988	2007	2015	2020	2030
1. Energy	**440 437.35**	**302 824.57**	**279 382.94**	**266 848.17**	**286 702.76**
A. Fuel combustion	440 389.27	302 626.10	278 848.00	266 339.47	286 273.05
1. Energy industries	268 294.61	181 992.63	157 359.05	141 181.34	149 714.36
2. Manufacturing industries and construction	42 536.34	34 664.17	27 687.78	29 656.03	33 156.55
3. Transport	21 846.92	38 212.74	42 519.48	45 455.14	55 564.05
4. Other sectors	107 711.40	47 756.56	51 281.69	50 046.95	47 838.10
B. Fugitive emissions from fuels	48.08	198.46	534.94	508.70	429.71
1. Solid fuels	2.17	1.57	1.31	1.34	1.48
2. Oil and natural gas	45.91	196.89	533.62	507.35	428.23
2. Industrial processes	**27 244.74**	**24 426.94**	**26 864.87**	**26 960.86**	**26 960.86**
A. Mineral products	10 802.63	10 399.77	11 694.90	11 694.90	11 694.90
B. Chemical industry	4 801.70	4 244.16	4 324.21	4 324.21	4 324.21
C. Metal production	11 640.41	8 826.39	9 788.79	9 884.78	9 884.78
D. Other production		0.08	6.32	6.32	6.32
G. Other processes		956.54	1050.65	1050.65	1050.65
3. Solvent and other products use	**882.46**	**609.04**	**711.53**	**711.53**	**711.53**
4. Agriculture	0	0	0	0	0
A. Enteric fermentation	0	0	0	0	0
B. Manure management	0	0	0	0	0
D. Agricultural soils	0	0	0	0	0
F. Field burning of agricultural residues	0	0	0	0	0
5. Land use, land-use change and forestry	**-32 934.72**	**-42 884.81**	**-4 006.67**	**-4 006.67**	**-4 006.67**
Article 3.3 of the Kyoto Protocol			-1 000.00	-1 000.00	-1 000.00
Article 3.4 of the Kyoto Protocol			-3 006.67	-3 006.67	-3 006.67
6. Waste	**579.27**	**311.55**	**314.25**	**312.49**	**315.01**
A. Solid waste disposal on land	0.00	0.00	0.00	0.00	0.00
B. Waste-water handling	0.00	0.00	0.00	0.00	0.00
C. Waste incineration	579.27	311.55	314.25	312.49	315.01
Total CO_2 emission excluding sector 5	**469 143.82**	**328 172.10**	**307 273.58**	**294 833.04**	**314 690.16**
CO_2 emission from biomass	3 866.95	21 358.10	25 509.40	33 201.32	38 654.66

Source: IOŚ.

Table 5.14. Structure of CO_2 emission in 1988, 2007 and for 2030 according to the PEP'09 scenario

Categories of sources	Structure of CO_2 emission [%]		
	1988	2007	2030
1. Energy	93.88	92.28	91.11
2. Industrial processes	5.81	7.44	8.57
3. Solvent and other product use	0.19	0.19	0.23
6. Waste	0.12	0.09	0.10

Source: IOŚ.

5.13. Hence CO_2 emission gets to the level of 307 274 Gg in 2015 and subsequently decreases by ca. 4% to 294 833 Gg in 2020. By 2030 emission is going to grow once again by ca. 6.7%. As compared to the base year of 1988 a significant emission decrease will take place: by 35% in 2015, by 37% in 2020 and by 33% in 2030. The biggest impact on fluctuations of emission will be exerted by sector 1. *Energy*.

Changes in the emission structure of carbon dioxide in 1988, 2007 and 2030 by IPCC source categories is presented in table 5.14. A decrease is visible in the share of the sector *Energy* in total emission with concurrent increase in the share of sectors: *Industrial processes* and *Waste*.

Table 5.15. CH_4 emission for the PEP'09 scenario in a division into IPCC source categories as compared to data for the years 1988 and 2007

Source category	Methane emission by years [Gg CO_2 equivalent]				
	1988	2007	2015	2020	2030
1. Energy	**27 555.85**	**16 131.75**	**14 763.25**	**14 812.08**	**15 131.75**
A. Fuel combustion	4 840.91	2 682.56	2 746.89	2 710.79	2 653.11
1. Energy industries	75.09	61.51	96.22	134.20	151.22
2. Manufacturing industries and construction	46.58	77.76	64.21	70.69	80.16
3. Transport	134.02	111.36	116.99	124.18	150.32
4. Other sectors	4 585.20	2 431.93	2 469.46	2 381.73	2 271.41
B. Fugitive emission from fuels	22 714.95	13 449.19	12 016.36	12 101.29	12 478.64
1. Solid fuels	18 583.63	8 610.95	7 638.88	7 249.83	6 790.04
2. Crude oil and natural gas	4 131.32	4 838.24	4 377.49	4 851.46	5 688.60
2. Industrial processes	**293.62**	**426.00**	**404.02**	**409.06**	**409.06**
A. Mineral products	0.00	0.00	0.00	0.00	0.00
B. Chemical industry	255.46	280.31	257.58	257.58	257.58
C. Metal production	38.16	145.69	146.44	151.48	151.48
4. Agriculture	**19 157.04**	**12 980.01**	**12 709.22**	**12 962.83**	**13 539.03**
A. Enteric fermentation	15 706.86	9 305.67	9 297.34	9 502.30	9 927.17
B. Manure management	3 419.72	3 649.41	3 387.85	3 436.50	3 587.84
D. Agricultural soils	0	0	0	0	0
F. Field burning of agricultural residues	30.46	24.92	24.02	24.02	24.02
5. Land use, land-use change and forestry	**7.48**	**2 385.30**	**0.00**	**0.00**	**0.00**
6. Waste	**6 658.51**	**7 527.93**	**7 635.73**	**8 020.15**	**8 541.94**
A. Solid waste disposal on land	4 934.38	6 471.52	6 457.47	6 775.92	7 188.64
B. Waste-water handling	1 724.13	1 056.40	1 178.26	1 244.23	1 353.30
C. Waste incineration	0.00	0.00	0.00	0.00	0.00
Total CH_4 emission excluding sector 5	**53 665.03**	**37 065.69**	**35 512.22**	**36 204.12**	**37 621.78**

Source: IOŚ.

Table 5.16. Structure of CH_4 emission in 1988, 2007 and 2030 according to the scenario PEP'09

Source category	Structure of CH_4 emission [%]		
	1988	2007	2030
1. Energy	51.35	43.52	40.22
2. Industrial processes	0.55	1.15	1.09
3. Solvent and other product use	0.00	0.00	0.00
4. Agriculture	35.70	35.02	35.99
6. Waste	12.41	20.31	22.70

Source: IOŚ.

The projected methane emission is expected to grow gradually from 35 512 Gg in 2015 to 37 622 Gg in 2030. Changes in emission are insignificant – the anticipated increase is by 1.9% in 2020 as compared to 2015 and by 3.9% in 2030 as compared to 2020. In relation to 1988 the CH_4 emission decreases by ca. 34% in 2015, by 33% in 2020, and by 30% in 2030. The biggest impact on changes in methane emissions in the period covered by the forecast is exerted by sectors 4. *Agriculture* and 6.*Waste*.

The structure of methane emission in 1988, 2007 and 2030 by IPCC source categories is presented in table 5.16. A considerable increase is visible of the share of sector 6. *Waste* in domestic methane emission with a concurrent decrease in the share of sector 1. *Energy*.

Results of **projections for nitrous oxide emission** are presented in table 5.17. The N_2O emission in 2015 is expected to amounted to 31 168 Gg, and will subsequently grow by ca. 0.5% in 2020 and by ca. 2.0% to almost 32 074 Gg in 2030. The forecasts assume a decrease in emission by ca. 22.5%, 22.1% and 20.5% in 2015, 2020 and 2030 respectively as compared to 1988. The biggest decrease in N_2O emission since 1988 has been recorded in sector 4. *Agriculture* along with a decreasing livestock and the volume of applied fertilizers as well as decreasing cropland areas.

Changes in the emission structure of nitrous oxide in 1988, 2007 and 2030 according to IPCC sectors are presented in table 5.18. A decrease is visible in the share of *Agriculture* in favour of the remaining IPCC source categories.

Table 5.17. Emission of N_2O for the PEP'09 scenario in a division into IPCC source categories as compared to data for the years 1988 and 2007

Source category	Emission of nitrous oxide by years [Gg of CO_2 equivalent]				
	1988	2007	2015	2020	2030
1. Energy	**2 315.86**	**1 925.79**	**2 683.93**	**2 732.14**	**3 066.43**
A. Fuel combustion	2 315.86	1 925.55	2 683.48	2 731.71	3 066.05
1. Energy industries	1 192.18	830.44	796.74	797.23	854.22
2. Manufacturing industries and construction	226.41	211.99	178.31	201.90	235.46
3. Transport	278.17	460.95	1 239.96	1 260.24	1 502.84
4. Other sectors	619.11	422.16	468.47	472.34	473.52
B. Fugitive emission from fuels	0.00	0.24	0.45	0.44	0.39
1. Solid fuels	0.00	0.00	0.00	0.00	0.00
2. Crude oil and natural gas	0.00	0.24	0.45	0.44	0.39
2. Industrial processes	**4 993.43**	**4 810.76**	**4 784.27**	**4 784.27**	**4 784.27**
A. Mineral products	0.00	0.00	0.00	0.00	0.00
B. Chemical industry	4 993.43	4 784.27	4 784.27	4 784.27	4 784.27
C. Metal production	0.00	26.49	0.00	0.00	0.00
3. Solvent and other products use	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**
4. Agriculture	**31 736.85**	**22 059.63**	**22 560.08**	**22 687.84**	**23 021.49**
A. Enteric fermentation	0.00	0.00	0.00	0.00	0.00
B. Manure management	9 335.10	6 077.80	5 716.52	5 824.03	6 062.96
D. Agricultural soils	22 378.37	15 967.77	16 829.51	16 849.77	16 944.48
F. Field burning of agricultural residues	23.38	14.06	14.04	14.04	14.04
5. Land use, land-use change and forestry	**0.76**	**2.42**	**0.00**	**0.00**	**0.00**
6. Waste	**1 163.38**	**1 111.90**	**1 111.15**	**1 106.75**	**1 077.37**
A. Solid waste disposal on land	0.00	0.00	0.00	0.00	0.00
B. Waste-water handling	1 142.28	1 083.32	1 080.23	1 074.94	1 045.56
C. Waste incineration	21.10	28.58	30.92	31.81	31.81
Total N_2O emission excluding sector 5	**40 333.53**	**30 032.08**	**31 263.42**	**31 435.00**	**32 073.56**

Source: IOŚ.

Table 5.18. Structure of N_2O emissions in 1988, 2007 and 2030 according to the PEP'09 scenario

Source category	Structure of N_2O emission [%]		
	1988	2007	2030
1. Energy	5.74	6.41	9.56
2. Industrial processes	12.38	16.02	14.92
3. Solvent and other products use	0.31	0.41	0.39
4. Agriculture	78.69	73.45	71.78
6. Waste	2.88	3.70	3.36

Source: IOŚ.

5.3. Comparison of projection results for the PEP'09 scenario with emission projections presented in the Fourth National Communication

Tables 5.19 and 5.20 present results of a comparison made for projections in the PEP'09 scenario with the scenario "with measures" contained in the Fourth National Communication in 2015 and in 2020. The comparison has shown that the Fourth National Communication adopted higher projections of greenhouse gas emission for all categories, except for forecasts of SF_6 emission.

Total greenhouse gas emission in the PEP'09 scenario in 2015 amounted to 75 160 Gg of CO_2 equivalent less than in the Fourth National Communication, while in 2020 – by 112 992 Gg CO_2 equivalent less. Consequently the decrease in the anticipated emission in relation to the Fourth National Communication was 17% for 2015 and ca. 24% for 2020.

A comparison of the PEP'09 scenario with the scenario "without measures" under the Fourth National Communication points to much bigger differences in total GHG emission. In 2015 emission according to PEP'09 is by 115 062 Gg CO_2 equivalent lower than in the Fourth National Communication, and in 2020 by 151 118 Gg CO_2 equivalent (tables 5.21 and 5.22). Reduction of the projected emission as compared to the Fourth National Communication was consequently ca. 23% for 2015 and ca. 29% for 2020.

Table 5.19. Comparison of the present projections of greenhouse gas emissions with the scenario "with measures" from the Fourth National Communication by greenhouse gases

Greenhouse gas (or greenhouse gas groups)	Greenhouse gas emission according to the PEP'09 scenario by years [Gg CO_2 equivalent]		Greenhouse gas emission according to the scenario "with measures" by years [Gg CO_2 equivalent]	
	2015	2020	2015	2020
CO_2	307 273.58	294 833.04	383 039.83	407 858.53
CH_4	35 512.22	36 204.12	35 943.31	36 874.05
N_2O	31 263.42	31 435.00	31 271.00	31 775.44
HFCs	3 254.27	3 265.85	2 204.78	2 217.69
PFCs	265.82	260.92	271.63	266.73
SF_6	30.94	35.72	29.64	34.42
Total excluding sector 5	**377 600.26**	**366 034.66**	**452 760.19**	**479 026.87**

Source: IOŚ.

Table 5.20. Comparison of the present projections of greenhouse gas emissions with the scenario "with measures" from the Fourth National Communication by main IPCC source categories

Source category	Greenhouse gas emission according to the PEP'09 scenario by years [Gg CO_2 equivalent]		Greenhouse gas emission according to the scenario "with measures" by years [Gg CO_2 equivalent]	
	2015	2020	2015	2020
1. Energy	296 830.12	284 392.39	381 014.25	405 993.10
2. Industrial processes	35 604.20	35 716.69	25 740.96	25 755.77
3. Solvent and other products use	835.53	835.53	0.00	0.00
4. Agriculture	35 269.29	35 650.66	34 856.64	35 045.12
5. Land use, land-use change and forestry	-4 006.67	-4 006.67	-22 763.35	-20 637.60
6. Waste	9 061.13	9 439.39	11 148.34	12 232.88
Total excluding sector 5	**377 600.26**	**366 034.66**	**452 760.19**	**479 026.87**

Source: IOŚ.

Table 5.21. Comparison of the present projections of greenhouse gas emissions with the scenario "without measures" under the Fourth National Communication by greenhouse gases

Greenhouse gas (or greenhouse gas groups)	Greenhouse gas emission according to the PEP'09 scenario by years [Gg CO_2 equivalent]		Greenhouse gas emission according to the scenario "without measures" by years [Gg CO_2 equivalent]	
	2015	2020	2015	2020
CO_2	307 273.58	294 833.04	420 972.34	443 070.55
CH_4	35 512.22	36 204.12	37 401.67	39 231.93
N_2O	31 263.42	31 435.00	31 764.74	32 309.52
HFCs	3 254.27	3 265.85	2 204.78	2 217.69
PFCs	265.82	260.92	271.63	266.73
SF_6	30.94	35.72	46.84	56.40
Total excluding sector 5	**377 600.263**	**366 034.66**	**492 662.01**	**517 152.82**

Source: IOŚ.

Table 5.22. Comparison of the present projections of greenhouse gas emissions with the scenario "without measures" under the Fourth National Communication by the main categories of sources

Source category	Greenhouse gas emission according to PEP'09 scenario by years [Gg CO_2 equivalent]		Greenhouse gas emission according to the scenario "without measures "by years [Gg CO_2 equivalent]	
	2015	2020	2015	2020
1. Energy	296 830.12	284 392.39	420 898.85	444 448.31
2. Industrial processes	35 604.20	35 716.69	25 758.17	25 777.75
3. Solvent and other products use	835.53	835.53	0.00	0.00
4. Agriculture	35 269.29	35 650.66	34 856.64	35 045.12
5. Land use, land-use change and forestry	-4 006.67	-4 006.67	-22 763.35	-20 637.60
6. Waste	9 061.13	9 439.39	11 148.34	11 881.64
Excluding sector 5	**377 600.26**	**366 034.66**	**492 662.01**	**517 152.82**

Source: IOŚ.

5.4. Sensitivity analysis for data for 2030

As regards the definition presented by Morgan and Henrion (1990)[20] the sensitivity analysis may be defined as modelling the impact of changes in input parameters or assumptions on the final results.

For Poland the sensitivity analysis for annual greenhouse gas emission inventories was carried out for the first time in 2007. Identical assumptions as for the analysis scenarios have been also adopted for the projected data for 2030. In the first stage of works input data are analysed and divided into key sources and the remaining ones. As regards 2030, the pool of emission from key sources was 369 753 Gg of CO_2 equivalent, which accounts for ca. 95% of total emission equalling to 387 948 Gg of CO_2 equivalent.

The analysis of key emission categories has shown that the biggest share in total emission – ca. 45.7% was recorded for the collective category defined as solid fuel combustion in the Energy Industry Sector (IPCC categories 1.A.1, 1.A.2, 1.A.4), and the smallest sources considered as the key category comprise emission of industrial gases from Refrigeration and ventilation (IPCC 2.F.1 0.69%); table 5.23. The structure of categories of key sources with the biggest impact on total emission was presented on fig. 5.2.

Data selected on the basis of an analysis of key sources are subjected to a sensitivity analysis the objective of which was to find the impact of selected input data and of certain initial assumptions on total results of inventories emissions. Changes of parameters have been grouped in four basic scenarios, which allowed identifying the "strength" of particular

[20] Morgan, M.G., Henrion, M. (1990). *Uncertainty. A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis*. Cambridge University Press. ISBN 0-521-42744-4.

Table 5.23. List of key categories for emission projections in 2030

Source category	Greenhouse gas	Emission in 2030 [Gg]	Share in total emission [%]	Accumulated share in total emission
1.A.1,2,4. Combustion of solid fuels – stationary sources	CO_2	177 175.89	0.4567	0.4567
1.A.3.b Road transport	CO_2	54 691.12	0.1410	0.5977
1.A.1,2,4. Gaseous fuel combustion – stationary sources	CO_2	32 102.01	0.0827	0.6804
1.A.1,2,4. Combustion of liquid fuels – stationary sources	CO_2	21 431.11	0.0552	0.7357
4.D.1. Direct emissions from soils	N_2O	11 257.23	0.0294	0.7651
4.A. Enteric fermentation	CH_4	9 927.17	0.0256	0.7907
2.C.1. Iron and steel production	CO_2	9 404.91	0.0242	0.8149
2.A.1. Cement production	CO_2	7 827.00	0.0202	0.8351
6.A. Solid waste disposal on land	CH_4	7 188.64	0.0185	0.8536
1.B.1 a. Coal mining	CH_4	6 702.70	0.0173	0.8709
4.B. Manure management	N_2O	6 062.96	0.0156	0.8865
1.B.2.b. Natural gas	CH_4	5 576.77	0.0144	0.9009
4.D.3. Indirect emission from soils	N_2O	5 152.51	0.0133	0.9142
2.B.2. Nitric acid production	N_2O	4 552.69	0.0117	0.9259
2.B.1. Ammonia production	CO_2	4 288.48	0.0111	0.9370
4.B. Manure management	CH_4	3 587.84	0.0092	0.9462
2.F.1. Refrigeration and air-conditioning	HFC	2 676.06	0.0069	0.9531

Source: IOŚ.

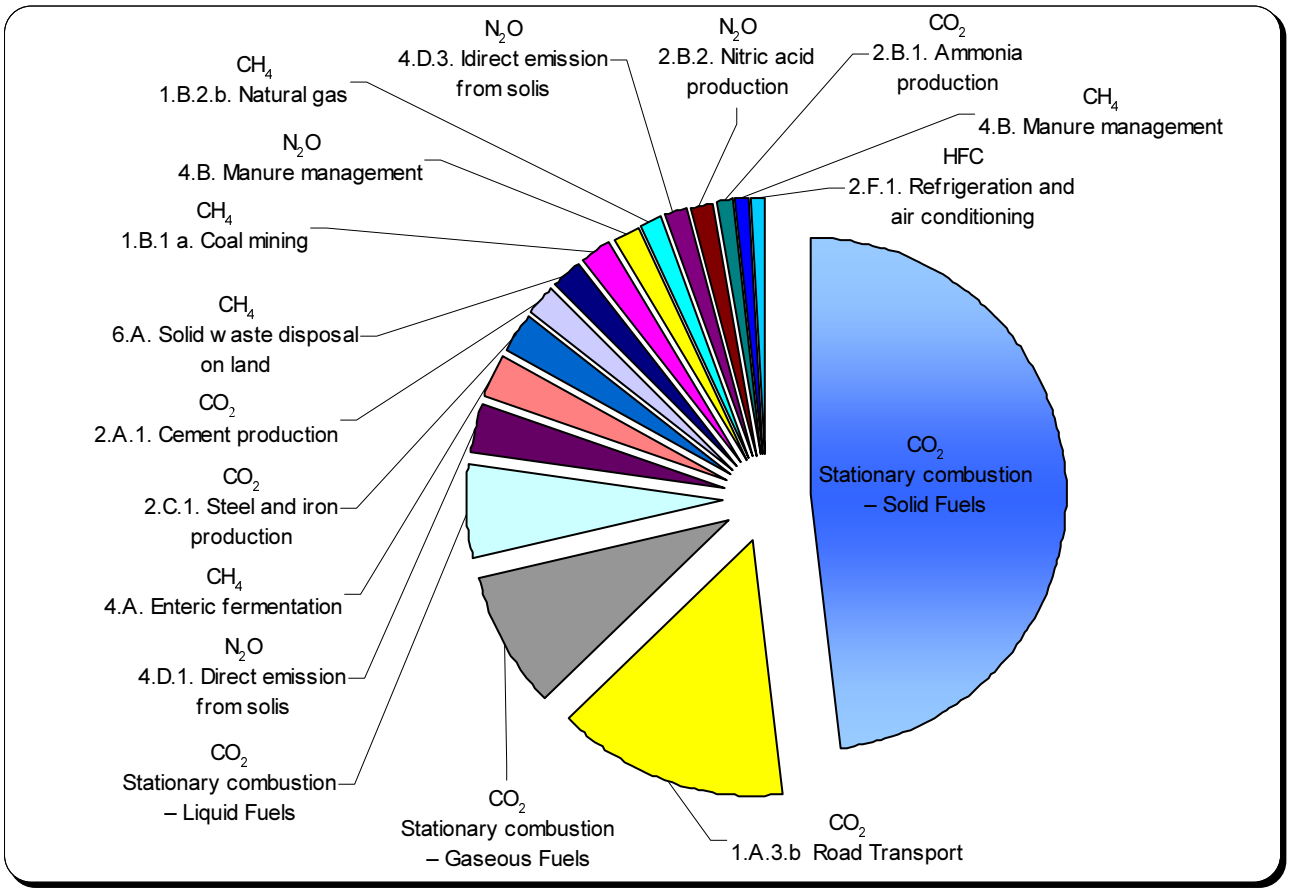

Figure 5.2. Structure of key emission sources in 2030, source: IOŚ

sources and selection of the ones having the biggest impact. Emissions from categories not considered to be key emission sources have been reviewed as constant, and owing to the insignificant impact on total results of the inventory they have been excluded from the sensitivity analysis (as a principle they account to a total of less than 5% of total emission). Calculation procedure was presented below (Fig. 5.3).

Preparation of the sensitivity analysis scenarios was preceded by an in-depth analysis of trends in inventory data particularly including the sector *Energy* (IPCC 1.) and *Agriculture* (IPCC 4). A simplified method of the deterministic analysis has been chosen for the numerical analysis, in which more than one input parameters were subjected to changes concurrently. Below and in tables 5.24–5.25 a discussion is contained of four options of the conducted analysis, hereinafter referred to as scenarios.

"Gaseous" Scenario A has been based on the assumptions that a part of the combustion solid fuels will be replaced by gaseous fuels. This change in the fuel consumption structure is taken into consideration owing to considerably lower CO_2 emission factors of gaseous fuels than solid fuels.

Assumptions: decrease in solid fuel consumption by 10%, increase in gaseous fuel consumption by 55%.
Result:
– emission from the key sources reduced only by 0.02%,
– total emission decreased by 0.02%.

"Energy +5%" Scenario B has been based on the projected development of the energy industry and increase in the consumption of fuels in this sector by 5%. Activities of the key emission sources in the IPCC sector 1. *Energy* have been increased by 5%, while the remaining activities have been maintained on the hitherto level.
Result:
– emission from the key sources increased by 3.86%,
– total emission increased by 3.68%.

"-5% emissivity" Scenario C has been based on the assumptions that new technologies and control systems of pollution emission to the air (APC) will be introduced, especially with respect to limiting the CO_2 emission. The CO_2 emission factors for the key emission sources have been reduced by 5%.

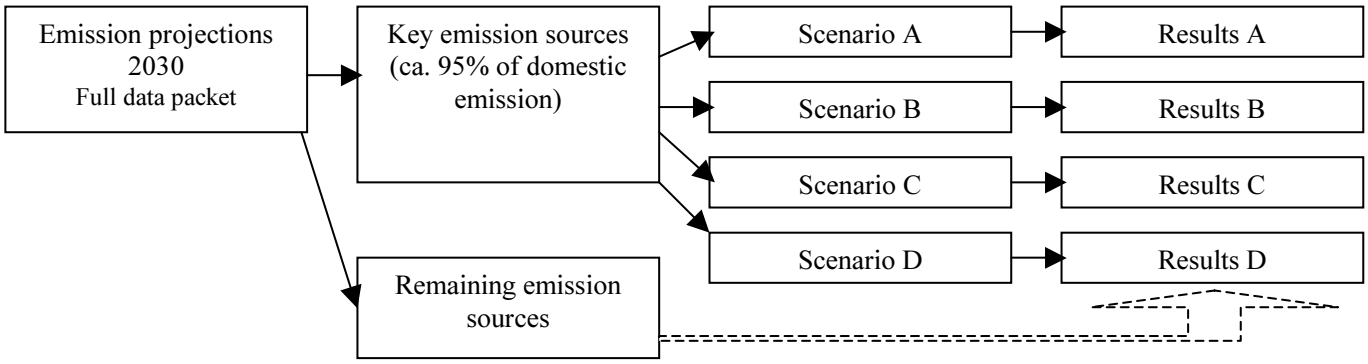

Figure 5.3. Simplified scheme of sensivity analisis for data, source: IOŚ

Table 5.24. General description of each scenario including identification of initial conditions and the main results for the four analysis options

Scenario	Name	Description	Assumptions	Main results
A	Gaseous Scenario	The scenario assumes partial transition from solid fuels to gaseous ones in the energy sector	Reduced consumption of solid fuels by 10% and an increase in gaseous fuel consumption by 55%	Decrease of total emission by ca. 0.02%
B	+5% Energy Scenario	The scenario assumes an increased consumption of all fuels in the energy sector	A 5% – increase in key activities in the energy sector	Growth of total emission by ca. 4%
C	-5% Reduced Emissivity Scenario	The scenario assumes the application of better control systems for industrial processes and exhaust gas purification. The assumed reduction in CO_2 emissivity was by 5%	A 5% – decrease in key CO_2 emission factors	Decrease of total emission by ca. 4%
D	Agricultural Scenario	The scenario assumes transformation in the agricultural sector, inter alia in the use structure of mineral fertilisers and in grazing	Growth of direct N_2O emission from soils by 4%, increased emission from animal excrements by 30%	Growth of total emission by ca. 0,6%

Source: IOŚ.

Table 5.25. Collective results of the sensitivity analysis and impact of changes in input parameters on the emission from key sources and on total emission

Scenarios	Key sources [%]	Total emission [%]	Total emission [Gg CO_2 equivalent]
Results of the emission inventory (projections) for 2030	**369 753.17**	**387 948.00**	**387 948.00**
Scenario A – change in emission as compared to inventory	-0.02%	-0.02%	387 886.51
Scenario B – change in emission as compared to inventory	3.86%	3.68%	402 218.00
Scenario C – change in emission as compared to inventory	-4.15%	-3.96%	372 601.97
Scenario D – change in emission as compared to inventory	0.62%	0.59%	390 223.10

Source: IOŚ.

Result:
- emission from the key sources decreased by 4.15%,
- total emission decreased by 3.96%.

"Agricultural" Scenario D has been based on assumptions for an increased consumption of mineral fertilisers, increased share of the manure management systems in the sector of utilisation of cattle and swine excrements and a decrease in the population of livestock.

Result:
- emission from the key sources increased by 0.62%,
- total emission changed by 0.59%.

The sensitivity analysis has shown that as regards scenarios connected with the dominating energy industry sectors (scenarios A, B and C) of particular importance is appropriate selection of data on activities of sources and assigning appropriate emission factors to them (Fig. 5.4).

The analysis of uncertainty for data from the energy sector indicates a low uncertainty of input data, yet owing to its dominating share in total emission it should be subject to further numerical studies, among others with the use of distributions of a random variable and modelling by the Monte Carlo method.

5.5. Aggregated effects of the policy and measures

To evaluate the effectiveness of implemented policies of GHG emission reduction, an analysis was carried out of changes in emission and emissivity over the years 1997–2007. A review was made of recalculated inventories of greenhouse gas emission from the years 1997, 2000, 2003 and a GHG inventory for 2007 with respect to identification of sectors and subsectors, in which the most significant reduction of GHG emission takes place. The main focus was on CO_2 emission in two sectors from category 1.A – *Fuel Combustion*, i.e. 1.A.1 – *Energy Industries* and 1.A.2 – *Manufacturing Industries and Construction*, as it accounts for ca. 66% of total domestic CO_2 emission. The CH_4 and N_2O emission from fuel combustion, converted into CO_2 equivalent, is insignificant and is not going to have a considerable impact on the national greenhouse gas emission.

As regards sector 2 (*Industrial processes*) CO_2 emission was taken into account, and additionally N_2O emission (table 5.32), which occurs only in subsector 2.B of this IPCC category.

The emission reduction may be a result of a change of the activity or emission factor. The analysis comprises mainly

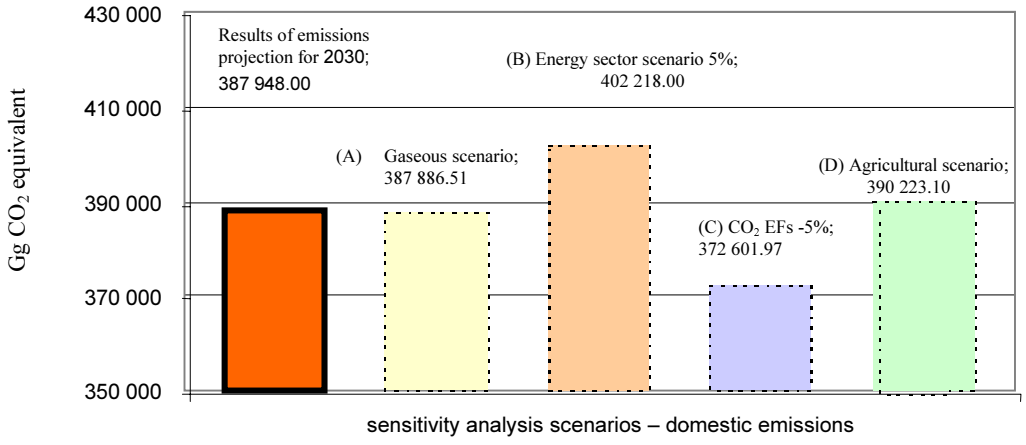

Figure 5.4. Total emissions allowing for assumptions for particular scenarios, source: IOŚ

subsectors with the highest emission share, which affects the value of domestic emission value. This analysis was contained in table 5.26, which presented for particular subsectors percentages of CO_2 emission in total domestic emission, excluding sector 5 IPCC – LULUCF). The CO_2 process emission has been added in the following IPCC sectors: 1.A.1.b (*Petroleum Refining*), 1.A.1.c.i (*Coking plants*), 1.A.2.a (*Iron and Steel*), 1.A.2.b (*Non-Ferrous Metals*), 1.A.2.c (*Chemicals*), 1.A.2.d (*Pulp, Paper and Print*), 1.A.2.f (*Other*).

The level of data aggregation in table 5.26 arises from methodological changes introduced in the national GHG emission inventory, connected inter alia with the undertaken process of harmonising data in inventories with data in international statistics, which present the fuel consumption in a pattern of higher aggregation. A significant change concerning 2007 is the application in inventories of data on activities and values of CO_2 emission from verified reports prepared by installations for the needs of the emission allowances trading system.

The table 5.26 clearly shows that the biggest share in domestic CO_2 emission is held by the sector *Electricity and heat generation* (over 51%).

The subsequent stage of works was determination of changes in CO_2 emission in particular subsectors in the periods 1997–2000, 2000–2003, 2003–2007 and 1997–2007. Those changes were presented in tables 5.27 and 5.28. Table 5.27 presented CO_2 emission from combustion of fuels allowing for process emission of CO_2, and table 5.28 – excluding emission from sector 2. In both tables the negative mark defines an emission reduction.

A significant reduction of emission from *Public Electricity and Heat Production* (subcategory 1.A.1.a) took place in the years 1997–2000. In this period a significant decrease was also recorded for emission from subsectors 1.A2.f, 1.A.2.a and 1.A.2.e. In the subsequent periods (2000–2003 and 2003–2007) smaller emission reductions took place, and in some subcategories the volumes of emitted CO_2 have even grown.

Table 5.26. CO_2 emission from particular subsectors in total domestic CO_2 emission in 2007

Source categories	IPCC code	2007	
		emission [Gg]	share in domestic emission [%]
Public Electricity and Heat Production	1.A.1.a	168 814.7	51.4
Other (excluding mobile ones)*	1.A.2.f	22 636.4	6.9
Iron and Steel*	1.A.2.a	14 621.1	4.5
Chemicals*	1.A.2.c	10 851.7	3.3
Petroleum Refining*	1.A.1.b	7 000.2	2.1
Food Processing, Beverages and Tobacco	1.A.2.e	4 710.0	1.4
Coking plants (and gasworks)*	1.A.1.c.i	4 534.6	1.4
Non-Ferrous Metals*	1.A.2.b	1 705.6	0.5
Pulp, Paper and Print*	1.A.2.d	1 306.1	0.4
Total			72.0
Total domestic CO_2 emission (excluding sector 5)		328 172.1	

* Subsectors in which – apart from emission from fuel combustion – also process CO_2 emission has also been allowed for.

Source: IOŚ.

Table 5.27. Change of CO_2 emission in the periods: 1997–2000, 2000–2003, 2003–2007 and 1997–2007 allowing for emission from sector 2

Source category	IPCC Code	Change of CO_2 emission by years [Gg]			
		1997–2000	2000–2003	2003–2007	1997–2007
Public Electricity and Heat Production	1.A.1.a	-12 734.4	5045.2	-1676.0	-9365.1
Petroleum Refining*	1.A.1.b	983.4	542.8	1785.0	3311.2
Coking plants (and gasworks)*	1.A.1.c.i	-360.2	-380.4	-88.9	-829.6
Iron and Steel*	1.A.2.a	-3616.2	-4756.1	3497.7	-4874.6
Non-Ferrous Metals*	1.A.2.b	-258.0	34.4	-561.4	-785.1
Chemicals*	1.A.2.c	-1235.3	-2112.6	-555.7	-3903.6
Pulp, Paper and Print*	1.A.2.d	-796.0	-33.4	-371.4	-1200.8
Food Processing, Beverages and Tobacco	1.A.2.e	-3545.1	163.2	-944.0	-4325.8
Other (excluding mobile ones)*	1.A.2.f	-8657.7	-4261.9	3714.3	-9205.2

* Subsectors which – apart from emission from fuel combustion – also included process CO_2 emission.

Source: IOŚ.

Table 5.28. Change of CO_2 emission in the periods: 1997–2000, 2000–2003, 2003–2007 and 1997–2007, excluding emission from sector 2

Source category	IPCC Code	Change of CO_2 emission by years [Gg]			
		1997–2000	2000–2003	2003–2007	1997–2007
Public Electricity and Heat Production	1.A.1.a	-12 734.4	5045.2	-1676.0	-9365.1
Petroleum Refining	1.A.1.b	983.4	542.8	933.7	2459.9
Coking plants (and gasworks)	1.A.1.c.i	-524.6	-425.4	513.4	-436.6
Iron and Steel	1.A.2.a	-3266.7	-4359.5	-1112.0	-8738.2
Non-Ferrous Metals	1.A.2.b	-143.3	-84.1	-313.2	-540.5
Chemicals	1.A.2.c	-1131.8	-2373.9	-649.0	-4154.6
Pulp, Paper and Print	1.A.2.d	-796.0	-33.4	-371.4	-1200.9
Food Processing, Beverages and Tobacco	1.A.2.e	-3545.1	163.2	-944.0	-4325.8
Other (excluding mobile ones)	1.A.2.f	-7882.8	-2466.1	-127.1	-10 476.1

Source: IOŚ.

The biggest decrease of CO_2 emission over the years 1997–2007 took place in subsectors: *Public Electricity and Heat Production*and *Other* (excluding mobile ones). In the analysed period the emission decreased in those sectors by over 9,000 Gg in each of them. A significant CO_2 emission reduction also took place in sectors: *Iron and Steel* (by ca. 4,800 Gg), *Food Processing, Beverages and Tobacco* (by 4,300 Gg), in *Chemicals* (by ca. 3,900 Gg) and in the *Pulp, Paper and Print* (by ca. 1,200 Gg).

As regards refineries, the growth of emission partly arises from adding in 2007 process emission contained in reports prepared by various entities for needs of emission allowances trading system. For the years 1988–2004 the process emission from refineries has not been estimated in greenhouse gas inventories.

Based on the aggregated data obtained from the G-03 report, a calculation was made for the years covered by the analysis of emissivity factors in selected subsectors (with the exception of coking plats and gas works and refineries, the determined emissivity factors allow for indirect CO_2 emission included in total emissions from fuel combustion). The results of this analysis were presented in Table 5.29 and figures 5.5 and 5.6. Furthermore, an analysis was also carried out of the emissivity for electricity and heating generation (table 5.31) because of the significant share of this sector in domestic emission.

Pursuant to data presented in table 5.29 the CO_2 emissivity of the major part of the analysed sources was lower in 2007 as compared to values from 1997. The most significant decrease in CO_2 emissivity (besides steel manufactured in open hearths, which has not been produced since 2003) took place in manufacturing of iron casting (ca. 65%) and sugar (ca. 39%). The decrease in emissivity is connected first of all with reducing emissions form fuel combustion, which arose from a reduction in production energy intensity in the analysed sectors. Table 5.30 presented examples of unit energy consumption [MJ/t] for production of iron casting and sugar, i.e. products, which according to data in table 5.29 were characterised by a significant decrease in emissivity over the years 1997–2007.

Generally it may be assumed that the decrease of the emissivity factor over time reflects changes in the share of fuels to limit the consumption of coal and carbon based fuels, to allow an increase in the energy consumption efficiency and to introduce technologies with a lower emissivity.

Data presented in table 5.31 shows that CO_2 emissivity in all subcategories of 1.A.1.a had a downtrend over the years 1997–2003. Also recorded was a decrease in emissivity in the period of 1997–2007 (this concerns a comparison of values for 2007 calculated with a method consistent with emission/emissivity values for the years 1997–2000–2003, i.e. data from columns in table 5.31 marked as 2007*).

Process N_2O emission from sector 2 IPCC concerns exclusively the chemical industry, i.e. subcategory 2.B (table 5.32). In the period 1997–2007 an increase of N_2O emission took place by 3.1 Gg, i.e. by ca. 965.5 Gg CO_2 equivalent. In this particular case changes of emissivity reflect changes in activities, i.e. production values for the given product.

The N_2O emissivity from production of nitric acid, the main source of N_2O emission in sector 2 of IPCC, was presented in table 5.32.

Table 5.29. Emissivity [kg CO_2/Mg] (or in determined cases [kg of CO_2 equivalent/Mg]) and its changes [%], from selected sources in the years 1997–2007

Source of emission	Emissivity by years [kg CO_2/Mg]				Change in emissivity by years [%]
	1997	2000	2003	2007	1997–2007
Steel from open hearth furnaces	952.2	1 233.4	–	–	-100.0
Iron casting	1 444.2	704.1	723.1	507.0	-64.9
Sugar	1 142.4	918.5	810.0	699.7	-38.8
Pig iron	999.3	773.3	709.1	668.5	-33.1
Nitric acid	146.3	102.2	106.3	105.3	-28.0
Hot rolled semi-products and products	310.0	261.7	275.2	236.5	-23.7
Electrolytic copper	2 403.7	2 117.3	1 780.3	1 861.1	-22.6
Ammonia	2 659.9	2 475.3	2 480.0	2 313.7	-13.0
Coke	509.1	557.7	457.2	446.0	-12.4
Electrolytic aluminium	13 704.9	13 702.4	12 560.3	12 489.6	-8.9
Cement – milling	39.0	38.0	39.1	35.9	-8.0
Steel from electric furnaces	541.8	512.6	416.9	509.0	-6.0
Burnt lime	1 287.9	1 250.5	1 238.9	1 227.2	-4.7
Cement clinker – dry method	926.5	898.1	887.0	909.5	-1.8
Cement clinker – wet method	1 190.6	1 107.6	1 086.3	1 182.9	-0.6
Steel from converters	212.3	230.6	226.4	284.9	34.2
Refineries	247.8	255.7	298.7	348.0	40.4
Coke [CH_4 in CO_2 equivalent]	10.6	10.6	10.6	10.6	0.0
Nitric acid [N_2O in CO_2 equivalent]	2 006.4	2 006.4	2 006.4	2 006.4	0.0
Ammonia [CH_4 in CO_2 equivalent]	104.7	104.1	103.5	103.3	-1.3

Source: IOŚ.

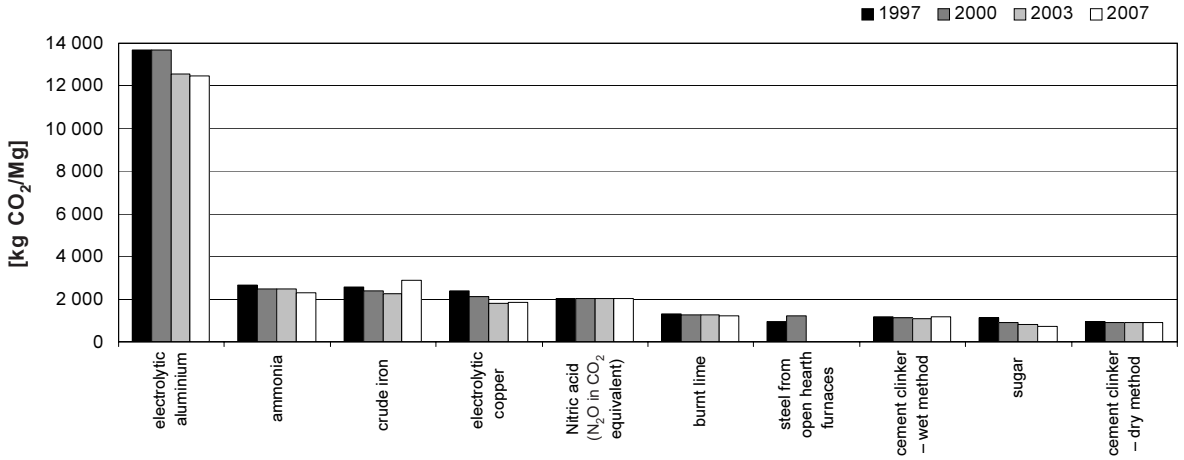

Figure 5.5. Emissivity change in kg of CO_2/Mg (or in particular cases in equivalent of CO_2/Mg) from selected sources in the years 1997–2007, source: IOŚ

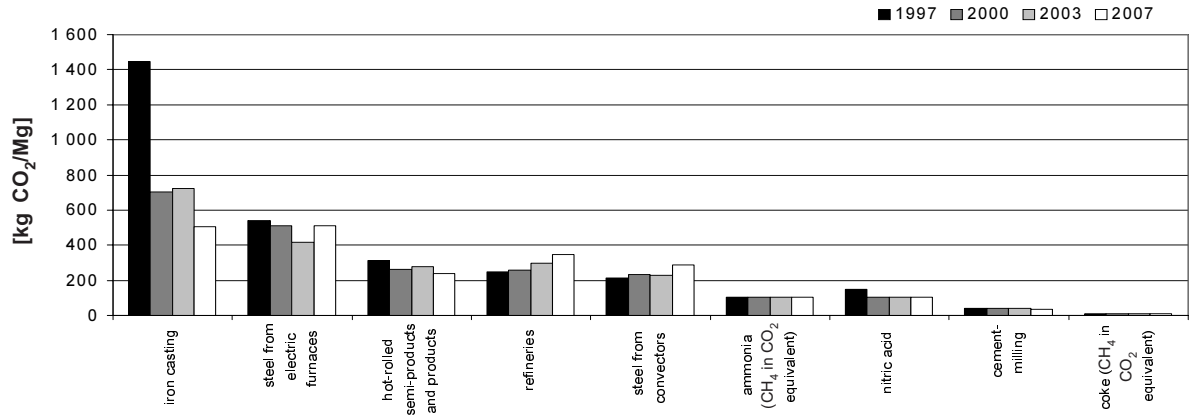

Figure 5.6. Emissivity change in kg of CO_2/Mg (or in particular cases in kg of CO_2/Mg equivalent) from selected sources in the years 1997–2007, source: IOŚ

Table 5.30. Unit energy consumption [MJ/t of product] for production of sample products

Product	Energy intensity of production by years [MJ/t of product]			
	1997	2000	2003	2007
Iron casting	13963.7	10306.8	9028.2	8566.4
Sugar	10187.4	8181.0	6917.2	6070.7

Source: IOŚ.

Table 5.31. CO_2 emission and emissivity connected with electricity and heating generation

Source of emission	Volume of CO_2 emission by years [Gg]				
	1997	2000	2003	2007	2007*
Electricity and heating generation	178 180	165 445	170 491	168 815	168 457
Public power plants and heat and power plants	145 927	141 572	145 549	–	149 395
Autoproducing CHP plants	8971	7278	9501	–	7191
Heat generation plants	23 282	16 595	15 441	–	11 871
Energy output by years [TJ]					
Electricity and heating generation	923268	848 511	901 785	882 207	–
Public power plants and heat and power plants	658938	647 943	677 644	712 100	–
Autoproducing CHP plants	64690	56 664	81 336	58 366	–
Heat generation plants	199641	143 904	142 806	111 741	–
CO_2 emissivity by years [kg/GJ of generated energy]					
Electricity and heating generation	193.0	195.0	189.1	191.4	190.9
Public power plants and heat and power plants	221.5	218.5	214.8	–	209.8
Autoproducing CHP plants	138.7	128.4	116.8	–	123.2
Heat generation plants	116.6	115.3	108.1	–	106.2
Change in emissivity in the years 1997–2007 [%]					
Electricity and heating generation	-1.1				
Public power plants and heat and power plants	-5.3				
Autoproducing CHP plants	-11.2				
Heat generation plants	-8.9				

2007* – column in which volumes of CO_2 emission are not directly derived from the inventory, but have been instead evaluated based on statistical data for 2007 from the Eurostat data base, i.e. without the use of data from verified reports prepared for needs of the emission trading system; emissivity in column 2007* has also been calculated on the basis of emission value assessed in such a way; values of this assessment have been given owing to the fact that in GHG inventory for 2007 data on activities and emission concerning power and heating generation, have been aggregated to subcategory 1.A.1.a without a division into: public power plants and heat and power plants, industrial heat and power plants and heat generation plants.

Source: IOŚ.

Tabela 5.32. Emisja N_2O z sektora 2. *Procesy przemysłowe* w podziale na podsektory według klasyfikacji IPCC

Source category	N_2O emission by years [Gg CO_2 equivalent]			
	1997	2000	2003	2007
2. Industrial processes				
B. Chemical industry	3818.8	4242.1	4296.3	4784.3
2. Nitric acid production	3627.3	4026.2	4072.4	4552.7
5. Other (caprolactam production)	191.5	215.9	223.9	231.6
Emission changes by years [Gg CO_2 equivalent]				
2. Industrial processes	1997–2000	2000–2003	2003–2007	1997–2007
	423.3	54.2	488.0	965.5

Source: IOŚ.

6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE EFFECTS AND ADOPTION MEASURES

6.1. Agriculture

Issues pertaining to the impact of climate change on the Polish agriculture constitute considerably important problem in the light of the state's food safety. Significant roles are played by such aspects as the impact of climatic conditions on crops, plants growth and occurrence of pathogens affecting the production organization in the agriculture. The specific structure of the Polish agriculture is still – in most cases – characterized by the dispersion and farms with small acreage, as well as traditional production methods. Therefore, the Polish agriculture may handle worse with threats resulting from climate change than the agriculture in most EU countries of a different agriculture structure.

The research on consequences of changing climatic conditions in Poland is conducted in many academic centres and scientific institutions. Under analyses results it may be predicted that the expected air temperature increase in Poland will change conditions of plants growth – for instance the temperature increase by 1°C will accelerate the ripening process of basic cereals such as wheat, rye, barley by one week, and maize by two weeks. Therefore, it is possible to accelerate the growth of cultivated plants, but also weeds and pests that may be more onerous for the agriculture. It will be necessary to develop relevant agrotechnical and plants protection recommendations.

The analysis of differences between obtained and potential crops leads to a conclusion that the main reason of such situation is environmental stresses. Fertilisation or irrigation is not always – according to economic and technological point of view – profitable in all conditions. In a longer duration the increase of outlays on growing varieties resistant to environmental stresses will result in the increase of prices, however it is profitable due to the crops stability. In Polish conditions it is significant to consider tolerances for periodic shortage of water and too low or too high temperatures in programmes concerning growing of new agricultural plants varieties. Such factors affect plants with various intensity and in different periods of their growth and development. Hence, it is significant to establish critical values for individual stress-inducing factors and depending on their yields in order to carry out the selection effectively. Irrespective of the specificity of reactions of individual species on stress influence, plant cultivation examines spring and winter varieties independently. In order to keep the stability of planned spring varieties, resistance to drought is more significant while in case of planned winter varieties – it is resistance to frost. As for bulb and root plants, too high temperature is another adverse factor affecting these plants besides drought. Both high temperature and drought may decrease the crop by 50% and may additionally result in numerous physiological defects of bulbs. Thus, adoptive actions should include the cultivation supported by biotechnological and molecular techniques.

Results of crops forecasts for the years 2071–2100 carried out within the PESETA European Commission show that – depending on the climatic scenario applied – average crops in Poland will change slightly – in the central Poland average crops will decrease by approximately 5% in comparison with the years of 1961–1990 and in the northern Poland they will raise by 5% (according to the HadCM3/HIRHAM climatic model). While the ECHAM/RCA3 model forecasts considerable decrease of crops in most parts of Poland, in the northern part – by 5%, in the central part – up to 10%, in the southern and in the south-western part by up to 15%. According to both models the considerable crop growth equalled to 30% may be expected in mountain areas.

Expected temperature changes will presumably prolong the plant growth period and result in shifting growing phases and agrotechnical measures, including sowing and harvests. In the future, the rye harvest may begin as early as at the beginning of July or even in June and the winter wheat harvest – at the beginning of July. Winter cereals will be sown approximately 1–3 weeks later than at present. Predicted climate change will result in the selection of growing plants and their regionalization – late varieties of maize grown for grains will be able to ripen even in the coldest parts of the north-eastern Poland. In addition, it would be possible to grow other thermophile plants like soybean or sorghum on a larger scale.

Research results carried out for the Wielkopolska Province on the effect of forecast climate change on the phenology of maize grown for grains (under GISS model results for Central Europe in 2050) prove that the growing period may be

prolonged from average 230 days to 261 days and may last from 4 March (23 days earlier than in the years 1991–2005) to 20 November. Sowing may be on 1st April, and the harvest may begin between 5th and 8th August. Individual phonological maize phases would commence much earlier in comparison with the years of 1991–2005. These results prove that it is possible to shorten considerably the entire growing maize period from average 149 days to 126 days for early varieties, from 154 days to 128 days for medium-early varieties, and from 160 days to 129 days for medium-late varieties. All growing maize periods may be shortened except for the interphase of the features occurrence – full maturity will be prolonged by 20 days on average.

Potential climate change will require to take new actions in respect of the plants protection. Modified thermal, humidity and soil conditions will affect the pests growth speed, their number, population dynamics, intensity of occurrence and feeding or their harmfulness. Depending on expected climate change, some pests may be more harmful to the agricultural production, whilst other pests may be less harmful. Among 27 species of pests of agricultural plants monitored in 2006, 12 species were noticed to be more harmful, like puccinia recondite, corn stalks brittleness, cereal leaf beetle, scaevus (especially locally on winter wheat), corn borer on maize, beetles, grubs and noctua pronuba on potatoes, pegomyia hyoscyami on sugar beets, meligethes aeneus, ceutorhynchus assimilis and dasyneura brassicae on winter rapes. Due to prolonged autumns and mild winters winter plants are attacked by soil pests, snails, nematodes, rodents, birds and game.

The occurrence of virus cereal diseases in Poland is a relatively new phenomenon and together with climate warming that is proceeding, it must be expected that such occurrence will be more and more significant. Observations carried out on *Rhopalosiphum padi L.* prove that the number of days inducing their growth changes consisting for creating permanently viviparous forms (being a vector of barley yellow dwarf virus – BYDV) and their growth in autumn on winter cereals significantly increased in previous years. In 2006 in Poznań the number of such days equalled to 17, and the critical temperature below which aphids die in many regions of Poland did not occur. Viruses vectors, mainly oat aphids (*Rhopalosiphum padi*), were firstly found on winter cereals in 1989 and since then there has been noticed the growing number of such aphids and the expansion of BYDV virus in Poland. The research performed in 2007 found BYDV virus in winter barley in all regions of Poland, but with a different intensity. Chemical elimination of aphids in winter plants allows limiting the infection occurrence, but not prevent it. Preventive actions to protect cereals against BYDV viruses will consist in selecting varieties resistant to aphids, applying special isolations from maize growing and sowing winter cereals as late as possible.

The future demand for water in agriculture must be forecast in conditions of predicted shortages resulting from drought effects and the increase of biomass production for needs of renewable energy sources. An increase of water consumption in comparison with the present consumption must be expected, for the temperature growth will make evapotranspiration more intensive with the expected decrease of rainfall in the growing period. It may turn out that the limited access to water after 2030 will be a barrier of the agriculture development. Therefore, it is necessary to develop the water management strategy in the agriculture, assess demands for irrigating field and fruit crops and industrial plants. Such actions should consist in propagating growing of plant varieties characterized by less water demands, in particular in areas of periodic water shortages, as well as propagating effective irrigation methods and simultaneously controlling water drawing more intensively.

Due to forecast threats for the Polish agriculture pertaining to climate change, the following terms and conditions of good agricultural conduct should be developed and implemented:

at the country level:
- development of the threat limitation strategy resulting from changed climatic conditions,
- conducting plant growing research on new varieties of cultivated plants resistant to water and thermal stresses,
- conducting research on the occurrence of diseases and pests in changing habitat conditions and developing practices decreasing the vulnerability of crops to diseases' and pests' impact,
- popularizing information and supporting education concerning climate change and adoption measures,

and

at the regional level:
- monitoring the climate change impact on the agricultural production,
- implementing new species of cultivated plants and water-economical techniques,
- monitoring the spread of pests and diseases (growing rotation, resigning from monocultures),
- intensifying processes of setting up woodlots to prevent the soil erosion,
- protecting animals against a high temperature in grazing lands and providing access to water, considering the increased demanded for water,
- providing trainings on the adaptation of the agriculture to climate change.

6.2. Coastal zone

Measurements of sea level changes made in Świnoujście belong to the longest series of measurements made in the world. These results prove that the speed of an average

sea level growth in Świnoujście equalled to 0.061 cm per annum in the years 1811–1990, and in the years 1951–1990 the speed was much faster and equalled to 0.32 cm per annum (16 cm). Simultaneously, these observations of long standing of the coastline prove the land rerteat by 0.12 metres per annum on the Polish Baltic Sea coast. The research on the vulnerability of the Polish coast to climate change conducted within the ASTRA project comprises three scenarios of the seal-level increase: by 0.3, 0.6 and 1.0 m per 100 years, increase of frequency and intensity of storms, longer drought periods, as well as increase of rainfall and temperature of sea waters. It is estimated that in the event of increasing the sea level by 0.6 m, lack of any actions may result in losing around 120 square kilometres of the land due to the coastline erosion, and 2,200 square kilometres can be flooded by storm floods. This will be the direct threat for 300 thousand people and indirectly for other 1.7 million people due to floods, erosion and land falls.

The expected effect of the so-called climatic conditions on the coastal zone of the Baltic Sea will intensify already observed phenomena such as:

- coastline erosion – loss of deposits on the foreshore and higher instability of cliffs,
- storm floods and river swells,
- intrusion of salty waters to aquifer levels,
- increase of groundwater level,
- landfalls,
- water eutrophisation (growth of algae) in the Gdańska Bay,
- overflows over coast protection constructions.

In other research on vulnerability of the Polish coast to climate change there were approved scenarios of increasing the sea level by 30 cm and 100 cm by 2100 and additionally by 10 cm and 30 cm by 2030. Considering aforementioned scenarios of the sea level increase, endangered zones were selected, if the sea level increases by 0.3 m and 1.0 m and additionally storm waves cause possible floods (increase by 1.5 m), which totally establish the maximum range of the endangered coastal zone by 2.5 m above the current sea level. It is estimated that over 2,400 square kilometres and 244 thousand people reside in the zone endangered by the sea level increase. The total cost of losses related to the realization of +1.0 m scenario was estimated at almost USD 30 billion with extra USD 18 billion in the event of a flood threat, when the total cost of the full protection equals to USD 6 billion (according to estimates in 1995). The performed environmental conditions analysis prove that regions in the mouth of the Vistula River and the lower Odra River, as well as regions located nearby inshore lakes are most vulnerable to erosion. In the event of heavy rains there is a threat of floods in estuary sections of rivers located in the mid-part of the coast due to dunes located in the coastal zone that make water difficult to outflow. Currently, the total length of the coast at risk from the sea level increase and floods equals to around 208 kilometres, or 41.5% of the coastline of the open sea (together with Hel Peninsula). The endangered zone includes, inter alia, naturally valuable areas such as the Słowiński National Park whose landscapes cover water basins, marshes and dunes listed in the UNESCO World Heritage List.

Coastal processes pertaining to the sea level increase are multi-scale phenomena, hence technical measures applied and actions taken must include extensive areas. It will be necessary to use considerable financial means and obtain the social consent in the process of making a decision. All technical, economic and social actions whose aim is to prevent adverse effects of the sea level increase should be proceeded by research on the optimization of benefits and minimization of damage and by the feasibility study. On the basis of estimated protection costs in relation to the capital value losses, in the event of the +3.0 m scenario it is recommended to apply the full protection option, for this cost is much smaller than the value of potential losses, most notably at the western and eastern coast. In the event of the +1.0 m scenario the ratio of the full protection cost to the capital value loss is low (below 36%) for the entire coast. This requires the complex approach engaging all users of the coastal zone within the framework of the so-called integrated coastal zone management (ICZM). Currently, in Poland the main coordinator of works over the ICZM implementation is the Minister of Infrastructure. The domestic legal system comprises number of institutions, regulations and juridical solutions specially pertaining to the coastal zone, including processes of making decision on the sea areas usage in compliance with the ICZM concept. The most important are, as follows: the formal establishment of the coastal belt with a width of around 3 km comprising the technical belt (with a width of 10 m–1 km) and the protection belt (100 m–2.5 km), in which in all decision-making processes there must be significantly included safety issues, risk management and environmental protection relating to the mutual effect of the sea and land. Moreover, the monitoring of numerous elements (aspects) of coastal areas is carried out, but it has not been integrated, yet, thus it will be necessary to make it function correctly and comprehensively and require the real social participation in the management. It is planned to develop the national strategy of the ICZM whose main aims are to improve the prosperity of communities living in coastal areas and maintain and increase, if necessary, the safety of land facilities and environmental condition.

The erosion of the Polish Baltic Sea coast that has been proceeding for many years and is predicted to be more and more intensive, causes the considerable threat for the flood safety of coastal areas and the natural environment. This threat also worsens tourist conditions and lives of residents of coastal cities, towns and villages. The adaptation to effects of the increasing sea level and more intensive storms mainly consists in protecting coasts of the Baltic Sea. The

legal frameworks for the performance of such actions is specified by the Act of 28 March 2003 Program of Protection of Sea Coast (Dz.U. No. 67, item 621). The basis of this Act is the strategy of protecting sea coasts in a 100-year perspective, including not only the safety aspect, but also the risk management and environmental protection. The key aim of the sea coast protection programme established for the years 2004–2023 is to protect the sea coast against erosion. Within the programme there are performed tasks pertaining to the construction, expansion and maintenance of the coastal areas flood protection system, including removing damage in the coast flood protection system, providing the stabilization of the coastline according to the 2000 state, preventing beaches from disappearing, monitoring the sea coast, as well as activities, works and research on establishing the current condition of the sea coasts whose aim is to indicate necessary actions to save the sea coast. The preferable coast protection method is pro-ecological, artificial feeding with sand from the sea bottom.

Instances of tasks performed by Maritime Offices in 2006 within the framework of the *Sea Coast Protection Programme* included, as follows:

- Mrzeżyno – artificial feeding together with auxiliary facilities,
- Niechorze – modernization of coastal reinforcements, artificial feeding,
- Łeba – modernization of coastal reinforcements, artificial shore feeding,
- Dźwirzyno – modernization of coastal reinforcements: dune embankment with reinforcements,
- Ustronie Morskie – modernization of coastal reinforcements: stone shore band with a length of 300 m,
- Kopań Lake Sandbar – construction of the flood embankment (2nd phase), 470-metre stone protection from the side of the sea,
- Darłówek – artificial shore feeding
- Jastrzębia Góra – cliff drainage,
- Babie Doły – cliff basement protection,
- Vistula Lagoon – reconstruction of the Nowa Pasłęka groyne,
- Gdańska Bay – artificial feeding of Jelitków, Orłowo stone groynes,
- Hel Pennisula – artificial feeding,
- Władysławowo – artificial feeding from the open sea.

6.3. Water resources

Under selected climate change scenarios since the 1990s there have been conducted research on the potential climate change impact on the state's water resources. The instance is a hydrological simulation conducted for the basin of three rivers: the Warta River (west), the Narwia River (north-east), and the upper Vistula River (south-east) located in various climatic regions of Poland. Four climatic scenarios designed for 2050 under results of the general circulation model (GCM): Canadian CCCM, American GFTR and two British models: UKHI and UKTR were applied here. Possible consequences of the air temperature increase and changes in the rainfall regime forecast by these climatic models include the temperature increase of waters of rivers and lakes in summer months and the decrease of frequency of occurring ice phenomena. In case of relatively clean rivers and lakes, considerable changes in water quality are not expected in contrary to lowland rivers burdened with the substantial pollution emission. Forecast water temperature and water equilibrium changes (hydrological regime) may worsen the water quality relating to the oxygen equilibrium, thermal pollution, food ingredients equilibrium, eutrophisation, nitrogen pollution, toxicity, salinity and acidity of waters. Research results conducted in the aforementioned three basins by means of the ECHAM1/LSG model showed the diversified scope of forecast changes of parameters, but a general trend for all analyzed regions is the same – decrease of the river outflow, basin retention and evapotranspiration.

Systems of water resources in Poland may be the subject of the effective adaptation to changed climatic conditions, but the adaptation cost in various regions of the country will depend on a predicted water shortage. Therefore, it is necessary to develop the water demand management and to take proper institutional actions in order to reinforce the resistance of water resources systems in conditions of increasing uncertainty concerning climate change. The adaptation to long-term, adverse climatic conditions require to enhance the existing infrastructure management and its enlargement, as well as to decrease the water consumption by applying various means of its protection.

All these and other actions were specified in the Water Management Strategy prepared by the Ministry of the Environment and approved by the Council of Ministers on 13 September 2005. Due to the necessity to adjust Polish law to directives of the European Community, the updated document called: *The 2030 National Water Management Strategy* (including the 2015 stage) was prepared. The superior aim of the strategy is to develop legal. organizational and technical solutions in the water management that allow conducting the social and economic development of the country in a constant and stable way, including forecast climate change. Strategic aims of the water management include the necessity to adopt to climate change, increasing risk of occurring violent weather phenomena, potential of the effective water usage and possible changes in the spatial management in the context of limiting sources allocations in space.

Detailed tasks pertaining to the adaptation to climate change planned to be performed up to 2030 include, as follows:

- restoring peat-forming processes and increasing the biological diversity of re-natured ecosystems by changing the approach to drainage,
- rebuilding the natural basin retention that will improve humid ground conditions and ecological condition of water ecosystems, as well as delay the flow of rainwater,
- developing retention systems based on the natural and body retention in areas requiring the intervention due to climate change (drought threat increase) and developing the spatial development,
- reducing the water deficit in agriculture (due to the drought risk increase) by applying water-saving plants and technologies and limiting dehydration on the basis of justified resources allocation,
- applying the saving policy in using water resources with a division into types of this demand and on the basis of water-saving technologies,
- reducing dehydration in agriculture,
- renaturing water conditions in forests and restoring natural watering of forest habitats depending on water in order to enhance tree stands growth and condition of mid-forest water and marsh ecosystems,
- reducing the drought risk,
- reducing the flood risk and adverse flood effects, including diversified approaches in mountain, foothill, lowland and mouth regions, as well as in agglomerations and areas of intensive urbanization,
- providing security to ageing hydrotechnical facilities by reconstructing and modernizing them,
- using existing water routes suitably,
- assessing results of the water use and threats of its quality connected with the development of renewable energies from various sources,
- increasing retention capabilities of river catchments, in particular the natural retention restoration,
- restoring and revitalizing degraded valleys and river beds based on the functionality assessment and economic effectiveness of water constructions and devices adversely affecting the morphology of river beds and reducing the natural retention of their valleys.

6.4. Forestry

Due to the current incomplete knowledge it is hard to reliably specify the impact of climate change on economic, natural and social aspects of the forest management. On the basis of the knowledge of mechanisms of effects of climatic factors on trees' physiology, knowledge of wood properties as a product, historical observations, modelling and dispersed experimental data, it is possible, however, to draw more important conclusions within this scope. Thus changes in the productivity of ecosystems that will have an ambivalent character can be expected: on the one hand forests may temporarily become more productive depending on air temperature or rainfall changes or reaction of trees to the higher concentration of CO_2 in the atmosphere. On the other hand significant changes in the amount and degree of disruptions in the forest growth, such as winds, fires, droughts, pests, diseases etc must be assumed. Therefore, it would be necessary to implement corrections in the forest protection strategy referring to the protection against biotic threats (particularly against secondary pests, diseases etc.) and abiotic threats (fires, winds, droughts, floods, extreme temperatures, season shifts etc.).

Existence of forests in changed climatic conditions will depend on adoption abilities of tree species, which will – during their long growth cycles – face changes of fundamental growth factors: temperature, CO_2 concentration, soil humidity and settlement eutrophisaction. Ecophysiological reactions of forests will depend on interspecies variability (genetic diversity), but also on the relationship between species and ecosystem processes – the spread and conduct of pollinate species, herbivores, insects, pathogens and other pathogenic factors. Properties that have not been known so far may occur and it may be difficult to predict the reaction of the entire ecosystem. The existing fragmentation of forests will affect shifting of species towards their ecological optimum together with changeable climatic conditions. Changes in the species distribution may lead to new species compositions of forest communities and extinction of specialized species. Changes in the number and quality of forests will result in – as the feedback – accelerating already happening changes.

It is necessary to develop and implement the strategy of the forest management adaptation to climate change that should contain – in the short- and long-term planning – actions consisting in applying periodically increased growth abilities of trees and changing moderately the structure of coniferous forests to mixed or broadleaf tree stands. In addition, there must be considered actions concerning the rationalization of the forest usage in the relationship: supply – growth – size and suitable (to climate protection tasks) wood management. Moreover, this strategy should contain such actions as: implementation of the second layer, undergrowth, care cutting, increase of the coal retention in soil and protection of the organic matter, structure disturbance restriction and preferences for natural restorations and multi-directional wood promotion, particularly long-term wood management and its products, afforesting new areas and change of forms of the land usage, energetic tree stands (plantations) and others.

An important element of the forest and forest management adoption strategy to climate change is to leave representative forest areas to spontaneous adaptation processes (referential forests) without the economic intervention and to shift the obtained knowledge to economic areas. The operation of adoptive processes by means of well-known growing methods, id est basing on the knowledge obtained in the past may be misleading and hard to verify without the opportunity of implementing well-aimed corrections. Forest ecosystems are a very significant element in the state's water resources management, hence the National Water Management Strategy implementation plan should include the following recommendations pertaining to actions in the forest sector connected with the water management:

– improving the coordination of the forest resources management policy with the water management policy in a way that allows maintaining and increasing water services rendered by forest ecosystems, in particular within enhancing the catchments retention,
– supporting the afforestation in places playing a key role in the processes of improving the catchments retention, developing outflow and enhancing the condition of water and water-depending ecosystems,
– protecting and restoring destroyed forests in upper parts of river catchments,
– developing complex and cohesive programmes of increasing the water retention in forest divisions affected by lack of water, integrating hydrological and ecological analysis, as well as presenting proposals of technical and non-technical solutions,
– supporting activities in respect of reducing the surface runoff and increasing the natural retention in forests – providing the permanent existence and restoration of peat bogs, boggy areas and seepage spring area, as well as natural (unregulated) flows; eliminating dehydration systems in forests, performing in forests small retention supporting the restoration of natural water conditions, further reduction of total logging and increase of sources of decomposing wood,
– verifying the management in water-protective forests consisting in excluding boggy habitats, limiting the total forest cutting in wet and alder habitats.

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, Poland provides such assistance, to the extent possible.

7.1. International development assistance

By joining the EU in 2004 Poland took on international obligations pertaining to the amount of the development assistance and its quality. Under accepted obligations financial means for the development assistance will systematically grow in order to reach in 2010 the ODA factor of 0.17% GDP and 0.33% GDP by 2015. Since 2004 the value of the Polish development assistance for developing countries has been steadily growing up. In 2004 the value of the development assistance submitted to developing countries equalled to PLN 501 million, in 2005 as much as PLN 663 million, and in 2006 it reached PLN 992 million. Further increase was noticed in 2007 when the value of the development assistance provided by Poland exceeded PLN 1 billion.

7.1.1. Polish development assistance in 2005

The superior aim of the Polish cooperation and development assistance is to support and tend to reach the sustainable development in countries taking advantage of the Polish assistance. The official Polish development assistance in 2005 equalled to PLN 663.07 million (USD 204.98 million), which was 0.067% GDP. In 2005 key beneficiaries of the Polish development assistance were, as follows: Afghanistan, Angola, Palestinian Autonomy, Georgia, Iraq, Moldova and Vietnam. Furthermore, Poland supported Ukraine and Belarus financing Polish non-governmental organizations and state administrative authorities in respect of assistance projects for these countries. In 2005 Poland adopted Paris Declaration on Aid Effectiveness and committed itself to observe its obligations whose aim is to increase the effectiveness of submitting the development assistance to developing countries.

Poland provided the development assistance within mutual and multilateral assistance. The total mutual assistance in 2005 equalled to PLN 155.77 million (USD 48.16 million) and the multilateral assistance equalled to PLN 507.30 million (USD 156.83 million). As for the mutual assistance in 2005 the Ministry of Foreign Affairs had special funds within two specific purpose reserves for technical assistance for countries in transition and for development assistance, totalled PLN 18 million.

Subsidies granted to non-governmental organizations for assistance projects for individual countries were, as follows: Ukraine (PLN 4.6 million), Moldova (PLN 1.09 million), Belarus (PLN 1.05 million), Afghanistan (PLN 0.88 million), Iraq (PLN 0.49 million), Georgia (PLN 0.43 million), Angola (PLN 0.2 million) and for other countries, including the subsidies for Armenia, Serbia and Montenegro, Tajikistan and subsidies covering more than one country (PLN 0.67 million).

Whereas, subsidies granted to state administrative authorities for assistance projects were, as follows: Ukraine (PLN 2.81 million), Vietnam (PLN 0.29 million), Angola (PLN 0.18 million), Palestinian Autonomy (PLN 0.05 million), Moldova (PLN 0.04 million). Within the entire mutual assistance in 2005 Poland submitted the amount of PLN 155.77 million (USD 48.16 million).

Within the mutual assistance in the form of the Small Grants Funds in 2005 small assistance projects were financed in developing countries at the request of Polish embassies. The total number of 25 projects worth of PLN 758,898 were carried out. The largest share in obtained financial means fell to the following beneficiaries: Senegal (PLN 122.4 thousand), Kenya (PLN 122.3 thousand), Rwanda (PLN 90.08 thousand), Zambia (PLN 73.2 thousand), Democratic Republic of Congo (PLN 72.6 thousand), Burundi, Cambodia and Sierra Leone.

Within the multilateral assistance the Ministry of Finance provided the foreign assistance in the form of credit agreements under the tied assistance. Beneficiaries were, inter alia: Uzbekistan, People's Republic of China, Serbia and Montenegro. In addition, Poland subsidized international organizations providing the Official Development Assistance (id est, the European Bank for Reconstruction and Development,

Investment Bank and World Bank). Within the multilateral Official Development Aid in 2005 Poland granted PLN 507.30 million (USD 156.83 million)[21].

7.1.2. Polish development assistance in 2006

In 2006 the value of provided assistance equalled to PLN 922.2 million (USD 297.2 million), or 0.09% GDP. Within the mutual assistance Poland granted PLN 370.4 million and PLN 551.7 million within the multilateral assistance.

The value of the Polish assistance increased by 40% in comparison with the assistance equalled to 0.07% GDP in 2005.

In 2006 within mutual assistance funds granted by the Ministry of Foreign Affairs from the special purpose reserve of the state budget were mainly earmarked for proposals and their value equalled to PLN 85 million. From those funds non-governmental organizations, bodies of the state administration together with entities of the local administration in cooperation with the Ministry of Foreign Affairs conducted the total number of 229 assistance projects, including 176 projects of the Polish local administration's organizations, 44 projects of bodies of the state administration and 9 assistance projects of entities of the local administration. In 2006 within the mutual ODA assistance Poland first and foremost supported: Angola, Ukraine, Belarus, Uzbekistan, Kazakhstan, Montenegro, Moldova, Indonesia, Afghanistan, and Georgia. In addition, the Polish participation in the performance of small assistance projects conducted within the Small Grants Fund must be stressed, thanks to which Polish foreign posts conducted 131 projects valued of PLN 5.2 million.

Within the multilateral assistance as much as PLN 503.3 million (USD 162.2 million) funds were earmarked for the EU assistance budget and other financial means constituted voluntary payments and contributions to Institutions of the United Nations, World Bank Group and other programmes and funds[22].

7.1.3. Polish development assistance in 2007

In 2007 within the ODA Poland submitted to the developing countries the development assistance equalled to PLN 1.01 billion (USD 362.83 million), or 0.09% GDP. The amount of the official development assistance granted by Poland increased by approximately 9% in comparison with 2006. The development assistance submitted by Poland in 2007 was earmarked within the multilateral and mutual assistance. In that period the amount of PLN 573.60 million was earmarked for the multilateral assistance and PLN 431.41 million for the mutual assistance.

Polish activity as regards multilateral assistance is especially noticed in the forum of the European Union. In 2007 the largest part of funds within this assistance was earmarked for the assistance budget of the European Union and equalled to PLN 549.28 million (USD 198.30 million). Other funds were earmarked within the multilateral assistance for voluntary payments and contributions for the World Bank Group (PLN 2.29 million) and Institutions of the United Nations.

Within the mutual assistance funds granted by Poland in 2007 came from two separate sources. The first source was funds from the special purpose reserve of the state budget which equalled to PLN 90 million. Within these funds there were conducted projects of the state administration, local administration, non-governmental organizations, projects within the Small Grants Fund and other initiatives. The other source of the mutual assistance was funds granted by other bodies of the state administration that earmarked PLN 915 million for that purpose. That source was used for projects prepared by the Ministry of Finance, Ministry of Science and Higher Education and other bodies of the state administration. The total mutual assistance submitted by Poland from the two sources equalled to PLN 431.41 million in 2007.

The most important beneficiaries of the Polish mutual assistance in 2007 were, as follows: China, Nicaragua, Belarus, Montenegro, Ukraine, Uzbekistan, Kazakhstan, Afghanistan, Moldova and Georgia. Among them the largest assistance was submitted to China and Uzbekistan thanks to paying credit tranches and Nicaragua's debt of PLN 84.7 million was amortized.

Within the mutual assistance from assistance funds of the Ministry of Foreign Affairs over 350 assistance projects were carried out. Within the form of assistance there were earmarked PLN 45 million and as many as 180 projects in developing countries were conducted, including 111 projects put forward by Polish non-governmental organizations, 50 projects prepared by the state administration and 24 projects of the local administration. Within projects the largest beneficiaries were Belarus, Ukraine, Afghanistan, Moldova and others. The other source of assistance proposals are actions taken by means of the Small Grants Fund where – thanks to applications of Polish embassies in 2007 there were conducted 170 small projects equalled to PLN 12 million in 42 developing countries. The main beneficiaries of those projects were, inter alia: Tanzania, Senegal, Ethiopia and Angola.

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[21] *The Polish Development Cooperation. 2005 Annual Report,* Ministry of Foreign Affairs, Development Cooperation Department, Warsaw, August 2006 (www.polskapomoc.gov.pl). Polish.

[22] *The Polish Development Cooperation. 2006 Annual Report,* Ministry of Foreign Affairs, Development Cooperation Department, Warsaw, August 2007 (www.polskapomoc.gov.pl). Polish.

Within the financial assistance in 2007 the Polish Ministry of Finance provided the financial assistance in respect of payments of preferential governmental credits granted under the tied assistance. Within that scope main beneficiaries of the Polish assistance within the tied assistance were the following countries: China which was earmarked PLN 188.3 million for financing credits concerning, inter alia, the environmental protection, mining and power industry, as well as Montenegro which was granted PLN 36.65 million for modernizing the domestic infrastructure and agriculture[23)].

7.2. Transfer of technology under Art. 4.1, 4.3 and 4.5. of the Convention

Within the Official Development Assistance submitted in previous years, Poland conducted projects as part of supporting and providing technological assistance and promoting the technological development in developing countries and other countries with the economy in transition in the years 2005–2007.

Among numerous assistance programmes in those years some of them were directly connected with actions for limiting emissions or adaptation. They are, inter alia:

- providing assistance in performing the project to supply water to the village of Asengo in Kenya,
- preparing the assistance project to extend the sanitary infrastructure in the village of Gadduiye in Kenya,
- providing medicines and solar energy to the health care centre in Bumba in the Democratic Republic of Congo,
- supporting the ECO project – Construction in Ukraine – the energy-saving and ecological construction in the economic transformation,
- sharing experience of Poland in respect of limiting energy consumption by the economy and improving the energy safety – motions for Ukraine, cooperation prospects,
- supporting the modelling partnership for the sustainable development in Moldova,
- constructing the complex of schools and water reservoirs in Afghanistan,
- developing water infrastructure – the Water Treatment Plant in the Babil province in Iraq,
- preparing the State Forest Service of the Kyrgyz Republic to implement the afforestation programme – sharing Polish experience,
- providing the exemplary local partnership in respect of the sustainable energy development in Kazakhstan,
- installing solar batteries system in the education centre for girls and boys in Rwanda,
- purchasing a solar pump for a dwell in Tanzania,
- providing the sustainable development of rural areas in Azerbaijan by limiting the use of forest products,
- analyzing the bio fuel liquid production potential and export in Ukraine,
- supporting authorities and local communities of Kiev in implementing energy-saving technologies,
- providing a model of the sustainable energy development strategy of a Moldovan commune as an element of the regional development, Polish experience for Moldova,
- purchasing solar collectors for an outpatient clinic in Namiungo in Tanzania.

23) *The Polish Development Cooperation. 2007 Annual Report,* Ministry of Foreign Affairs, Development Cooperation Department, Warsaw, (www.polskapomoc.gov.pl). Polish.

8. RESEARCH AND SYSTEMATIC OBSERVATION

8.1. National-level activities

8.1.1. Climate research in the state scientific policy

National Framework Programme. The National Framework Programme approved in 2005 was the basis for the Ministry of Science and Higher Education to announce competitions for ordered research projects. One of strategic research areas was environment, which was the basis for establishing the research movement: *Economy as the Climate Change Factor*. The subject of the research was to determine methods of reducing greenhouse gas emissions in Poland and increasing their removals, limiting the use of non-renewable energy sources and increasing the use of renewable energy sources, as well as preventing negative consequences of emissions of these gases for the economy and environment.

On 30 October 2008 the Minister of Science and Higher Education established the National Scientific Research and Development Works Programme (KPBNiPR). The aim of the *Advanced Energy Recovery Technologies* strategic programme conducted within the KPBNiPR is to support research and development works, as well as implementation works connected with environmental-friendly modern technologies concerning the output and treatment of coal.

Polish Climate Policy. The document contains recommendations on research studies, education, training and raising public awareness. Within that scientific research the document comprises, as follows:

- conducting studies on the use of energy and its production, as well as on increasing the effectiveness of its use,
- continuing research studies to track climate change and climatic processes,
- continuing research on climate change scenarios for Poland related to the growing concentration of greenhouse gases in the atmosphere,
- continuing research on the climate change impacts and adaptation in Poland,
- providing financing for the aforementioned activities.

Furthermore, the document specifies that it is necessary to conduct systematic observations in the following fields:

- monitoring of the climate variability in Poland,
- monitoring of emissions and removals of greenhouse gases,
- monitoring of the state of the atmosphere and hydrosphere,

as well as

- participating in the Global Climate Observing System and world-wide international programmes like World Climate Programme, European Climate Change Programme, International Geosphere-Biosphere Programme, Intergovernmental Panel on Climate Change – IPCC.

8.1.2. Research activity fields in climate change

Polish scientific research studies of climatology cover a wide range of topics that have not changed for years and among which the following can be distinguished:

- physical climatology,
- topoclimatology (in particular, climatology of urban areas and selected areas in the limited local anthropogenic impact),
- dynamic climatology,
- regional climatology,
- applied climatology,
- climate change.

The following major issues may be identified in climate change research:

- research on historical 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 in Poland, 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. The research works are limited to analyses of variability of thermal and pluvial characteristics. Long-term homogenous series of atmospheric temperatures elaborated for the Polish stations, such as: Warsaw, Cracow, Puławy, Gdańsk, Hel, Koszalin, Szczecin, Bydgoszcz, Łódz, as well as Śnieżka may serve as an example.

Studies belonging to this group aimed at seeking historical climate change trends and potential periodicities 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.).

Simultaneously, there were being carried out research studies 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, Kasprowy Wierch Mountain – the Tatra Mountains, Śnieżka – the Karkonosze Mountains) and aerosols and optical properties of the atmosphere (the Institute of Oceanology of the Polish Academy of Sciencies – IO-PAN, Institute of Geophysics of the Polish Academy of Sciences – IGF PAN, IMGW). These studies, despite their relatively short data series, constitute an important and to a certain extent sophisticated contribution to the knowledge of Polish climate.

The research on modelling climate change and attempts to predict it are systematically being intensified, however the achievements of the Polish climatology in this respect are still insufficient. This is mainly due to the costs required for such research studies and to their crosscutting inter-disciplinary nature as well as the insufficient number of experienced specialists. Research on the climate change impacts on human activities that are most frequently conducted by the Polish scientific environment are focused on some fields that are most vulnerable to climate change such as: water resources, agriculture, coastal zone, ecosystems, forestry and power industry. Since 1994 there have been carried out around 95 research projects concerning climate change and global warming process of both domestic and European significance.

Research regarding areas located in high latitudes play a very significant role in the Polish scientific studies. Two Polish polar stations (in Hornsund, SW Spitsbergen and King George Island, South Shetland Islands) regularly continued their work. Both cases were dominated by issues concerning global climate change. Furthermore, in the summer time on the island of Spitsbergen Polish universities carry out very diverse research on the climatology of polar areas, glaciology and geology.

Research on oceanography and physics and chemistry of atmosphere basically focus on issues concerning water circulation, energy and mass transport to high latitudes of the north hemisphere, transport of the solar energy into the ocean, aerosols and related changes of optical properties of the atmosphere, aforementioned ozone (trophospherical and stratospherical), as well as changes concerning UVB radiation. An important part is played by the research on greenhouse gases in the atmosphere.

Furthermore, as in previous years scientists from various Polish centres were involved in numerous projects on climate change and their specific consequences, which were financed from foreign resources, mainly of the European Union. The IMGW, University of Łódź (UŁ), University of Silesia (UŚ) continued their research in the international team preparing the regional analysis on climate change and its consequences in the Baltic Sea region (Assessment of the Climate Change for the Baltic Sea Basin) that summarize more than ten-year-works carried out by many European research centres within the BALTEX project being the part of the global GEWEX project. Research on characteristics of climatic conditions near Cracow in both pre-instrumental and instrumental periods were continued within the Millenium project financed by the European Union.

The following research projects were carried out within the adaptation to climate change:

- Developing Policies & Adaptation Strategies to Climate Change in the Baltic Sea Region (ASTRA),
- Global Climate Change Impact on Building Heritage and Cultural Landscapes (NOAH ARK), the Institute of Catalysis and Surface Chemistry PAS,
- Preparation of methodological basis for the adaptation of plants production in agricultural farms of various farming types and production scale for expected climate change, the Institute of Environmental Protection,
- Central and Eastern Europe Climate Change Impact and Vulnerability Assessment (CECILIA), the Warsaw University of Technology,
- Adaptation of Agriculture in European Regions at Environmental Risk under Climate Change (ADAGIO), the Poznań University of Life Sciences.

8.2. Participation in international programmes

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

Polish National Committee (PKN) of the IGBP continued its activity covering a broad research and organisational area, in particular:

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

Biospheric Aspects of the Hydrological Cycle (BAHC). In Poland studies on the impact of the nonstationarity of geophysical processes on domestic water resources with particular consideration of extreme hydrological events, such as floods and droughts, were continued. The studies undertaken provided new results proving previous results and identified hazards of water resources and extreme hydrological events resulting from temperature changes. The detailed research covered selected parts of Poland, mainly lake districts, marshland and overflow areas. The research on changing the water and thermal equilibrium of selected regions (Wielkopolska, Kaszuby Lake District) and climate change of the Polish water equilibrium were still being carried on. The methodology on assessing the risk of occurring adverse processes in the coastal zone of the Baltic Sea, in particular in the region of large agglomerations (Szczecin, Gdańsk, Gdynia and Sopot), the Vistula River and Żuławy delta due to global warming was being developed.

Global Change and Terrestrial Ecosystems (GCTE). The GCTE programme covered research studies on the carbon cycle in selected freshwater ecosystems (Wielkopolskie Lakes, North Eastern Poland) and on the carbon cycle in forest ecosystems and on the effects of forest reclamation in industrial areas. Within the cooperation of some European and American research centres monitoring of ion exchange was carried on and changes taking place in the population of pine forests in the southern cross-section of Europe (from Laponia to the Carpathians) were analyzed. Thanks to this research a clear trend was noticed for a 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 and the Sudety Mountains. A separate and very interesting research field is peat bogs, particularly placed in the northern Poland. Research on the assessment of climate change impact on plant production in Poland and in forestry was still being carried out.

Land Surface Biosphere and Atmospheric Chemistry (IGAC). Within the IGAC programme monitoring of stable and radioactive isotopes in the atmosphere targeted at discovering the isotopic composition of CO_2 and CH_4, and the proceeding changes connected with human interference were being carried on. The scope of monitoring performed was extended by quantitative and quality measurements of aerosols in sea areas (North Atlantic, Baltic Sea), coastal zone and on the land. Thanks to theses studies, it was possible to monitor optical atmosphere properties and modelling their impact on the inflow radiation to the Earth surface. 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 (in a vertical profile and in the entire column), as well as on changes in UVB 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 was still being carried out. Special attention in the Glacial period was given to climate change registered in loess sediments and to the deglaciation process and permafrost recession. Research on sediments in Lake Gościąż and samples collected from a dozen lakes in Pomorze was continued. Due to numerous investments conducted in the entire country it was possible to carry out wide archaeological research studies in places of investments. Such studies provided the basis not only for a reconstruction of climatic conditions within the research area under biological traces. Polish scientific centres still participated in interdisciplinary research programmes on the history of Lake Baikal and Scandinavian lakes and on European palynological data bank.

Sea Biosphere and Atmosphere (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 had been carried out for years. Those studies were conducted within the area of the North Atlantic and the Baltic Sea.

Several new methods useful for Baltic Sea monitoring, inter alia, based on the satellite technology, were developed and implemented (IMGW, PAN Institute of Oceanology and the University of Gdańsk). Polish research studies in polar zones significantly contribute to the knowledge of the impacts of global warming on ocean ecosystems.

Land Ocean Interactions in the Coastal Zone (LOICZ). Traditionally, special attention has been drawn 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 resulting in frequent flooding the coastal zones. Studies on the dynamics of the coastal zones (evolution of the Baltic coastline and eroded material transport) and sea sediments and on the evolution of the south 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.

8.2.2. Cooperation under the World Climate Programme (WCP)

Polish scientists and experts actively participate in the work of the World Meteorological Organization (WMO) and its commissions as well as in its individual programmes. Traditionally, research activities under the World Climate Programme – Water and marine climatology (JCOMM, WMO/IOC) were carried out. The Institute of Meteorology and Water Management (IMGW) organized the conference called: *Advances in Marine Climatology, CLIMAR-III* participated by over 70 scientists from over 20 countries specializing in the marine climatology. The IMGW continued to carry out a programme commenced in 2005, for saving historical data, including their scanning and digitization from archive materials, inter alia, from the period of 1890–1950. Analogical programmes for saving historical data are carried out by the University of Gdańsk in reference to Gdańsk and its neighbourhood and by Nicolaus Copernicus University (UMK) in reference to polar regions. Studies on the variability of climatic conditions in Poland based on long-term series of climate data are constantly continued (by the IMGW and numerous universities).

8.2.3. Global Climate Observing System (GCOS)

Routine research activities and GCOS schedule was continued. In 2008 the report on the implementation of the GCOS in Poland was prepared. The detailed information on observation systems within the GCOS: GOOS, GTOS and GAW was specified 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 designated in 1990 by the Minister of the Environment and located at the Institute of Meteorology and Water Management in Warsaw continued its works in order to coordinate works for the IPCC in Poland, provide opinions to IPCC documents and nominate experts to participate in working group sessions and expert meetings. One of Polish scientists was the author of a leading technical report called: *Water and Climate* issued in 2008. The IMGW organized IPCC workshops in Poland where representatives of the world of media, administration and science had the opportunity to familiarize with the most important results of the IPCC Fourth Assessment Report. Workshops participants could also listen to the presentation of Polish specialists discussing results of Polish research complied with the scope of individual IPCC working groups.

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 continue carrying 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 works 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

Same tasks pertaining to monitoring selected Significant Climate Variables are carried out by science and research institutions, inter alia, the Institute of Geophysics of the Polish Academy of Sciences (IGF PAN), the Institute of Oceanology of the Polish Academy of Sciences (IO PAN), the Institute of Environmental Protection (IOŚ), University of Science and Technology (AGH), and universities – Adam Mickiewicz University in Poznań (UAM), University of Gdańsk in Gdańsk (UG), Jagiellonian University in Cracow (UJ), Maria Skłodowska-Curie University in Lublin (UMSC), Nicolaus Copernicus University in Toruń (UMK), University of Silesia in Sosnowiec (UŚ), University of Warsaw in Warsaw (UW), University of Wrocław in Wrocław (UWr) and Jan Kochanowski University of Humanities and Sciences in Kielce (UJK), as well as National Parks – Wigry (WPN) and Kampinos (KPN).

The advancement of individual elements of the system varies. The biggest differences are definitely visible in the field of systems of ground measurements of significant climate

variables in meteorology (on the land, in oceans and in the highest layers of the atmosphere) and hydrology (monitoring of a snow cover, rivers and lakes) basically carried out by the IMGW under the State Hydrological and Meteorological Services (PSHM). Satellite systems within meteorological and oceanographic variables are very frequently used, but as for hydrological variables and other land characteristics, such systems are less often applied. In this case the IMGW also plays the dominant role. However, actions taken by other institutions, such as the Institute of Oceanology of the Polish Academy of Sciences in Sopot and the Institute of Oceanography of the University of Gdańsk, considerably enhance this field. Moreover, the contribution of Polish institutions, most notably the Institute of Geophysics PAN and the University of Silesia, to the climate observation programme in high latitudes is also very important.

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 (IMGW). The whole network follows a programme for measurements and observations, which is compliant with standards of the World Meteorological Organisation and the equipment installed in the observation and meteorological network undergoes systematic control and periodical calibration.

The number of the observation and measurement network of the IMGW as of 30th June 2008 was, as follows:

- total number of meteorological stations and posts – 1317,
- synoptic stations – 62,
- climatological stations – 222,
- precipitation stations – 1030,
- aerological measurement stations (GUAN) – 3.

The observation network is expanded by the actinometric network established in the early 1960s, currently comprising 25 stations. Data collected at four actinometric stations are submitted to the World Radiation Data Centre (WRDC) in Sankt Petersburg in Russia every three months.

Information from the network of measurement and observation stations and posts of the IMGW 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).

Meteorological measurements in Poland are also made within the Integrated Environmental Monitoring (ZMŚP) carried out within the State Environmental Monitoring. Its aim is to observe the largest possible number of environmental elements on the basis of organized stationary research, Base stations of the ZMŚP are located within areas representing basic types of Polish landscapes.

8.3.2. Ocean observing systems

Research on the maritime environment of the Polish zone of the Baltic Sea is carried out by numerous institutions. The dominating role is played by the Department of Oceanography and the Baltic Sea Monitoring of the IMGW in Gdynia which monitors deep-sea zone within the State Environmental Monitoring. The monitoring research of the inshore zone, gulfs and bays of the Baltic Sea have been carried out by Regional Environment Protection Inspectorates since 2007. Under this programme, besides meteorological observations, there are carried out measurements of physical parameters such as sea water temperature, salinity, sea currents and chemical parameters, such as oxygen concentration, content of biogens, heavy metals, organic compounds and biological parameters and content of radionuclides. The Baltic Sea monitoring data are submitted to the European Environment Agency (EEA), Helsinki Commission (HELCOM) and International Council for the Exploration of the Sea (ICES). The maritime environmental research in the Polish zone of the Baltic Sea is also carried out by the Sea Fisheries Institute in Gdynia (MIR), IO PAN, UG, IM.

Poland carries out very limited oceanographic research outside the Baltic Sea. The research vessel “Oceania” of the IO PAN in Sopot regularly sailing on the North Atlantic and the Arctic (Norwegian) are exceptions. During sails the following parameters are measured: sea water temperature, salinity, sea currents and sea condition, as well as coal content in sea water, biogens and phytoplankton. In additions, samples of marine aerosols are collected.

Poland participates in the global ocean observing system within VOS and SOOP programmes. Most of the Polish shipping (82 vessels) participate in the programme for meteorological observations on the sea, most of vessels regularly transmit data to data centres (around 60 vessels). In the SOOP programme there are two vessels sailing on the Baltic Sea.

Since 2008 there has been operating the independent automatic meteorological station on a drilling platform owned by Petrobaltic Oil and Gas Prospecting and Exploitation Company, located on the Baltic Sea, near Rozewie Peninsula.

The IMGW’s network of coastal posts consists of 36 stations, including 13 posts located in river mouths, 5 posts are located on shores of Vistula Lagoon and Szczecińska Bay, remaining posts are located in the coastal zone of the open sea. Data on the sea level are routinely controlled in respect of the quality and then kept in the historical marine data base of the IMGW.

Currently, Poland submits operating data on sea levels from one station within the network of the ESEAS project.

Works pertaining to the collection and interpretation of satellite images about ocean ECV are conducted in Poland by the IMGW, UG, UŚ and IO PAN. Such works relate to selected aspects (wind field over sea basins, SST, ice cover and sea colour) only.

8.3.3. Terrestrial observing systems

The terrestrial system of the Significant Climate Variables comprises the following components: hydrology (GTN-H), river discharge (GTN-R), lakes (GTN-L), glaciers (GTN-G), permafrost (GTN-P). Within GTN-H the Institute of Meteorology and Water Management makes measurements of the water level at 893 inland posts. The fundamental measurement scope covers the observation of the water condition, ice phenomena and thickness of the ice cover, overgrowing river banks by plants and possible registration of daily run of water level and temperature measurement (at over 210 posts).

The density of hydrological measurements depends on a flood risk of a certain area. Therefore, such density is much greater in the southern Poland.

The snow cover thickness is determined at 1314 posts in Poland and at 1 post located at SW Spitsbergen – the Hornsund station (IGF PAN). At many stations, besides everyday measurements of the snow cover thickness, the snow cover density in the form of the water equivalent (mm H_2O/cm of the snow cover thickness) is also measured.

In order to determine the relationship between the water level and water discharge, hydrometric measurements are made within GTN-R at staff gauges.

The hydrologic inland measurement network is supplemented by limnological measurements (GTN-L) made on 15 lakes located in the northern and western Poland. Such measurements refer to the water balance of monitored lakes. On all lakes included in the limnological network inflow and outflow measurements are made. Furthermore, evaporation of lakes is measured on three lakes. In case of some lakes components of the water equilibrium have been systematically determined since the beginning of the 1960s. Moreover, some lakes are subject to measuring the temperature of the surface water or in the vertical section as well as water transparency and its quality are determined periodically.

Polish scientific institutions in high latitudes monitor land glaciers within GTN-G. As for the Norwegian Arctic (SW Spitsbergen) the glaciers monitoring programme has been carried out for many years and it covers plenty of parameters. The programme is conducted by the UŚ and IGF PAN. As far as the Antarctic is concerned research on glaciers is periodically and in a limited way carried out by the PAN near the H. Arctowski station. These studies, however, allow researchers to determine the glacier recession speed (since the 1950s) and summer outflow intensity.

Regular measurements of the summer thaw depth and systematic measurements of the soil temperature (up to 1.0 m) have been carried out since 1977 near the station in Hornsund, SW Svalbard, by IGF PAN within GTN-P.

Poland is a member of the International Permafrost Association (IPA) and participates in the Circumpolar Active Layer Monitoring (CALM) programme being the part of the global climate observing system GTN-P (UMK and UMCS). Measurement results are transferred to CALM data centres at the University in Cincinnati (USA) and to the National Snow and Ice Data Center, Boulder Colorado (USA).

The tradition of carrying out fenological observations dates back to the end of the 19th century. Observations were resumed by the IMGW after the Second World War, suspended in 1992 and resumed in 2005, again. The fenelogical observations network supervised by the IMGW presently comprises 70 posts. Own networks of fenological observations are also conducted by some universities and Agricultural Advisory Centres.

8.3.4. Satellite climate observing systems

Research on applying satellite products in meteorology and indirectly in climatology are carried out at the Satellite Teledetection Centre of the IMGW. The outset of the centre's activity was in the 1960s and since 1967 satellite products have been generated operationally.

Since the 1960s the centre has had the station of collection and proceeding satellite data comprising a dozen geostationary and circumpolar satellites: Meteosat, Meteosat-Rapid Scan, NOAA, MSG, METOP, GOES and Feng Yun, as well as the archive of satellite images in the form of images from image registers of METEOSAT and NOAA satellites. Since 1987 raw data have been archived in a digital form, thanks to which they can be reprocessed to obtain final products by means of applying any methods (reprocessing). Within this scope the research activity focuses on applying satellite information for needs of meteorology and hydrology. Furthermore, works on applying satellite data in climatology and natural environmental research are being carried out.

Poland is a member of the international EUMETSAT consortium and actively participates in developing projects within its activity. Besides activities pertaining to implementing current EUMETSAT products, the centre conducts works aiming at implementing results of designed projects, for instance since 2015 MTG (Third Generation Meteosat).

Works in the field of collecting and interpreting satellite images are also carried out in a limited way at some higher schools and scientific institutions of the PAN. The data rece-

ived 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 there 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 icing, 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.

8.3.5. Monitoring of greenhouse gases

Among Polish measurement and observation stations six of them are included in the Global Atmosphere Watch (GAW) established in 1989. These stations make measurements complied with requirements of the programme of GAW regional stations within an extended scope. Four of aforementioned stations, i.e. Jarczew, Śnieżka, Diabla Góra/Puszcza Borecka forest and Łeba, carry out additionally monitoring of background atmosphere pollution in compliance with the EMEP programme conducted within the State Environment Monitoring. In this field all Polish stations carry out a basic measurement programme (the so-called level 1) and the Puszcza Borecka forest – implements elements of the extended level.

Measurement results from GAW stations are transmitted to four global centres of the GAW and BMP/HELCOM.

The research on the ozone layer over Poland and measurements of UV radiation strength comprise as follows:

- measurements of the total ozone content in the atmosphere and vertical ozone layout,
- measurements of ozone profiles by a probing method,
- determination of areas of total ozone content over Europe by a satellite observing method,

and

- measurements of the UV radiation concentration at 4 stations.

Results of measurements are transferred to two global centres and the Atmosphere Physics Laboratory of the University in Saloniki.

In Poland atmospheric concentrations of main greenhouse gases have been regularly measured since 1994 at the measurement station located in the building of the Meteorological Observatory on the Kasprowy Wierch Mountain in the Tatra Mountains (49°14'N, 19°56'E; 1,987 metres above sea level). The High-Mountain Meteorological Observatory is a country unique research centre. Its location in a non-disturbed environment categorizes it to the referential climate networks of the International Meteorological Organization (WMO). The observatory is also the part of the European Network of High-Mountain Observatories.

The height of the station and its distance from local sources of greenhouse gases guarantee that at some hours of the day and night the station measures concentrations of greenhouse gases characteristic for the so-called free troposphere. This means that observed concentrations of greenhouse gases are representative in these periods for a large area of Eastern and Central Europe. Measurements of greenhouse gases on the Kasprowy Wierch Mountain are made by the Environmental Physics Chair, the Faculty of Physics and Applied Computer Science, the AGH University of Science and Technology in Cracow with the cooperation of the Institute of Meteorology and Water Management (IMGW).

The variability of the carbon dioxide concentration on the Kasprowy Wierch Mountain from 1994 to 2007 is shown in Figure 8.1. This is an average record based on selected measurement data representing measurements in the free troposphere after eliminating incorrect measurements and filtering out local effects. For comparison, Figure 8.1 also shows changes of the CO_2 concentration at the Mace Head measurement station located in Ireland.

The carbon dioxide concentration on the Kasprowy Wierch Mountain increased from around 360 ppm (1 ppm = 10^{-6} mol/mol) in 1994 to 386 ppm in 2007 (Table 8.1, Fig. 8.1), or by almost 7%. A similar increase speed was observed at the Mace Head station. This growth was not even, because in some years a considerable concentration change (for instance 1999–2001) was not observed. This mainly results from the fluctuation of the global carbon circulation intensity connected with changing CO_2 emissions to the atmosphere (both anthropogenic and natural), as well as the changing intensity of the CO_2 absorption by the world ocean.

The amplitude of seasonal changes of the CO_2 concentration on the Kasprowy Wierch Mountain is considerable and fluctuates between around 15 and 20 ppm (compare with Figure 8.1). Those fluctuations are related to the intensity of the photosynthesis process.

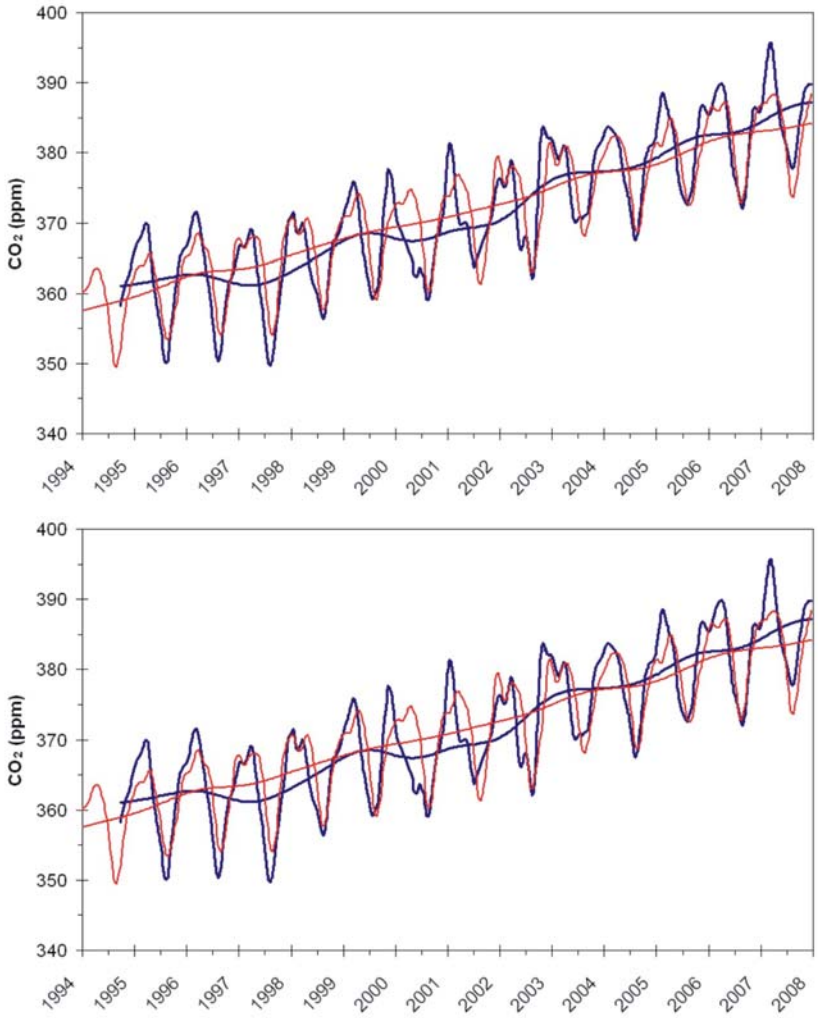

Figure 8.1. Changes of the carbon dioxide concentration (upper panel) and methane (lower panel) on the Kasprowy Wierch Mountain in the years 1994–2007 (navy blue lines). The figure shows properly selected and averaged measurement data representing concentrations of CO_2 and CH_4 in the free troposphere. For comparison concentrations of CO_2 and CH_4 measured at the Mace Head station in Ireland (red) are shown, source: IOŚ

Unlike the carbon dioxide concentration, the methane concentration measured on the Kasprowy Wierch Mountain in the years 1994–2007 did not show any changes. In that period the CH_4 concentration fluctuated around the value of 1830 ppb (1 ppb = 10^{-9} mol/mol), excluding the considerably higher concentration in the years 2000–2002, equalled to 1865 ppb. As for methane there is a lack of distinctive seasonal fluctuations. For comparison, Figure 8.1 shows the CH_4 concentration at the referential Mace Head station in Ireland.

Apart from monitoring greenhouse gases concentrations at the Kasprowy Wierch Mountain station, regular measurements of selected greenhouse gases (CO_2, CH_4, SF_6, CFC gases) in the urban environment with strong anthropopression (Cracow) are regularly made in Poland.

Table 8.1. Changes of concentrations of CO_2 and CH_4 in the atmosphere measured at the Kasprowy Wierch station in the years 1995–2007

Year	Average annual CO_2 concentration [ppm]	Amplitude of seasonal changes [ppm]	Average annual CH_4 concentration [ppb]
1995	361.9	20.7	1827.6
1996	362.3	19.9	1828.8
1997	361.8	20.3	1821.9
1998	365.1	17.9	1829.4
1999	369.4	18.3	1837.2
2000	366.5	20.0	1850.3
2001	369.7	19.5	1847.4
2002	373.7	20.1	1865.8
2003	376.3	14.7	1843.5
2004	377.7	18.1	1838.8
2005	381.3	16.8	1839.4
2006	382.6	19.5	1837.2
2007	386.2	19.5	1843.5

Source: IOŚ.

9. EDUCATION, TRAINING AND PUBLIC AWARENESS

9.1. Educational policy

The United Nations Framework Convention on Climate Change emphasized the Parties' obligations concerning the necessity to raise public awareness of climate change, its results and specifies relevant tasks in Art. 6. This Article recommends to support the implementation of proper educational programmes in the entire country, provide the open access to information on the environment, train personnel and cooperate and share experience at the international scale.

In Poland the necessity to raise ecological public awareness is laid down in all strategic documents pertaining to the broad environmental protection. Such necessity is specified in the *Second State Environmental Policy, in Poland 2025: Long-term Strategy for Sustainable Development, and in Poland's Climate Policy. The New National Environmental Policy for 2009–2012 and its 2016 outlook* adopted by the Council of Ministers in December 2008 emphasizes the consumer education, recommends to launch the nation wide social campaign shaping the sustainable consumption patters. As activity directions *the New Policy* recommends to develop the school education concerning the environmental protection, make access to the environmental information and shape behaviours complied with the sustainable development rule. In addition, it is recommended to cooperate closely with journalists in respect of the education of all social groups. In *the Act of the Environmental Protection*, the necessity of the environmental education is laid down in Section VIII Environmental education, environmental research and advertising. The access to the information is facilitated by *the Act of Access to Environmental Information and Cooperation with Community in Environmental Protection and Environmental Impact Assessment.*

The agreement between the Minister of National Education and Minister of the Environment resulted in adopting *the National Environmental Education Strategy – Through Education to Sustainable Development.* The strategy updated in 2001 was strengthened by the executive programme – the performed action plan encompassing individual age and professional groups and indicating educational entities suitable tasks and promoting methods of its financing. According to the *National Strategy* the environmental education, including the climate protection education, falls under the responsibility of the Ministry of National Education and the Ministry of the Environment with participation of all other ministries (in particular agriculture, national defence and regional development) within the scope of their competences.

9.2. Formal education

The education system in Poland encompass nursery schools, six-year primary schools, three-year gymnasiums, post-gymnasium secondary schools (general-grammar and profiled secondary schools, and technical and vocational schools) and higher schools. 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*. This provision alone gives a green light to the environmental education.

The main document specifying mandatory educational programmes in educational institutions is *the Programme Basis for Nursery School Level and General Education in Individual School Types*.

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 within individual subjects, and natural and social interdependences may be presented within the course of conducting the interdisciplinary pathway: environmental education. During these lessons school children get acquainted with problems concerning the relationship between human 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: co-relations between human and the environment; 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 various natural subjects, as well as in educational programmes in the form of interdisciplinary *environmental pathway.* 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 the energy production and transport; nuclear energy – safety and waste management; functioning of the natural Earth's ecosystem – phenomena, processes, environmental variability in time and space, weather changes, natural disasters; environmental equilibrium, threats to civilization connected with conventional and nuclear energy; renewable energy sources.

A student is expected to know reasons of the current environmental condition, preventions of adverse changes, as well as to notice co-relations between environmental elements and the human's activity at the global scale. The aim of the education is to take responsibility for actions that may affect the environment.

Students of post-gymnasium secondary schools who fail to choose advanced classes of individual natural subjects, attend the *nature* subject being their substitute and discussing among others the issues of the greenhouse effect from the physical point of view – controversies around the human's impact on deepening this effect. Generally, within this subject the educational aim is to explore individual threads of the environmental knowledge referring to important issues of our civilization.

The educational programme basis for vocational schools also broadly focuses on the educational effectiveness in natural and science subjects – in accordance with priorities of the Lisbon Strategy. Besides professional education, this type of schools are to provide their graduates with the fundamental general knowledge.

In all types of schools the students are expected to estimate changes in the environment due to the human's impact and their effect on the quality of life, as well as to be able to find preventive measures.

Development and production of good auxiliary materials in the educational process are supported by subsidies of the National Fund for Environmental Protection and Water Management (NFOŚiGW) and Regional Funds. A good instance of enhancing the climatic education may be a multimedia teaching material (book, lesson scenarios, DVD films) named: *Under a Glass Dome or the Weather Forecast* recommended by the Ministry of National Education and financed by the NFOŚiGW.

Except for the education resulting from the implementation of the basic educational syllabus, a great role in developing pupils' attitudes is also played by an instance of applying sustainable development rules in the school management practice. Among such good patterns there are variable actions of school authorities resulting in the energy saving or waste segregation. These efforts are estimated in the process of applying for the Green Certificate. This system run by the Fund of the Environmental Education Centre under the patronage of the Minister of the Environment evaluates educational institutions for the total approach to ecological issues in respect of educational innovations and care of the environment, So far, a few hundred Green Certificates have been awarded in Poland.

The formal educational system includes also higher schools. Higher schools are to crown the process of education of specialists who can practically apply sustainable development rules and climate protection actions. The *Environmental Protection* subject is offered by most of public and non-public higher schools as a field of study or a separate faculty, and many of such studies are inter-faculty studies, for instance the Inter-Faculty Studies in the Environmental Protection at the University of Warsaw, or even intercollegiate studies. As for universities, in order to enhance the educational process each year a different academic centre hosts methodological conferences: the Environmental Protection at environmental studies. According to the Statistical Yearbook in 2001 at Polish higher schools the environmental protection was studied by around 52 thousand students (all years), including over a half of them studied at technical fields of study like environmental protection engineering. In addition, full-time, extramural and evening studies allow working people to be awarded a degree. In recent years most of such lectures were about various aspects of global climate change. Furthermore, higher schools educate and conduct popularizing activities addressed to various groups of listeners by organizing scientific sessions for the general public and participating in the Science Festivals. For instance, in 2008 the University Centre for Environmental Studies organized on the Earth Day the scientific session for the general public named: *Between Bali and Poznań – Science, Economy and Politics in Connection with Climate Change*.

9.3. General information on training

In view of increasing the formal education level, trainings supplementing the knowledge in the field of the climate protection and improving methodological qualifications of teachers and educators (individuals educating at non-school institutions) are crucial. Such trainings are provided by the National In-Service Teacher Training Centre (CODN), Re-

gional Methodological Centres and higher schools. The system also includes post-graduate studies for teachers offering education as regards the content and methods of the ecological education, such as post-graduate studies at the University of Warsaw or the Cardinal Stefan Wyszyński University in Warsaw. In recent years among the most fundamental training subjects there are topics concerning explanation of reasons and effects of climate change. These trainings are not only addressed to teachers of natural subjects. A good example may be trainings in Cracow provided by the British Council and the CODN for teachers of English presenting how language teaching can be based on special materials on global warming issues.

9.4. Educational activity conducted by governmental institutions and NGOs

Except for programme activities within the educational system, various educational, promotional and information activities concerning the climate protection are also conducted by institutions of the state administration, scientific institutions and non-governmental ecological organizations. Many of these activities are carried out by the Ministry of the Environment or under the patronage of the Minister of the Environment. An example of such activities may be the educational and promotional campaign on climate change announced by the European Commission. Its aim is to raise the awareness of people that the activities of every single person may reduce the emission of greenhouse gases. This campaign included among others commercials and many sponsored radio programmes. For many years information on the influence of human activity on climate change has been regularly conveyed to the society in the *Climate Change* information bulletin edited by the Institute of Environmental Protection and commissioned by the Ministry of the Environment. The scope of presented subjects is diverse and refers to, inter alia, domestic and international actions taken in order to prevent climate change and to adopt to such changes or scientific research and simple actions leading to the reduction of greenhouse gases emissions. The entire Europe celebrates the *European Day without Cars.* The aim of this campaign is to make people aware of the impact of transport means on the greenhouse gases emission and to promote the public transport and bikes as alternatives for individual car transport. The Ministry of the Environment prepared promotional posters and provided the Day's media setting.

One of the largest events promoting the environmental protection in broad social structures is the all-Poland celebration of World Earth Day organized since 1990. The World Earth Day festival in 2008 was celebrated under the banner of activities for the climate. An extensive programme of the festival lasting for over a month aimed at raising social awareness in various social groups by applying various means. The popular and scientific part of the programme included *Between Bali and Poznań* Academic Forum addressed to students and employees of higher schools. It was organized by the Higher School of the Educational Association and the University Centre for Environmental Studies of the University of Warsaw. *The Impact of Climate Change on Biological Diversity* panel organized by the Educational Centre of the Kampinoski National Park was addressed to foresters and people dealing with environmental protection, whereas a workshop on the civic involvement arranged by the Institute for Sustainable Development was addressed to non-governmental organizations. During the festival that was broadcast on the Polish public television (TVP) all Warsaw residents were informed about global warming by means of various sources (workshops, concerts, educational plays).

A good opportunity to present all-Poland and local climate protection activities to the general public is the International Environmental Day celebrated on 5th June. The central celebrations arranged each year in a different province emphasize local actions and present efforts of services and particularly distinguished professionals.

A significant educational base is a network of regional ecological education centres governed by local administration, community organizations and organizations of national and landscape parks. Various activities organized by them like regular classes, workshops for teachers, competitions and theme campaigns involve local community and support the formal education. Individual actions of specific non-governmental organizations popularizing the knowledge of climate change threats were enhanced by cooperation within the Climate Coalition. This Coalition is an open agreement concluded by 15 non-governmental organizations. The Coalition arranges climate change workshops, conferences and theme trainings, as well as provides information actions on its website.

An instance of the education at schools provided by non-governmental organizations is the Eco-teams programme commenced in Poland by the GAP Polska Fund. The programme consists in, inter alia, establishing school teams and their competitions for reducing energy wastage and acquiring the pro-ecological life style.

9.5. Education financing

The performance of all aforementioned programmes and forms of education require large financial outlays. Besides financing the ecological education by local administration provided at schools and local community organizations, the largest sponsor of the ecological education is the National Fund for Environmental Protection and Water Management (NFOŚiGW). Financial means earmarked for the education

equal to around PLN 25 million annually. Subsidies comprise various educational projects: trainings, educational materials, films, radio programmes, campaigns, competitions, etc. A very important role is also played by a programme supporting non-governmental ecological organizations (POE), which enhances the potential of civic actions. Similar financial support for local projects is granted by 17 Regional Funds and commune funds. Climate protection projects were also financed by the Global Environmental Facility (GEF UNDP). Particularly popular among Polish ecological organizations small GEF grants always included educational elements. Substantial financial means for education are also earmarked by the State Forests. This organization maintains numerous forest educational centres, prepares the infrastructure (e.g. educational paths) and give classes to the youth. The role of EU financial resources is significantly growing in financing of ecological education.

9.6. Participation in international activities

It's hardly to find a large international environmental protection programme in which Polish schools would not participate to a smaller or larger extent. One of examples may be the GLOBE Programme (Global Learning and Observations to Benefit the Environment) introduced to Polish schools in 1997 when the Ministry of National Education of Poland signed an agreement with the United States National Oceanic and Atmospheric Administration. The GLOBE Programme involving over 20,000 schools from 110 countries, is coordinated in Poland by the Environmental Information Centre GRID-UNEP operating at the National Foundation for Environmental Protection. A considerable part of the programme covers methodological environmental observations that also concern atmosphere pollution and temperature measurements transmitted and gathered in the NASA information base. According to statistics, the largest number of data comes from observations conducted by Polish schools. An important international programme is the Baltic Sea Project referring to the Baltic states and involving the UNESCO School network. The Baltic Sea Project consists in exchange of information and cooperation of schools in projects aiming at acquisition and protection of various elements of the environment, including air protection and energy saving. Each country, one by one, coordinates the cooperation and is responsible for issuing the bulletin. In 2007 the project was coordinated by Poland.

Activities concerning the climatic education are also conducted in Poland by various international organizations, scientific institutions, embassies and cultural representatives. One of the most comprehensive, long-term programme that is addressed to various communities is conducted by the British Council. In the years 2004–2007 the *Zero Carbon City* programme was launched. It involved cooperation with in-service teacher training centres in various cities of Poland and prepared suitable educational materials for the global warming education. The climatic education and promotion of individual preventive actions referred not only to teachers of natural subjects, but also teachers of English who could discuss climate issues while teaching English. The programme also offered classes for older people conducted at the University of the Third Age. Separate actions were addressed to the academic community.

Another good example of international and bilateral cooperation constitute educational actions conducted under the patronage of European embassies. One of them is the information campaign on the environmental-friendly energy that promotes education devoted to increasing energy efficiency in households carried out by the Embassy of Denmark. This campaign is conducted under the patronage of Danish and Polish ministers of the environment. Moreover, other embassies arrange series of seminars and workshops addressed to various audience groups (e.g. *Clean and Green – Innovation Day for Polish Municipalities* organized by embassies of Denmark, Sweden and Norway), study tours and conferences. These activities are supported by experts from individual countries who present specific solutions for development of renewable energy and new no-emission processing technologies. A special role was played by the embassy of France, due to its chairmanship in the EU as well as the European Commission representative in Poland who popularized European climate protection actions. Thanks to the information campaign addressed to the wide audience (e.g. on billboards) and theme seminars with the participation of members of parliament, representatives of local authorities and journalists, and Polish policy-makers could acquaint with the EU climate protection practice.

Educational activities are also conducted by other international organizations or organizations representing individual countries. A series of seminars, workshops and conferences organized by the Heinrich Böll Foundation within the regional programme (Poland, Germany, Czech Republic) *the Energetic Policy and Climate Protection* may serve as one of the examples. The aim of the programme is to provide the education and draw the public attention to the significance of issues concerning climate change mitigation.

The international experience-sharing concerning the climatic education is especially obvious in case of the Regional Environmental Centre for Central and Eastern Europe (REC) due to the close cooperation of all national offices of the REC. For instance, the Polish REC office promotes multimedia educational set for schools named: *The Green Package.* It is adjusted to our conditions and concerns issues of the sustainable development and global problems like climate change.

Polish organizations and higher schools participate as

partners in many projects aiming at promotion of knowledge on climate change and life style that are financed from European funds, such as the Grundtvig or Socrates. These projects are the basis for educational materials, courses and trainings addressed to various audiences. One of examples is the pan-European educational project (financed from the European Commission Socrates/Minerwa fund) *Carbon Game – Emissions Trading,* gathering partners from the UK, Italy and Slovakia, as well as the University Centre for Environmental Studies of the University of Warsaw. Within this project an international educational Internet game was developed showing dilemmas of CO_2 emissions trading addressed to teachers and the youth attending gymnasium schools.

9.7. Use of the Internet in education

Each year the role of the Internet as an up-to-date medium that serves to make information widely available and to support the ecological education is growing. In conformity with this tendency in 2005 the Ministry of the Environment launched the information portal managed by the Environmental Information Centre www.ekoportal.gov.pl including, inter alia, information on the up-to-date ecological policy and issues concerning the climate protection. Apart from climate issues frequently presented for a long time on websites devoted to the broadly defined ecological education, a lot of new specialist portals have been established recently. One of them is the Centre for Environmental Studies' portal www.ekoedu.uw.edu.pl focusing on the sustainable development education and designed for teachers and educators. Recently, a special *climate* tab has been added to the portal which includes educational materials divided into topics like *Climate and its threats, Policy and economy towards climate change, What can we do themselves to protect climate.*

A great deal of information and discussion articles about climatic issues can be also found on the private platform of the Internet services like the Polish ecological portal www.ekologia.pl.

Similarly, a lot of information on climate can be found on websites of large non-governmental organizations like the WWF or Our World. The Climate Coalition has also its own website: www.koalicjaklimatyczna.org.

As for portals, one of the most complex portals is the recently established web portal: ziemianarozdrozu.pl conducted by the British Council within climate advocates' projects.

2008 saw a new climate portal professionally conducted by the Institute for Sustainable Development www.chronmy klimat.pl supplementing the *Climate Bulletin* periodically issued in the electronic form.

9.8. Education and raising ecological awareness of business

There is a distinctive tendency of the private sector and various business institutions to get involved in activities raising awareness in their own companies, conduct or sponsor external actions – the social education related to climate. These actions may frequently involve emphasizing own achievements in the field of energy saving and reduction of air polluting emissions as an instance of the good practice. Bank Ochrony Środowiska (Environmental Protection Bank) together with the Institute for Sustainable Development is the co-author of the pilot project: *Zero Emission,* according to which the bank is the first financial institution in Poland to have been audited comprehensively in respect of the impact of its operation on climate. Audit results will affect ecological awareness of employees and result in making the bank's management more pro-ecological. Similar actions of proprietors of small and average companies associated in the Clean Business Clubs aim at managing the company or changing its activity in a way that minimizes the adverse impact on environment. Companies participating in the Clean Business Programme involve themselves in developing their cities, towns or regions and show that the development based on the ecological and social responsibility is possible and is a condition for building a modern economy. In the years 1998–2008 over 5,000 companies participated in the programme, their example may have a great impact on development of ecological awareness of other companies. Enterprises are also the initiators of numerous actions aiming at raising awareness of children and teenagers.

9.9. Role of media

In recent years the involvement of media in the climatic education increased. Climate change is the most comprehensively discussed in the specialist press covering around 90 titles: branch magazines like *Oceny Oddziaływania na Środowisko* (Assessments of the Environmental Effects) quarterly or *Gospodarka Wodna* (Water Management) quarterly, as well as magazines addressed to the environmental protection administration like, for instance, *Środowisko* (Environment) or *Biznes i Ekologia* (Business and Ecology) addressed to the business. Popular and scientific magazines like *Aura* or periodicals issued by non-governmental organizations like *Dzikie Życie* (Wild Life) or *Biuletyn Polskiego Klubu Ekologicznego* (Bulletin of the Polish Ecological Club) are addressed to the audience interested in ecology. These magazines and periodicals play an important role in the information transmission in professional or hobby circles associated with the environmental protection, but in the light of the press

studies such magazines and periodicals may be read by maximum 2% of press readers in Poland.

The largest role in reaching wide circles of the society is played by the nation-wide press – three main national daily newspapers *Rzeczpospolita, Gazeta Wyborcza* and *Dziennik* that more and more frequently publish articles about causes and effects of global warming, as well as economic and social implications. *Gazeta Wyborcza* daily, through its publications, was one of the first newspapers involved in the *Partnership for Climate* action, emphasizing its many years involvement in informing of climate change. *Dziennik* daily has a special insert named *Ecology* comprehensively discussing these issues. *Rzeczpospolita* daily periodically publishes the insert sponsored by the Ministry of the Environment presenting directions of Polish climate protection actions, for instance the condition and advantageous of renewable energy sources. Moreover, large opinion-forming magazines like *Polityka,* through their articles, raise social awareness of threats resulting from global warming.

A large role in reaching residents of towns and villages is played by a few hundred titles of the local press presenting regional issues, for instance air pollution emissions, or practically advising on the energy saving and other pro-ecological consumer actions.

Journalists specializing in ecological topics, including issues of the energy policy and climate protection, are associated in Poland at the Journalists Environmental Protection Club EKOS. The club arranges trainings and study tours that allow its members to extend their knowledge of climate change issues and improve journalists' skills.

Besides productions made on the initiative of the media itself, numerous regular radio programs (for instance a series of renewable energy sources programs) and TV programs were financed by the National Fund for Environmental Protection and Water Management (NFOŚiGW). Instances of such programs are, inter alia, 12-episode series of educational films for teenagers named: *Under a Glass Dome or the Weather Forecast* broadcast by the Polish public television (TVP).

Appreciating a role of good journalism in shaping social sensitivity to global warming issues, the Climate Coalition announced in 2008 the *Climate for Climate* competition under the patronage of the EKOS Club addressed to radio and television journalists for the best material on climate change and protection.

9.10. Social awareness of global climate change

The effectiveness of all presented educational actions and results of social communication concerning climate change may be evaluated on the basis of their impact on social ecological awareness. Ecological awareness is a set of information and beliefs on the environment and observance of relationships between the state and character of the environment and conditions and quality of the human's life.

Ecological awareness, especially in the sphere concerning climate change is the subject of sociological research, polls carried out by newspapers and opinion poll companies. A typical poll was conducted at the request of *Rzeczpospolita* daily at the end of November 2008, the day before COP 14. As many as 90% of the Poles believe that the environmental protection is an important threat for Poland, and global warming was third in the ranking of threats, just after air and water pollution. This is believed by 30% of respondents. Global warming is believed by 86% of respondents to be one of threats, including 30% of respondents who believe global warming to be one of the largest threats.

Results of the poll carried out by CBOS Fund at the request of the Institute for Sustainable Development in April 2008 in a representative sample prove that 54% of the Poles agree that *Poland can afford to develop its economy and simultaneously bear outlays on the environment protection.* Respondents indicated global warming as one of the most dangerous threats. Global warming dethroned the ozone layer that so far had been ranked first on the threats list. Over 67% of respondents mentioned the industry as the activity having the greatest adverse impact on climate; second was the large-area forest cutting (46%) and other causes are transport and power industry. Each social and professional group responding to the question on the type of the energy policy development, always ranked renewable energy sources first (44%) and 50% in groups of people with higher and secondary education. As the alternative to the previous energy policy respondents ranked energy saving as second.

LIST OF ABBREVIATION

AGH	University of Science and Technology
AIJ	Activities Implemented Jointly
ARE	Energy Market Agency
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
BULiGL	Office for Forest Planning and Management
CALM	Circumpolar Active Layer Monitoring
CBOS	Public Opinion Research Centre
CDM	Clean Development Mechanism
CHP	Combined Heat and Power
COP 14	14th Conference of the Parties to the United Nations Framework Convention on Climate Change
CRF	Common Reporting Format
DSO	Distribution System Operator
Dz.U.	Polish Journal of Laws
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
EEA	European Environment Agency
EMEP	European Monitoring and Evaluation Environmental Programme
ENGOs	non-governmental environmental organisations
ENPEP	Energy and Power Evaluation Program
ENR	Enhanced Nutrient Removal
EOTA	European Organisation for Technical Approvals
ERT	Expert Review Teams
EU	European Union
EU-15	Old EU Member States, before enlargement
EU-27	Current EU Member States, after enlargement
EU ETS	the European Union Emission Trading System
EUMETSAT	Europe's Meteorological Satellite Organisation
EuroGOOS	European component of the Global Ocean Observing System (GOOS)
Euro00	Euro value expressed in term of market value of year 2000
F-gases	Fluorinated gases
FLUXNET	Global Terrestrial Network–Carbon
FMGO	Forest Management and Geodesy Office
GCOS	Global Climate Observing System
GCM	General Circulation Model
GCS	Great Chemical Synthesis
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 gas
GIOŚ	Chief Inspector for Environmental Protection
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-C	Global Terrestrial Network-Carbon
GTN-G	Global Terrestrial Network-Glaciers
GTN-P	Global Terrestrial Network-Permafrost
GTOS	Global Terrestrial Observing System
GUAN	GCOS Upper Air Network
GUGiK	*Head Office of* Geodesy and Cartography
GUS	Central Statistical Office
HDI	Human Development Index
HELCOM	Helsinki Commission (Baltic Marine Environ-

	ment Protection Commission), under the Convention on the Protection of the Marine Environment of the Baltic Sea
IBL	Forest Research Institute
IBR	Increased Biogene Removal
IBRD	International Bank for Reconstruction and Development
ICES	International Council for the Exploration of the Sea
ICOADS	International Comprehensive Ocean-Atmosphere Data Set
IDA	International Development Association
IEM	Integrated Environmental Monitoring
IETU	Institute for Ecology of Industrial Areas
IGAC	International Global Atmospheric Chemistry Project
IGBP	International Geosphere-Biosphere Programme
IGF PAS	Institute of Geophysics of the Polish Academy of Sciences
IGSO	Institute of Geography and Spatial Organisation
IHDP	International Human Dimensions Programme
IHE	Institute of Hydro-Engineering
IIASA	International Institute for Applied Systems Analysis
IMGW	Institute of Meteorology and Water Management
IO	Institute of Oceanology of the Polish Academy of Sciences
IOC	Intergovernmental Oceanographic Commission
IOŚ	Institute of Environmental Protection
IPA	International Permafrost Association
IPCC	Intergovernmental Panel on Climate Change
ISA PAN	Institute of Studies of the Antarctica of the Polish Academy of Sciences
IT	Information technology
ITS	Motor Transport Institute
IUNG	Institute of Soil Science and Plant Cultivation
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
JGOFS	Joint Global Ocean Flux Study
JI	Joint Implementation
JKU	The Jan Kochanowski University of Humanities and Sciences in Kielce
JU	Jagiellonian University in Cracow
KASHUE	National Administration of the Emissions Trading Scheme
KCIE	National Emission Centre
KPN	The Kampinos National Park
LOICZ	Land Ocean Interactions in the Coastal Zone
LPG	Liquified Petroleum Gas
LUCF	Land-Use Change and Forestry
LULUCF	Land Use, Land-Use Change and Forestry
MCSU	Maria Curie-Sklodowska University in Lublin
ME	Ministry of Economy
MFA	Ministry of Foreign Affairs
MFI	Marine Fishery Institute
MI	Maritime Institute
MoU	Memorandum of Understanding
M.P.	Polish Monitor – Polish Journal of Official Strategic Documents
NAP	National Allocation Plan
NCU	Nicolaus Copernicus University in Toruń
NDP	National Development Plan
NFEPWM	National Fund for Environmental Protection and Water Management
NILU	Norwegian Institute for Air Research
NOAA	National Oceanic and Atmospheric Administration
NPAFC	National Programme for the Augmentation of Forest Cover
NTTC	National In-Service Teacher Training Center
NWMP	National Waste Management Plan
OJ	Official Journal of the European Union
PAGES	Past Global Changes
PEMP	Polish Energy Efficiency Motors Programme
PGNiG S.A.	Polish Oil and Gas Company
PKD	Polish Classification of Activities– equivalent to La nomenclature statistique des activités économiques dans la Communauté européenne (NACE)
PKN	Polish National Committee
PSE S.A.	Polish Power Grid Company
PSHM	State Hydrological and Meteorological Service
R&D	Research & Development
REC	Regional Environmental Centre for Central and Eastern Europe
RES	Renewable Energy Sources
RGB	Red Green Blue
SDOL	Substances That Deplete the Ozone Layer
UAM	Adam Mickiewicz University in Poznań
UG	University of Gdańsk
UN	The United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change

UNIC	United Nations Information Centre
UoS	University of Silesia
UoW	University of Warsaw
UoWr	University of Wrocław
WCP	World Climate Programme
WDCA	The World Data Centre for Aerosols
WDCGG	The *World Data Centre for Greenhouse Gases*
WDCPC	World Data Centre for Precipitation Chemistry
$WDCSO_3$	The World Data Centre for Surface Ozone
WIOŚ	Voivodship Inspectorate for Environmental Protection
WMO	World Meteorological Organisation
WNP	The Wigry National Park
WRDC	World Radiation Data Centre
ZBŚRiL PAN	Research Center For Agricultural and Forest Environment, Polish Academy of Sciences

ANNEXES

ANNEX 1. Greenhouse gas emission and removal trends in 1988–2007

Carbon Dioxide [Gg CO_2 equivalent]

Greenhouse gas source and sink categories	Years																			
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1. Energy	**440 437**	**419 231**	**347 466**	**350 307**	**342 355**	**349 334**	**343 424**	**346 297**	**356 754**	**349 635**	**323 873**	**313 118**	**302 102**	**301 249**	**290 814**	**300 334**	**300 144**	**296 311**	**305 397**	**302 825**
A. Fuel Combustion	440 389	419 184	347 419	350 260	342 297	349 266	343 344	346 214	356 665	349 553	323 772	312 997	301 922	301 038	290 613	300 123	299 900	296 078	305 177	302 626
1. Energy Industries	*268 295*	*262 302*	*228 008*	*224 079*	*215 681*	*205 438*	*204 255*	*190 608*	*196 404*	*191 194*	*184 731*	*179 163*	*176 808*	*178 915*	*173 447*	*182 223*	*180 636*	*178 380*	*182 537*	*181 993*
2. Manufacturing Industries and Construction	*42 536*	*39 597*	*42 430*	*39 774*	*37 091*	*48 051*	*48 341*	*62 406*	*66 563*	*64 463*	*55 226*	*47 324*	*47 341*	*41 612*	*38 439*	*38 136*	*38 333*	*31 697*	*32 699*	*34 664*
3. Transport	*21 847*	*21 643*	*24 927*	*23 551*	*23 665*	*24 072*	*26 190*	*28 478*	*31 680*	*32 435*	*33 333*	*33 408*	*32 202*	*31 425*	*31 137*	*32 089*	*34 111*	*35 918*	*38 141*	*38 213*
4. Other Sectors	*107 711*	*95 643*	*52 054*	*62 856*	*65 860*	*71 704*	*64 557*	*64 723*	*62 018*	*61 462*	*50 481*	*53 102*	*45 572*	*49 086*	*47 591*	*47 675*	*46 820*	*50 083*	*51 800*	*47 757*
B. Fugitive Emissions from Fuels	48	47	48	47	58	68	80	82	89	82	101	121	180	211	200	211	244	234	219	198
1. Solid Fuels	*2*	*2*	*2*	*2*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*2*
2. Oil and Natural Gas	*46*	*45*	*46*	*46*	*57*	*67*	*79*	*81*	*88*	*81*	*100*	*120*	*179*	*210*	*199*	*210*	*243*	*232*	*218*	*197*
2. Industrial Processes	**27 705**	**26 770**	**20 299**	**17 004**	**16 450**	**15 959**	**17 370**	**19 092**	**17 650**	**18 722**	**16 538**	**15 560**	**17 544**	**15 023**	**13 891**	**15 776**	**16 280**	**21 005**	**23 312**	**24 427**
A. Mineral Products	10 803	10 983	8 519	7 775	7 979	7 594	9 186	9 078	8 549	9 129	8 551	8 297	8 354	6 950	6 585	6 558	7 176	8 040	9 147	10 400
B. Chemical Industry	5 262	5 254	3 463	3 406	3 059	3 094	3 632	4 130	3 990	3 993	3 596	3 172	3 890	3 691	2 862	4 151	4 248	4 503	4 277	4 244
C. Metal Production	11 640	10 533	8 317	5 823	5 412	5 272	4 552	5 885	5 111	5 600	4 391	4 091	5 300	4 382	4 444	5 067	4 855	7 368	8 743	8 826
D. Other Production	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,08	0,05	0,08
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	1 094	1 144	957
3. Solvent and Other Product Use	882	822	505	484	435	395	397	401	423	419	419	411	492	513	540	523	581	582	582	609
5. Land Use, Land-Use Change and Forestry *	**-32 935**	**-35 492**	**-25 187**	**-31 420**	**-30 415**	**-23 874**	**-23 720**	**-22 926**	**-24 332**	**-25 887**	**-25 818**	**-26 660**	**-26 497**	**-26 187**	**-32 064**	**-33 172**	**-36 436**	**-37 725**	**-42 882**	**-42 885**
A. Forest Land	-42 705	-43 078	-38 792	-44 563	-43 237	-36 661	-36 359	-35 896	-36 626	-38 715	-38 511	-39 049	-38 723	-38 264	-44 108	-44 994	-47 667	-49 227	-54 266	-54 132
B. Cropland	8 165	6 890	10 773	10 232	9 939	9 874	9 746	10 012	9 788	9 853	9 718	9 399	9 207	9 044	8 999	8 745	8 720	8 522	8 237	8 420
C. Grassland	4 531	3 823	77	147	111	128	96	143	-319	140	139	138	137	136	135	134	-454	-6	131	-201
D. Wetlands	IE,NE	IE,NE	2 813	2 822	2 832	2 844	2 856	2 863	2 875	2 887	2 894	2 913	2 941	2 960	2 974	3 010	3 036	3 058	3 090	3 102
E. Settlements	-2 925	-3 127	-59	-59	-59	-59	-59	-48	-50	-53	-58	-62	-60	-64	-64	-67	-71	-72	-74	-73
6. Waste	**579**	**535**	**459**	**413**	**394**	**390**	**392**	**396**	**401**	**400**	**424**	**357**	**450**	**431**	**448**	**370**	**292**	**318**	**309**	**312**
C. Waste Incineration	579	535	459	413	394	390	392	396	401	400	424	357	450	431	448	370	292	318	309	312
Total (including category 5)	**436 670**	**411 866**	**343 542**	**336 788**	**329 218**	**342 205**	**337 863**	**343 260**	**350 896**	**343 289**	**315 438**	**302 785**	**294 091**	**291 030**	**273 628**	**283 832**	**280 861**	**280 491**	**286 717**	**285 287**
Total (excluding category 5)	**469 604**	**447 358**	**368 729**	**368 209**	**359 633**	**366 079**	**361 583**	**366 186**	**375 228**	**369 176**	**341 255**	**329 446**	**320 588**	**317 217**	**305 693**	**317 003**	**317 297**	**318 216**	**329 599**	**328 172**

* net sink.

NA – not applicable, NO – not occurring, NE – not estimated, IE – included elsewhere.

Methane [Gg CO_2 equivalent]

Greenhouse gas source and sink categories	Years																			
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1. Energy	**26 842**	**24 770**	**20 316**	**19 842**	**18 862**	**19 888**	**20 052**	**20 382**	**20 388**	**19 953**	**18 430**	**18 374**	**17 507**	**16 814**	**15 956**	**16 522**	**16 617**	**16 585**	**16 553**	**16 132**
A. Fuel Combustion	4 841	4 211	2 396	2 945	3 169	4 295	3 925	3 951	3 857	3 607	3 039	3 099	2 520	2 744	2 567	2 460	2 435	2 635	2 922	2 683
1. Energy Industries	*75*	*72*	*68*	*66*	*65*	*60*	*60*	*49*	*50*	*49*	*48*	*46*	*45*	*47*	*47*	*48*	*50*	*56*	*60*	*62*
2. Manufacturing Industries and Construction	*47*	*44*	*67*	*70*	*65*	*89*	*89*	*123*	*130*	*124*	*104*	*92*	*88*	*81*	*78*	*77*	*76*	*67*	*75*	*78*
3. Transport	*134*	*138*	*129*	*141*	*135*	*136*	*153*	*160*	*183*	*168*	*159*	*141*	*116*	*110*	*109*	*112*	*115*	*111*	*115*	*111*
4. Other Sectors	*4 585*	*3 958*	*2 132*	*2 668*	*2 904*	*4 010*	*3 623*	*3 620*	*3 494*	*3 266*	*2 728*	*2 820*	*2 270*	*2 506*	*2 333*	*2 222*	*2 194*	*2 401*	*2 672*	*2 432*
B. Fugitive Emissions from Fuels	22 001	20 559	17 920	16 898	15 692	15 594	16 127	16 430	16 530	16 346	15 392	15 275	14 987	14 070	13 390	14 062	14 182	13 950	13 630	13 449
1. Solid Fuels	*18 584*	*17 244*	*14 825*	*13 963*	*12 952*	*12 664*	*13 201*	*13 243*	*13 194*	*13 019*	*12 021*	*12 006*	*11 451*	*10 374*	*9 782*	*10 089*	*9 971*	*9 630*	*9 272*	*8 611*
2. Oil and Natural Gas	*3 417*	*3 315*	*3 095*	*2 934*	*2 741*	*2 930*	*2 926*	*3 187*	*3 336*	*3 328*	*3 371*	*3 269*	*3 536*	*3 696*	*3 607*	*3 973*	*4 211*	*4 319*	*4 358*	*4 838*
2. Industrial Processes	**499**	**492**	**357**	**321**	**310**	**316**	**363**	**399**	**380**	**391**	**357**	**312**	**368**	**352**	**298**	**381**	**411**	**403**	**408**	**426**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	277	281	182	178	171	186	218	252	246	254	231	202	249	235	184	250	277	282	269	280
C. Metal Production	222	212	175	143	139	129	145	147	133	137	126	110	120	117	114	130	134	122	138	146
3. Solvent and Other Product Use	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4. Agriculture	**19 157**	**19 943**	**19 008**	**17 605**	**16 285**	**14 895**	**14 798**	**14 368**	**13 789**	**14 142**	**14 546**	**14 052**	**13 092**	**12 698**	**12 890**	**12 736**	**12 212**	**12 554**	**12 930**	**12 980**
A. Enteric Fermentation	15 707	16 436	15 598	13 890	12 578	11 588	11 361	10 775	10 423	10 781	11 044	10 453	9 724	9 348	9 073	9 022	8 765	8 949	9 168	9 306
B. Manure Management	3 420	3 475	3 380	3 686	3 683	3 278	3 414	3 565	3 340	3 336	3 473	3 574	3 342	3 322	3 793	3 692	3 419	3 581	3 738	3 649
5. Land Use, Land-Use Change and Forestry	**7**	**4**	**2 155**	**2 161**	**2 186**	**2 182**	**2 192**	**2 198**	**2 209**	**2 231**	**2 222**	**2 239**	**2 258**	**2 276**	**2 284**	**2 320**	**2 332**	**2 349**	**2 375**	**2 385**
A. Forest Land	IE,NE	IE,NE	3	1	18	3	4	3	6	18	3	4	2	6	3	10	4	3	3	3
C. Grassland	NA,NO	NA,NO	2	2	2	2	2	4	1	2	1	2	1	1	1	2	1	1	2	4
D. Wetlands	NA,NO	NA,NO	2 150	2 158	2 166	2 176	2 186	2 192	2 202	2 212	2 218	2 233	2 255	2 270	2 280	2 308	2 327	2 344	2 369	2 378
E. Settlements	7	4	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	**7 639**	**7 903**	**8 034**	**8 366**	**8 456**	**8 574**	**8 599**	**8 500**	**8 560**	**8 794**	**9 027**	**9 214**	**8 037**	**7 745**	**7 679**	**7 609**	**7 598**	**7 520**	**7 340**	**7 528**
A. Solid Waste Disposal on Land	5 914	6 162	6 373	6 488	6 556	6 615	6 656	6 707	6 741	6 809	6 898	6 988	7 085	6 798	6 715	6 621	6 594	6 500	6 305	6 472
B. Waste-water Handling	1 724	1 741	1 662	1 878	1 899	1 959	1 943	1 793	1 819	1 985	2 129	2 226	953	947	964	988	1 004	1 020	1 035	1 056
C. Waste Incineration	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total (including category 5)	**54 143**	**53 114**	**49 871**	**48 295**	**46 098**	**45 855**	**46 004**	**45 848**	**45 326**	**45 512**	**44 583**	**44 191**	**41 261**	**39 885**	**39 107**	**39 567**	**39 171**	**39 411**	**39 605**	**39 451**
Total (excluding category 5)	**54 136**	**53 110**	**47 715**	**46 134**	**43 912**	**43 673**	**43 812**	**43 649**	**43 117**	**43 281**	**42 361**	**41 952**	**39 004**	**37 609**	**36 823**	**37 248**	**36 839**	**37 063**	**37 230**	**37 066**

NA – not applicable, NO – not occurring, NE – not estimated, IE – included elsewhere.

Nitrous oxide [Gg CO_2 equivalent]

Greenhouse gas source and sink categories	Years																			
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1. Energy	**2 316**	**2 199**	**1 920**	**1 922**	**1 899**	**2 082**	**2 035**	**2 101**	**2 210**	**2 208**	**2 045**	**1 979**	**1 912**	**1 891**	**1 838**	**1 873**	**1 891**	**1 913**	**1 985**	**1 926**
A. Fuel Combustion	2 316	2 199	1 920	1 922	1 898	2 081	2 035	2 100	2 210	2 208	2 045	1 979	1 912	1 891	1 837	1 873	1 891	1 912	1 984	1 926
1. Energy Industries	*1 192*	*1 167*	*1 030*	*1 027*	*993*	*943*	*932*	*863*	*891*	*867*	*838*	*811*	*795*	*804*	*774*	*811*	*803*	*816*	*838*	*830*
2. Manufacturing Industries and Construction	*226*	*208*	*242*	*239*	*216*	*270*	*256*	*341*	*374*	*363*	*297*	*250*	*241*	*216*	*210*	*208*	*212*	*189*	*205*	*212*
3. Transport	*278*	*268*	*326*	*291*	*289*	*289*	*301*	*345*	*402*	*422*	*423*	*419*	*396*	*381*	*372*	*377*	*399*	*414*	*441*	*461*
4. Other Sectors	*619*	*555*	*322*	*365*	*400*	*579*	*546*	*551*	*542*	*556*	*487*	*499*	*480*	*490*	*482*	*476*	*477*	*493*	*501*	*422*
B. Fugitive Emissions from Fuels	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Oil and Natural Gas	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
2. Industrial Processes	**4 993**	**5 068**	**3 678**	**3 278**	**3 225**	**3 674**	**3 667**	**4 058**	**4 057**	**3 819**	**3 544**	**3 485**	**4 242**	**4 350**	**3 612**	**4 296**	**4 401**	**4 709**	**4 676**	**4 811**
B. Chemical Industry	4 993	5 068	3 678	3 278	3 225	3 674	3 667	4 058	4 057	3 819	3 544	3 485	4 242	4 350	3 612	4 296	4 401	4 686	4 649	4 784
3. Solvent and Other Product Use	124	124	124	124	124	124	124	124	124	124	124	124	124	124	124	124	124	124	124	124
4. Agriculture	**32 068**	**33 688**	**31 035**	**25 968**	**23 815**	**22 876**	**23 109**	**23 449**	**22 723**	**23 170**	**23 180**	**22 364**	**21 504**	**21 530**	**20 820**	**20 243**	**20 164**	**20 393**	**21 575**	**22 060**
B. Manure Management	9 335	9 426	9 151	8 859	8 412	7 601	7 620	7 522	7 110	7 240	7 269	6 906	6 459	6 365	6 288	6 047	5 686	5 859	6 094	6 078
D. Agricultural Soils	22 710	24 238	21 860	17 088	15 386	15 251	15 472	15 908	15 593	15 913	15 891	15 441	15 026	15 146	14 516	14 181	14 461	14 520	15 467	15 968
F. Field Burning of Agricultural Residues	23	24	23	21	18	24	17	19	20	18	20	17	18	18	16	15	17	14	14	14
5. Land Use, Land-Use Change and Forestry	**1**	**0**	**7**	**6**	**9**	**6**	**5**	**5**	**5**	**4**	**3**	**3**	**3**	**2**	**3**	**4**	**3**	**3**	**3**	**2**
A. Forest Land	IE,NE	IE,NE	1	0	4	1	1	1	1	1	0	1	1	0	1	2	0	1	1	0
C. Grassland	NA,NO	NA,NO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. Wetlands	NA,NO	NA,NO	6	6	5	5	4	4	4	3	3	2	2	2	2	2	2	2	2	2
E. Settlements	1	0	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
6. Waste	**1 163**	**1 004**	**1 112**	**1 132**	**1 131**	**1 120**	**1 077**	**1 089**	**1 103**	**1 090**	**1 122**	**1 115**	**1 107**	**1 109**	**1 119**	**1 120**	**1 117**	**1 113**	**1 113**	**1 112**
B. Waste-water Handling	1 142	985	1 096	1 117	1 117	1 106	1 063	1 075	1 089	1 076	1 096	1 094	1 083	1 072	1 081	1 085	1 085	1 084	1 083	1 083
C. Waste Incineration	21	19	16	15	14	14	14	14	14	14	25	20	25	37	38	34	32	29	29	29
Total (including category 5)	**40 666**	**42 083**	**37 877**	**32 430**	**30 204**	**29 881**	**30 018**	**30 825**	**30 222**	**30 415**	**30 018**	**29 070**	**28 892**	**29 007**	**27 515**	**27 660**	**27 699**	**28 255**	**29 475**	**30 035**
Total (excluding category 5)	**40 665**	**42 083**	**37 870**	**32 424**	**30 194**	**29 876**	**30 013**	**30 820**	**30 217**	**30 411**	**30 015**	**29 067**	**28 889**	**29 005**	**27 513**	**27 655**	**27 697**	**28 252**	**29 472**	**30 032**

NA – not applicable, NO – not occurring, NE – not estimated, IE – included elsewhere.

HFCs, PFCs and SF_6 [Gg]

Greenhouse gas source and sink categories	Years												
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Emissions of HFCs [Gg CO_2 equivalent]	**15.72**	**37.67**	**114.56**	**172.01**	**217.52**	**603.40**	**1 018.17**	**1 486.04**	**1 912.03**	**2 146.66**	**3 018.32**	**2 844.22**	**3 327.01**
HFC-23	NA	NA	NA	NA	NA	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	NA	NA
HFC-32	NA	NA	NA	NA	NA	0.0012	0.0020	0.0033	0.0066	0.0066	0.0066	NA	NA
HFC-125	NA	NA	NA	NA	NA	0.0292	0.0469	0.0600	0.0843	0.0843	0.0843	NA	NA
HFC-134a	0.0121	0.0289	0.0880	0.1322	0.1663	0.3187	0.5423	0.8259	1.0347	1.2146	1.8841	2.1772	2.5462
HFC-152a	NA	NA	NA	NA	NA	0.0065	0.0075	0.0100	0.0127	0.0240	0.0130	0.0002	0.0002
HFC-143a	NA	NA	NA	NA	NA	0.0269	0.0459	0.0620	0.0826	0.0826	0.0826	NA	NA
HFC-227ea	NA	0.0000	0.0000	0.0001	0.0004	0.0005	0.0011	0.0009	0.0029	0.0027	0.0036	0.0048	0.0059
Emissions of PFCs [Gg CO_2 equivalent]	**252.24**	**235.68**	**248.92**	**251.26**	**239.74**	**248.87**	**269.93**	**286.59**	**278.39**	**285.08**	**259.95**	**269.75**	**276.65**
CF_4	0.0340	0.0317	0.0327	0.0330	0.0311	0.0319	0.0333	0.0359	0.0349	0.0359	0.0327	0.0341	0.0352
C_2F_6	0.0034	0.0032	0.0033	0.0033	0.0031	0.0032	0.0033	0.0036	0.0035	0.0036	0.0033	0.0034	0.0035
C_4F_{10}	NA	0.0001	0.0009	0.0009	0.0013	0.0017	0.0033	0.0029	0.0028	0.0026	0.0025	0.0024	0.0022
Emissions of SF_6 [Gg CO_2 equivalent]	**30.53**	**24.93**	**24.02**	**25.08**	**24.64**	**24.18**	**23.96**	**24.42**	**21.72**	**23.43**	**28.09**	**30.02**	**31.92**
SF_6	0.0013	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0009	0.0010	0.0012	0.0013	0.0013

NA – not applicable, NO – not occurring, NE – not estimated, IE – included elsewhere.

ANNEX 2. Supplementary information under Article 7, paragraph 2 of the Kyoto Protocol

Information under Article 7, paragraph 2	Reported in:
National systems in accordance with Article 5, paragraph 1	NIR 2009
National registries	NIR 2009
Supplementarity relating to the mechanisms pursuant to Articles 6, 12 and 17	Chapter 4
Policies and measures in accordance with Article 2	Chapter 4
Domestic and regional programmes and/or legislative arrangements and enforcement and administrative procedures	Chapters 2 and 4
Information under Article 10	
art. 10.a) Efforts to improve emissions inventories	Chapter 3, NIR 2009
art. 10.b) Policy action on mitigation and adaptation measures	Chapters 4 and 6
art. 10.c) Activities related to transfer of technology	Chapter 7
art. 10.d) Activities related to research and systematic observation	Chapter 8
art. 10.e) Activities related to international education and training, and national level public awareness	Chapter 9

ANNEX 3. Summary of policies and measures

Name of policy/measure	Objective and activity affected	GHG	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact by gas in year [Gg]			
						2005	2010	2015	2020
ENERGY									
Promote renewable energy sources. Introduce financial mechanisms supporting energy generation from renewable sources	Exemptions from the excise tax on the sales of electricity from RES are introduced. The obligation was also imposed on energy generation companies which deal with sales of electric energy to the end-users that those have to obtain a specified number of certificates of origin for electric energy generated from renewable energy sources.	CO_2, CH_4	legal- -financial- -organisational	implemented	Minister responsible for economy				
Promote combined heat and power generation	The "red certificates", i.e. the certificates of origin of electricity produced in co-generation process, thus simplifying the companies' compliance with the obligation to purchase electricity produced in co-generation and its further sales to the end-users.	CO_2	legal- -financial- -organisational	implemented	Minister responsible for economy				
Introduce "green certificates", certificates of origin for electricity generated from renewable energy sources	The certificates were introduced under the Act on Energy Law.	CO_2	legal- -financial- -organisational	implemented	Minister responsible for economy				
Introduce a system of incentives for enterprises to undertake investments leading to energy saving	The system of incentives consists of: 1. Preferential credits granted within a system of Funds for Environmental Protection and Water Management to retrofit of the energy production sources and to thermal modification activities, 2. Donations granted by the Eco-Fund Foundation to modification of energy generation and to renewable energy sources, 3. Donations with the European Funds' resources under the Integrated Operational Programme for Regional Development.	CO_2, CH_4	legal- -financial- -organisational	implemented	– The National Fund for Environmental Protection and Water Management – The Eco-Fund				
Introduce a system of incentives for the public sector to undertake investments leading to rational energy use	The system of incentives include: 1. Preferential credits granted within a system of Funds for Environmental Protection and Water Management to retrofit of the energy production sources and to thermal modification activities, 2. Donations granted by the Eco-Fund Foundation to modification of energy generation and to renewable energy sources, 3. Mechanisms under the Act on supporting thermal modification activities.	CO_2, CH_4	legal- -financial- -organisational	implemented	– The National Fund for Environmental Protection and Water Management – Minister responsible for building, physical management and housing				
Modify existing energy production technology and enhance the efficiency of energy transformation processes	Technology modification was carried out by means of putting into operation fluidized bed boilers, introducing co-incineration of biomass and technology adaptation to energy cogeneration processes.	CO_2	legal- -financial- -organisational	implemented	Minister responsible for economy				
Introduce the requirements on energy efficiency for new water heating boilers fired with liquid and gaseous fuels		CO_2	legal- -financial- -organisational	implemented	Minister responsible for economy				
Introduce the key requirements on energy efficiency for cooling equipment		CO_2	legal- -financial- -organisational	implemented	Minister responsible for economy				
Introduce the energy efficiency labels	The obligation of labelling household appliances was introduced.	CO_2	legal- -financial- -organisational	implemented	Minister responsible for economy				

Improve the effectiveness of electrical household appliances		CO_2	legal--financial--organisational	implemented	Minister responsible for economy				
Apply methane from mines for the purpose of utility heat generation	The measures relating to removal of methane are applied in hard coal mines with the aim of utilisation of this gas for industrial purposes.	CO_2	legal--financial--organisational	implemented	Minister responsible for economy				
Apply the exemption from excise tax on power generation with use of methane from hard coal mines	Draw up the application of exemptions from excise tax on power generated with use of methane released and captured from deep mining works.	CO_2	legal--financial--organisational	implemented	Minister responsible for public finance				
Set forth the National Target for increase in energy efficiency	1. Establish – under the *Act on energy efficiency* (2009) a legal framework for the National Target for increase in energy efficiency in the scope of enhancement of energy saving by the end-users. 2. Issue the Regulations by the Council of Ministers on setting forth the National Target for increase in energy efficiency – periodically from 2010. 3. Monitor implementation of the National Target for increase in energy efficiency – continuous measure.	CO_2		planned	– Minister responsible for economy (tasks 1 and 2) – The entity provided for in the *Act on energy efficiency* (task 3)				
Introduce regular mechanism supporting measures to implement the National Target for increase in energy efficiency	1. Set out the legal framework for supporting system under the *Act on energy efficiency* (2009). 2. Provide support to selected projects – continuous measure from 2011. 3. Monitoring performance of the supporting system – continuous measure from 2011.	CO_2		planned	– Minister responsible for economy (task 1) – The entity provided for in the *Act on energy efficiency* (tasks 2 and 3)				
Stimulate development of co-generation processes through supporting mechanisms with special regard to co-generation processes from sources below 1 MW municipal policies	1. Prepare and subsequently implement new principles to regulate prices of district heating that will provide for elimination of the cross-financing heat generation as coupled with the proceeds on both generating electricity and the certificates by means of introduction of a comparative (benchmarking) method for meting heat prices – from 2010. 2. Maintain the electric energy supporting system in high-efficiency co-generation technology processes on the level which provides for cost-effective investments in new power generation projects and making this system predictable in view of the subsequent 10 years – continuous measure. 3. Regulate under respective legal act of a procedure for drawing-up by the municipalities of the draft planning documents, and the plans themselves to supply heat, power and gaseous fuels, and the methods for implementation thereof; in particular, the obligation is to be introduced into these plans that provides for ranking possible methods to satisfy heat demand and choosing optimum option in a way securing implementation of the objectives included in the National Energy Policy – 2011. 4. Draw-up the assessment report on the progress achieved in enhancing the share of electric energy generated by high-efficiency co-generation processes versus the total electric energy generated domestically – 2011. 5. Make the assessment of efficiency of currently operated energy supporting system in co-generation processes – continuous measure. 6. Analyse the possibility to introduce obligation into the physical management plans to connect newly implemented investments to heating network in the areas where such network already exists – continuous measure.	CO_2		planned	– Minister responsible for economy (tasks 1 – 5) – President of the Energy Regulatory Office (tasks 1, 2, 5) – Municipalities (task 6)				
Use mandatory statements on energy characteristic for buildings and flats as required when placing those on the market or preparing to let	1. Grant permits to those authorised to drawing-up statements on energy characteristic for buildings and residential flats – continuous measure. 2. Participate in the EU legislative work on enhancing effectiveness of the system of the statements on energy characteristic for buildings and residential flats – from 2009. 3. Make the more stringent the minimum-level standards for energy-efficient buildings – 2010–2011.			planned	Minister responsible for building, physical management and housing (tasks 1–3)				

Provide for rating power-consumption in energy-using equipment and products and introduce the minimum-level standards for energy-using products	1. Participate in legislative work of the EU on a specimen of new label and expansion of the scope of the obligation to rating power-consumption by equipment – 2009–2010. 2. Implement into the Polish legal framework the new EU provisions on rating power-consumption – 2012. 3. Participate in legislative work of the European Commission on the Regulations implementing Directive 2005/32/EC on ecodesign requirements for energy-using products[1)]: 2009–2011. 4. Analyse the opportunities to apply incentives to purchase energy-efficient products and possible introduction thereof – 2011–2012. 5. Manage information and education actions on the amendments introduced into legal provisions – 2012.	CO_2		planned	Minister responsible for economy (tasks 1–5)				
Make the public sector committed to play a model role in energy efficient management	1. Sett out the list of measures to be applied by the public sector entities in order to increase energy efficiency – 2010. 2. Make the public sector entities committed to provide for energy efficient management and forwarding information on the measures implemented to increase energy efficiency – 2010. 3. Implement the energy saving obligation by the public sector entities – continuous measure. 4. Expand the scope of planning documents and the plans to supply heat, power and gaseous fuels by adding plans and management of the activities aimed at rational energy use and promotion of the solutions which reduce energy consumption in Municipal areas – 2010. 5. Disseminate the best available practices in the field of model role of the public sector entities in other EU Member States – from 2011. 6. Adapt the building being the seat of the Ministry of Economy to demonstration of model solutions in the field of energy efficiency – 2010–2011. 7. Monitor implementation of the energy saving commitment imposed on the public sector entities – from 2011.	CO_2		planned	– Minister responsible for economy (tasks 1, 2, 5, 6) – Public sector entities (task 3) – Municipalities (task 4)				
Support energy efficiency investments with the use of preferential credits and donations from domestic and European sources	1. Secure resources in support of the energy efficiency investments, in particular State Budget resources for implementation of the Act on thermal modification and repairs. 2. Grant the preferential credits under Act on thermal modification and repairs. 3. Support investments in application of the best available technology in industry, high-efficient co-generation processes, reduction of losses in power and heat transmission networks and thermal modification in buildings under both the Infrastructure and Environment Operational Programme for 2007–2013 and regional operational programmes. 4. Secure the preferences, as supported with the European Funds, to projects bringing about positive effects on energy efficiency. 5. Prepare and implement the programmes in support of energy efficiency with the resources from Environmental Protection and Water Management Funds, in particular implementation of: – programme for projects aimed at implementation of technology securing cleaner and energy-saving production and saving natural raw materials and primary energy, – programme for energy efficiency projects. Implementation of the above tasks is a continuous measure.	CO_2		planned	– Minister responsible for public finance (task 1) – Minister responsible for building, physical management and housing (task 2) – Minister responsible for economy (task 3) – Minister responsible for the environment (tasks 3, 5) – The Voivodship (i.e. Provincial) Boards (tasks 3, 4) – Minister responsible for regional development (tasks 3, 4) – The National Fund for Environmental Protection and Water Management (task 5)				

1) Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of ecodesign requirements for energy-using products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council (O.J. L 191 of 22.7.2005, pp. 29–58).

Provide support to science and research studies in the field of new technology solutions reducing energy consumption in all sectors of its processing and use	1. Secure resources amounting to at least 100 million PLN for granting donations in 2010–2012 to science and research studies in the field of energy efficiency. 2. Implement by the National Centre for Research and Development the tasks under strategic programme science and research studies as titled "Advanced technology for energy generation". Implementation of the above tasks is a continuous measure.	CO_2		planned	Minister responsible for science (tasks 1, 2)				
Apply the Demand Side Management techniques stimulated through daily diversification of electric energy prices as the effect of introduction of the current day market, and forward the price signals to the end-users by means of the remote two-way communication with electronic meters	1. Impose on the operator of power transmission system the obligation to implement architecture of new model of electric energy market, including introduction of the current day market – 2010. 2. Gradually introduce the obligation to apply electronic meters providing for transmission of the price signals to energy end-users – from 2011. 3. Apply the Demand Side Management techniques which provide for increase in the time coefficient of the use of the peak power load – continuous measure. 4. Provide for the opportunity to apply a system of incentives to rational use of electric energy by means of the distribution tariff (e.g. introduction of the tariff zoning) – 2011.	CO_2		planned	– Minister responsible for economy (tasks 1, 2, 4) – Energy marketing and distribution companies (task 3) – President of the Energy Regulatory Office (task 4)				
Manage information and education campaigns to promote rational energy use	1. Manage information campaigns with use of the public media. 2. Deliver lectures, training courses and education curricula. 3. Distribute the information and promotional materials. 4. Implement the website portal. 5. Support competitions in the field of energy efficiency. 6. Manage respective outdoor events. Implementation of the above tasks – 2009–2012.	CO_2		planned	– Minister responsible for economy (tasks 1 – 6) – Minister responsible for the environment (tasks 1–6) – President of the Energy Regulatory Office (tasks 2, 4)				
Develop the path to sustainable achievement of 15% share of RES in the total energy use, by specific types of energy, including electric energy, heat and cold, and renewable energy in transport	1. Draw-up the plan of the measures required for implementation Directive 2009/28/EC on the promotion of the use of energy from renewable sources[2)] – 2009 2. Consider the rightfulness and possible introduction of the solutions aimed at granting the public target status to investments in the use of renewable energy sources – 2010. 3. Prepare the *Plan of the Measures to Increase the Use of RES by 2020* – demonstrating the path to sustainable achievement of 15% share of RES in the total energy use, by specific types of energy, including electric energy, heat and cold and renewable energy in transport – 2010. 4. Analyse the legislative changes as required to introduce Directive on the promotion of the use of energy from renewable sources – 2010. 5. Implement of Directive on the promotion of the use of energy from renewable sources into the national legal framework – 2010.	CO_2		planned	Minister responsible for economy (tasks 1–5)				
Maintain support mechanisms for producers of electric energy from renewable sources, e.g. through a scheme of certificates of origin	1. Monitor performance of the support mechanism in a form of certificates of origin with view of its functioning to achieve the targets assumed and its possible improvement – from 2010. 2. Refine the analysis of cost effectiveness of supporting mechanism support with particular regard to the formula of the interim charge given the progressing growth of energy generated from fossil fuels, while guaranteeing stability of currently functioning mechanism – 2010. 3. Introducer the changes possible – 2012.	CO_2		planned	Minister responsible for economy (tasks 1–3)				

[2)] Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (O.J. L 140 of 5.6.2009, pp. 16-62).

Maintain the commitment to gradual enhancing the share of bio-components in transport fuels, so as to achieve the targets assumed	1. Change the legal provisions on bio-components and liquid bio-fuels, and particular: – enhance the share of bio-components in liquid fuels (petrol and diesel oil), – change in the method to calculate implementation of the National Indicative Target, – secure transfer of surplus of the National Indicative Target met between the entities committed to its implementation, – provide for the opportunities to meeting the National Indicative Target by means of application of new technology to produce liquid bio-fuels and cover these fuels by system of tax reliefs and exemptions (e.g. relief of the excise tax). Implementation of the above task – 2010. 2. Adapt the quality requirements on bio-components and liquid bio-fuels to new standards in order to secure placing new types of liquid bio-fuels on the market – continuous measure. 3. Analyse the need to maintaining the current tax-type support instruments given the termination on 30 April 2011 of operation of the notified public assistance programme – 2010. 4. Analyse, whether liquid bio-fuels and bio-components produced in existing installations meet the sustainability criteria as included in Directive on the promotion of the use of energy from renewable sources in view of possible introduction of technology changes thereto or replace them by other meeting these criteria – 2012.	CO_2		planned	– Minister responsible for economy (tasks 1–4) – Minister responsible for public finance (task 1)				
Introduce supplementary support instruments encouraging generation of heat and cold from renewable energy sources at a broader scale	1. Develop a system promoting the use of heat and cold from geothermal sources (including with application of heat pumps) and solar energy (with application of solar collectors) – 2010. 2. Analyse the need to introduce additional mechanisms supporting network heat and cold generated from renewable energy sources – 2010. 3. Prepare, if required, the draft provisions to regulate supporting network heat and cold from RES – 2011.	CO_2		planned	– Minister responsible for economy (tasks 1–3) – Minister responsible for public finance (task 1 – cooperation)				
Implement „The directions for construction of agricultural biogas plants in Poland by 2020", while securing that at least one, on average, such plant is put in operation by 2020 in each municipality	1. Approve, by the Council of Ministers, the Programme titled Innovative Energy Sector – Powerful Agriculture – 2009. 2. Remove the barriers to development of agricultural biogas plants as identified in the aforementioned Programme – from 2009. 3. Draw-up the *Guide for Investors* interested in building agricultural biogas plants that includes, amongst others, typical designs for biogas plants – 2010. 4. Manage, in cooperation with the local self-governments, information campaign demonstrating abundant and detailed information on benefits resulting from implementation of biogas plants – 2010. 5. Monitor implementation of the Programme – continuous measure.	CO_2		planned	– Minister responsible for economy (tasks 1–5) – Minister responsible for agriculture (task 2) – Minister responsible for the environment (task 2) – Territorial self-governmental entities (task 4)				
Secure the conditions favourable to building off-shore wind farms	1. Identify the legal barriers halting or hampering implementation of the off-shore wind farms – 2009–2010. 2. Prepare the draft legislative changes removing identified barriers, in particular, amendments in the *Act on the Marine Areas of the Republic of Poland and Marine Administrative Authorities* – 2010. 3. Resolve the issue on Poland's involvement in implementation of the „Supergrid" international marine cable power line being of key importance for development of the off-shore wind farms – 2010. 4. Identify potential location wind farms in marine areas of the Republic of Poland – 2010.	CO_2		planned	– Minister responsible for economy (tasks 1–3) – Minister responsible for marine economy (tasks 2, 4) – Territorial marine administration authorities (task 4)				

Secure direct support to building new RES units and power transmission networks which provide for connecting thereof with use of the resources originating from the European Funds and domestic Environmental Funds, including the proceeds on the temporary charge and fines	1. Provide the support while using public resources to construct new RES units, including to produce bio-components and liquid bio-fuels and the infrastructure required to connect RES under, amongst others: – The Infrastructure and Environment Operational Programme for 2007–2013, – The Regional Operational Programmes for 2007–2013, – The programmes under National Fund for Environmental Protection and Water Management for projects in the field of renewable energy sources, high-efficiency co-generation processes and biofuels. Implementation of the above tasks is a continuous measure. 2. Analyse the procedures in view of implementation of possible solutions aimed at easy accessing to foreign and domestic assistance funds through removal of too restrictive requirements and restrictions – 2010. 3. Develop and harmonise with Minister of Economy the subsequent priority programmes fed with financial resources originating from temporary charge and fines – 2010.	CO_2		planned	– Minister responsible for economy (tasks 1, 2) – Minister responsible for the environment (tasks 1, 3) – Minister responsible for regional development (task 1) – The Voivodship (i.e. Provincial) Boards (task 1) – The National Fund for Environmental Protection and Water Management (tasks 1, 2, 3)				
Stimulate development of industries manufacturing facilities for renewable energy sector, including with use of the European Funds	1. Analyse the development opportunities to manufacturing facilities for renewable energy sector in Poland for both domestic and export purposes – 2010. 2. Seek and provide for securing the opportunities to construct by the Polish companies the investments to implement RES abroad, including particularly in developing countries – 2010. 3. Support with the resources of both the Infrastructure and Environment Operational Programme for 2007–2013 and the Regional Operational Programmes the manufacture of the facilities for renewable energy sector – from 2009. 4. Analyse the opportunities to introduce supporting system for operators implementing new investments in the field of manufacture of the facilities for renewable energy sector and provide for possible legal amendments, as necessary – 2012. 5. Support the activities aimed at new technology applied for producing fuels and energy from renewable sources and securing stability of supplying this energy into energy grid – continuous measure.	CO_2, CH_4		planned	– Minister responsible for economy (tasks 1, 2, 4) – Minister responsible for regional development (task 3) – The Voivodship (i.e. Provincial) Boards (task 3) – Minister responsible for public finance (task 4 – cooperation) – Minister responsible for science (task 5)				
Provide support to development of technology and construction of installations to generate renewable energy from waste containing biodegradable materials	Issue the Regulation on the specific technical conditions to qualify part of energy recovered from thermal treatment of municipal waste – 2009.	CO_2, CH_4	legal	planned	– Minister responsible for the environment – Minister responsible for economy				
Assess the opportunity to use for energy purpose the existing water-damming facilities being the property of the State Treasury, through their inventory, preliminary assessment of their environmental impact, and development of their management principles	1. Make inventory of water-damming facilities being the property of the State Treasury, according to criteria designed by Minister responsible for water management in agreement with Minister responsible for the environment and Minister responsible for rural development – 2011. 2. Analyse the cumulative environmental impacts from hydropower sector (assessment of existing hydro technical waterworks, existing and planned forms of nature conservation, status of ichthyofauna) – 2011. 3. Identify existing water-damming structures being the property of the State Treasury that due to overriding State Treasury's interest and justified interest of the users of waters could be used for energy purpose by the entities who exercise their ownership rights of these waters – 2012. 4. Develop the principles for making available existing water damming facilities being the property of the State Treasury to be used for energy purpose for water using entities other than those who exercise their ownership rights of these waters – 2012.	CO_2	legal	planned	– Minister responsible for water management (tasks 1–4) – Minister responsible for the environment (tasks 2, 4) – Minister responsible for rural development (task 3) – Minister responsible for the State Treasury (task 3)				

Implement a management system for the national emission ceilings of greenhouse gas and other substances	1. Set out the principles for performance and introduction in Poland of the national scheme for financing green investments, under which the proceeds gained on the Assigned Amount Units sold in 2009–2012, under the Kyoto Protocol, will be allocated to co-financing implementation of environmental programmes or projects, in particular to reduction or avoidance of the national emissions of greenhouse gas – 2009. 2. Develop the National Emission Reduction Programme in order to meet the commitments assumed by Poland in this regard – 2010. 3. Develop assessment of greenhouse gas emission reduction potential in Poland – 2009 4. Implement the *Programme for operation of the National Emission Trading Scheme and for managing the responsibilities of the KASHUE and the tasks to monitor the quantities of emission of substances under this scheme* – continuous measure.	CO_2		planned	– Minister responsible for the environment (tasks 1, 2) – Minister responsible for economy (task 3) – The National Fund for Environmental Protection and Water Management (task 4)				
Implement the commitments under new ETS Directive for power generation and heating sectors	1. Prepare the list of power generation installations – existing and started by the late 2008 – that qualify for using the transitional period and consult the list with The European Commission – 2009–2011. 2. Develop the CO_2 emission reduction path in the installations using transitional period in the scope of the obligation to purchase all CO_2 emission allowances by auctioning method – 2009. 3. Develop the standards to provide for implementation of the aforementioned path, while based upon multi-fuels indicator method or emissions in 2005–2007 from installations the ETS – 2010. 4. Develop the national investment plan to provide for CO_2 emission reduction with regard to retrofit and modification of power generation infrastructure, development of clean coal technology, diversification of fuel structure, and fuel supply sources – 2010. 5. Prepare application to the European Commission for granting free of charge allowances that includes the methodology for allocation of greenhouse gas emission reduction allowances for power generation entities in 2013–2019 – 2010. 6. Prepare the list of heating installations and high-efficiency co-generation processes with regard to generation of heat and cold that could have be granted the free-of-charge allowances, while based upon indicators to be defined by comitology process – 2010. 7. Take account of the opportunity to implement measures for amendment in new ETS Directive that is aimed at full consideration of specific nature of coal-based economies – 2012.	CO_2		planned	– Minister responsible for economy (tasks 1–6) – Office of the Committee for European Integration (task 7)				
Use the proceeds on auctioning CO_2 emission allowances to supporting the measures which reduce greenhouse gas emissions	1. Develop a scheme and the principles for managing the proceeds on auctioning CO_2 emission allowances – 2010. 2. Set forth the priorities for using the proceeds on auctioning CO_2 emission allowances, including with regard to supporting: – improvement in coal gasification technology, – development of the use of renewable energy sources, – construction of new high-efficiency co-generation units committed to the purchase since 2013 of 100% of CO_2 emission allowances, – construction of CCS installations and research studies in this field, – research and development in the field of new generation fuel cells. Implementation of the measures – 2010.	CO_2		planned	– Minister responsible for economy (tasks 1, 2) – Minister responsible for public finance (task 1) – Minister responsible for the environment (tasks 1, 2) – Minister responsible for science (task 2)				

Introduce the standards on building new power plants within preparatory system to capturing CO_2, and set out domestic opportunities to geological storage of carbon dioxide	1. Participate to the European Commission' work on development of the standards to build new power plants within preparatory system to capturing CO_2 – from 2009. 2. Implement Directive on the geological storage of carbon dioxide[3)] into the Polish legal framework – 2011. 3. Carry out public information campaign on the most important aspects of the CCS technology – do 2012. 4. Implement the programme and its relevant projects aimed at determination of the national capabilities to carbon dioxide sequestration by geological method, as titled *Exploration of the strata and structures for safe geological storage of CO_2 including their monitoring programme* – 2009–2012. 5. Prepare and approve the report containing information acquired in course of running the above programme – 2012.	CO_2		planned	– Minister responsible for economy (tasks 1, 3) – Minister responsible for the environment (tasks 2–5)				
Participate actively in implementation of the European Commission's initiative on building the large scale demonstration objects in the field of carbon dioxide capturing and sequestration (CCS) technology	1. Undertake on the EU forum the comprehensive measures aimed at placing two Polish CCS installations on the European Commission' list of demonstration projects co-financed with the pool of the allowances kept as reserve for new installations under ETS – 2009–2010. 2. Set out support instruments for the Polish CCS projects – 2009–2010. 3. Consider the opportunity to make decision on supporting the CCS development technology under the Infrastructure and Environment Operational Programme – 2009–2010. 4. Start implementation of the two projects – 2009–2010. 5. Prepare the national flag programme in the field of development clean coal technology, including the CCS – 2010.	CO_2		planned	– Minister responsible for economy (tasks 1, 2, 3, 5) – Minister responsible for regional development (task 3) – Energy generation companies (task 4)				
Use the CCS technology to supporting extraction of petroleum and natural gas	1. Develop programme to indicate, amongst others, the sites potentially possible where the CCS technology could be applied for the purpose of supporting extraction of petroleum and natural gas, including its implementation time-table – 2010. 2. Consider the opportunities to and possible integration with the National Research Programme of the activities on the methods to supporting extraction of petroleum and natural gas with application of CO_2 – 2011.	CO_2		planned	– Minister responsible for the environment (task 1) – Minister responsible for economy (task 1) – Minister responsible for the State Treasury (task 1) – Companies in fuel sector (task 1) – Minister responsible for science (task 2)				
Intensify scientific studies and development research on the CCS technology and identification of new technology to provide for utilisation of CO_2 captured as a raw material for other industrial branches	1. Secure the resources amounting to at least 100 million PLN in 2010–2012 for donations to scientific and research studies in the aforementioned field. 2. Implement under performance of the National Centre for Research and Development the cooperation platform between the scientific circles and the industrial community – continuous measure. 3. Call for competitions to select the support projects – 2009.	CO_2		planned	– Minister responsible for science (task 1) – The National Centre for Research and Development (tasks 2, 3)				
Utilise coal waste for economic purposes	1. Implement in mining companies the measures to reduce the volume of waste from coal extraction and utilisation processes – 2010. 2. Make accessible to the entities concerned the waste originated from coal extraction and utilisation processes, as stored on the ground surface – continuous measure. 3. Analyse the opportunities of and possible introduction of financial mechanisms encouraging the entities to utilise coal waste for economic purpose – 2011.	CO_2		planned	– Minister responsible for economy (tasks 1, 3) – Coal companies (tasks 1, 2)				

[3)] Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, Euratom, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 (O.J. L 140 of 5.6.2009, pp. 114–135).

Enhance the use of by-products from combustion processes	1. Implement Directive 2008/98/EC on waste[4], in particular introduce its provisions in support of industrial utilisation of by-products from combustion processes – 2010. 2. Consider the opportunities to and possible integration with the National Research Programme of the activities on waste processing technology for energy purpose, in particular ashes with high-lime contents – 2011.	CO_2		planned	– Minister responsible for the environment (task 1) – Minister responsible for science (task 2)				
Support environmental protection measures with use of the resources from, amongst others, the European Funds	1. Support projects in the field of pollutant reduction in energy sector with use of the resources under the Infrastructure and Environment Operational Programme for 2007–2013 and the Regional Operational Programmes – continuous measure. 2. Support projects in the field of environmental protection with the resources of domestic Funds for Environmental Protection and water management, in particular through implementation of: – the programme for projects in the field of reduction of emissions of volatile organic compounds, – the programme for projects in the field of emission reduction from fuel combustion for energy purpose. This is a continuous measure. 3. Support projects in the field of emission reduction with the resources of the National Climate Fund – from 2011. 4. Develop long-term programme for reduction of emissions from combustion processes in housing sector, with the aim to: reduce heat demand for heating purpose, substitute solid fuels by environmentally friendly ones, and use renewable energy sources for household purposes – 2011.	CO_2		planned	– Minister responsible for the environment (tasks 1–4) – The Voivodship (i.e. Provincial) Boards (task 1)				
TRANSPORT									
Change energy efficiency in road transport	The road-label charge rates are differentiated in order to promote mobility of ”cleaner” vehicles on the national roads.	CO_2	legal--financial	implemented	Minister responsible for transport				
Use alternative fuels and introduce ”environmental” tax on fuels	The taxes imposed on engine fuels in Poland are one of the highest such ones in Europe (more than 60% of their retail prices). This results in merely inconsiderable opportunities to impose any additional burden without causing negative effects on both business activities and the costs to be borne by the general public.	CO_2	legal--financial	implemented					
Promote “environmentally clean” motor vehicles	The instruments promoting “environmentally clean” motor vehicles that are of long tradition in Poland form a system including the annual charges for taking use of the environment and also the vehicle operating costs (in which fuel costs are the major component) that considerably favours the vehicles releasing the lower pollutant emissions or those less fuel consuming. Moreover, in 2004, commonly accessible information system on fuel consumption and CO_2 emissions in the marketing of new cars was introduced under provision of Directive 1999/94/EC.	CO_2, N_2O	legal--financial	implemented	Minister responsible for transport				
Promote LPG and bio-diesel fuels	Since the late nineties, the tax reliefs apply to LPG and bio-components of engine fuels (dehydrated alcohols, ethers and esters) that result in discount prices on gaseous fuels and increased interest in introduction of fuel bio-components (however being conditional upon their manufacturing opportunities). The mechanisms introduced mostly recently support construction of installations producing bio-components and biofuels, and also promote the use of these fuels (i.e. production of biofuels for own operator's use, selected stocks, excise tax).	CO_2, N_2O	legal--financial	implemented	Minister responsible for economy				

[4] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (O.J. L 312 of 22.11.2008, pp. 3–30).

Introduce the road tax	In 2007, a change was introduced into the road charge system that consists in desisting of the lump sum and establishment of the charges levied electronically for using road infrastructure, dependant on the mileage driven and the ecological category of a vehicle, i.e. the EURO emission class (pursuant to Directive 2006/38/EC of the European Parliament and of the Council of 17 May 2006 amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures) that will contribute to reduction of air pollution caused by heavy road transport.	CO_2	legal--financial	implemented	Minister responsible for finance				
Construct motorways, by-pass roads and express roads	In 2005–2008, the total combined mileage of 230 km highways, 210 km express roads and 38 municipal by-pass roads were put into operation. In 2008, under the 2008–2012 Programme for Construction of the National Roads, the total of 66.7 km highway and 130.8 km express road and 84.7 km municipal by-pass road sections were put into operation.	CO_2, N_2O	technical	implemented	Minister responsible for transport				
Change the energy efficiency of railway transport	<u>Modification and installation of energy-efficient facilities for non-traction energy engineering:</u> – replacement of electrical systems into energy-saving ones is carried out in course of on-site repairs, e.g.: at the SKM Railway in the Tri-City – Gdańsk, Sopot and Gdynia – Conurbation; – electrical systems undergo successive adaptation to the current needs with regard to reduction in power consumption, e.g.: at the Tri-City SKM Railway, the PKP (*Polish State Railways*) Energetyka Ltd., the Arriva/PCC Ltd.; – power facilities, the electrical capacity of which is not fully used undergo successive adaptation to the current needs, e.g. at the SKM Tri-City Railway, the LHS Broad Gauge Metallurgical Railway Ltd.; – additional power meters are installed with the aim of effective monitoring consumption of electricity, e.g. at the SKM Tri-City Railway, the PKP Energetyka Ltd, the SKM Warsaw Urban Railway; – dusk circuit-breakers are installed, e.g. at the Tri-City Railway; – measures preventing illegal abstraction of electricity are installed, e.g. at the PKP Energetyka Ltd. <u>Stock modification:</u> – more efficient AC asynchronous motors are installed, e.g. at the PKP Regional Railways Ltd., the Mazovian Railways Ltd.; – enhanced thermal insulation head and side doors and windows are installed in electric train units; – thermal insulation systems are replaced by the more efficient ones with application of aluminium foil screens; – air conditioning systems are installed in the ED74 series electric train units for the PKP Intercity Inc.; – individually operated doors are installed in electric train units to eliminate opening all door-systems at the train unit; – new train units are provided with Anti-Lock Braking System, also preventing wheel spin when train starts, as well as the energy recovering system when train is braking; – power meters are installed for measuring energy abstracted from and returned into power traction line; – high-efficiency energy saving heating fans are installed; – electric radiators undergo partial replacement with new higher efficiency ones; – installation of the Cruise Control System (Tempomat) which causes reduction in energy use while maintaining stable velocity; – replacement of the piston compressors by the more efficient screw ones and the rotary phase converters by static ones;	CO_2	technical	implemented	Minister responsible for transport				

	– purchase new stock: 10 energy-efficient electric train units (more efficient asynchronous motors, power meters measuring energy abstracted from power traction line, individually operated train door system with automatic shutting, thermo pane windows, air conditioning system for the whole train unit, Anti-Lock Braking System also preventing wheel spin when train starts (and brakes) electro dynamically, efficient thermal insulation at the whole train unit. Modification of the railway infrastructure: – modification of the track structure including its subgrade and drainage system alongside the routes and at the stations; – modification of electric traction and power lines; – modification of automatic light signalling; – modification of the engineering sites; – modification of telecommunication and railway traffic control facilities; – construction of environmentally friendly installations. Modification of the railway buildings (at the Warsaw Suburb Railway Ltd.): – modification of heating system in the Company building; – provision of thermal insulation of the building by the "light" wet method with acrylic plaster; – modification of the roof cover on the inspection and repair hall. Thermal modification of the railway buildings: – replacement of the heating centres; – replacement of the old corroded and inefficient radiators; – application of glass with better heat-transfer coefficient when replacing window joinery; – replacement of the old solid-fuel fired boilers by new (coal and oil) ones featuring by better energy parameters. Energy-efficient train operation method: – rational standards in the scope of heating the train units; – periodical training course for drivers in the field of energy saving management in course of driving electric train units; – energy-saving measures in relation to operation of locomotives and improvement of train management, e.g. at the PKP CARGO Inc.: – reduction in fuel oil consumption by 34.62%, – reduction in traction power consumption by 6.3%.								
Technical projects connected with vehicle construction	– There is an on-going progress in the improvement of fuel consumption efficiency in new cars, trucks, buses, rail vehicles and aircrafts being put into service in Poland. In particular, development and implementation in Poland of serial manufacturing of hybrid propulsion technology in buses is noteworthy. – Studies on the Energy Efficiency Design Index (EEDI) formula for newly constructed vessels have to be mentioned here among the issues relating to CO_2 emission reduction measures pursued in the navigation sector. – Light rail vehicles were put into operation, which are the rail buses designated for servicing the local transport. – Automotive vehicles and also self-propulsion network trains provided with combustion engines were modified and purchased. – As regards building vehicles, the PKP CARGO Inc. manages modification of electric and combustion locomotives and undertakes measures aimed at maintaining reliability of its stock.	CO_2, N_2O	technical	planned	Minister responsible for infrastructure				

Improve the infrastructure for cyclists and pedestrians	The majority of new road investments, and also the redevelopment projects on existing roads (including their vicinity), take due account of the need to setting separate bike lanes. Bike transport is commonly promoted by means of setting or building bike lanes and pedestrian pathways for the every-day local and tourist transport, both in the urban areas and beyond them. Also bike parking places are constructed especially on the sites where people used to change their transport mode. Railway transport commonly secures the opportunity to carry bikes on trains (often more and more frequently on a free-of-charge basis in the summer season). Also such projects are implemented as construction of so called *"PARK&RIDE*" parking places.	CO_2, N_2O	legal--administrative	implemented	Minister responsible for transport				
Make more stringent the emission standards for combustion engines	As for CO_2 emissions from new vehicles, new requirements on new cars registered in the EU area were set forth on the turn of 2008 and 2009. The progress in reduction of fuel consumption and thus CO_2 emission reduction, results upon technology progress as declared by car manufacturers and decisions taken buy car buyers. According to monitoring research in Poland the unit CO_2 emission from cars declined from 177 g CO_2/km in 1998 to slightly more than 152 g CO_2/km in 2008. Moreover, the system of technical testes based upon requirements in the Council Directive 96/96/EC of December 20, 1996 on the approximation of the laws of the Member States relating to roadworthiness tests for motor vehicles and their trailers, provides for elimination of the vehicles found illegal and overexploited which have adverse environmental impact caused by their atmospheric emissions of excessive quantities of greenhouse gas and toxic compounds.	CO_2, N_2O	legal--administrative	implemented	Minister responsible for transport				
Promote public transport	Various (cyclical and periodical) public actions in the field of road transport are carried out, as titled e.g. „Change Your Car into Bus", European Mobility Week and European Day without Cars, Public Transport Days. The Railway Technology Days is an event promoting public railway transport. Publications are issued to promote public transport (*Truck Monsters Contra Railway Transport, The PKP Group Annual Report*) and there is a website continuously promoting urban transport. Moreover, a broad spectrum of incentives is introduced to use railway transport, including: introduction of integrated fares for selected routes, zone fares, and promotion of mobility by railway transport instead by private cars. Promotional actions include also cheaper travels, including e.g.: free transport of bikes in spring and summer seasons, or so called „family fares" during summer and winter school holidays. Investments are carried out into construction of new parking places and adaptation and modification of such existing sites. Irrespective of their location, the parking places are operated under either formula of commonly accessible sites or the *PARK&RIDE* formula. General principle calls for encouraging car users to leave their vehicles on designated sites and continue their trips by using the public urban transportation means.	CO_2, N_2O	legal--administrative	implemented	Minister responsible for transport				
Develop combined transport	New connections are put into operation and investments are carried out in the field of container terminals.	CO_2, N_2O	legal--administrative	implemented	Minister responsible for transport				
Promote bicycle transport	In the field of promotion of safe bike mobility many actions are carried out by the National Road Safety Council (KRBRD), as titled e.g. "Travel safely by bike" or "Safe trip. Bike pass – my first driving licence". Non-governmental organisations disseminate guides for those designing, implementing and using bike infrastructure, thus supplementing the current regulations in force.	CO_2, N_2O	legal--administrative	implemented	Minister responsible for transport				
Improve the quality of water transport	Poland, in cooperation with other EU Member States, provides for conditions favourable to establish a network of "marine highways" connecting the Polish harbours and those in other countries of the Baltic Sea Region, and also in Western European countries. The Inland Navigation Fund was established with the aim to implement projects promoting inland water transport as the most environmentally friendly transport mode. In Poland, given most inconsiderable share of river transport, if compared to other transport modes, including first and foremost land transport, CO_2 emission from that source also remains inconsiderable.	CO_2, N_2O	legal--administrative	implemented	Minister responsible for transport				

Improve traffic flows and parking opportunities for heavy goods vehicles in towns	Improvement in the heavy duty road vehicle traffic in towns is secured by means of construction of ring roads (both, around the whole urban area, and so called city centre by-pass roads) and upgrading the quality of street pavements, and also through respective adjustments in traffic engineering.	CO_2, N_2O	legal--administrative	implemented	Minister responsible for transport				
Effective organisation of the railway and road system	The size of the train units is adjusted to the shipment needs. Monitoring of the occupation of seats in specific trains causes that the intensity of the (passenger) train courses increases during the peak hours. This causes enhanced passengers' travel comfort and intensifies their in-town mobility.	CO_2, N_2O	legal--administrative	implemented	Minister responsible for transport				
Manage information and educational campaigns concerning the need for behavioural changes	The public campaigns include such events as: *Safe Car Academy – Do Not Expect Accident,* and *Speed Limits save Lives*. Both, operation of energy-efficient vehicles and restriction on the speed rates of motor vehicles cause increased road traffic safety, and influences directly reduction in environmental pollution, including that of greenhouse gas.	CO_2, N_2O	legal--administrative	implemented	The National Road Safety Council				
Implement measures to reduce greenhouse gas emissions from air transport	In 2005, cooperation with EUROCONTROL was continued on modelling of pollutant dispersion around the Warsaw–Okęcie Airfield, with particular emphasis put on the emissions from aviation sources. Delimitation of the boundaries of six aerodrome traffic area within the Aerodrome Traffic Zone (ATZ) was modified. The existing structures of the air zone were redeveloped and new ones introduced in order to provide for flexible management of time-separated airspace – the Temporary Segregated Area (TInc.), Temporary Feeding Router (TFR), Temporary Reserved Airspace (TRA) and the Military Route (MRT). Moreover, the Military Aerodrome Traffic Zone (MATZ) was restructured with the aim of covering the changes in horizontal and vertical delimitation of the boundaries. In 2006, the CAT database of the Common Airspace Tools was established and put into operation. In March 2009, Memorandum of Understanding was signed between the Polish Air Navigation Services Agency, the Polish Airports State Enterprise, the „LOT" Polish Airlines – and the handling agents – to introduce the Collaborative Decision Making (CDM) system in the Warsaw–Okęcie Airfield with the unified platform for full information flow between particular partners on servicing aircrafts in the airfield area (touch down, ground services, take up) as the fundamentals of the CDM system. It is anticipated that the CDM will have positive effects on reduction in environmental impact from the airfield (including reduced emission of air pollutants), reduction in the cost of the airfield ground traffic, and will provide for optimum use of the airfield infrastructure and for the more effective utilisation of the resources of the handling companies. The "LOT" Polish Airlines undertake measures, as forced by the adaptation requirement to absorb the growing fuel prices, to replace gradually the aircraft fleet into the more economically efficient planes with the more energy-saving engines. Already in 2004, the "LOT" began introducing Embraer 170 aircrafts into its fleet, with the aim to replace Boeing 737s on the shorter and less intensive routes. In the late April 2006, introduction of a bigger, but at the same lighter model of Embraer 175, while equipped with the state-of-the-art engines, was begun.	CO_2, N_2O	legal--administrative	implemented	Minister responsible for transport				

Implement measures to reduce greenhouse gas emissions from public transport	Introduction of the state-of-the-art transport fleet with the more stringent emission parameters is the most efficient method to reduce adverse impact of exhaust gases from urban transport. As for new rail vehicles, when compared to the currently operated ones, they feature by reduced energy consumption. Introduction of electrically propelled vehicles is one of the most efficient solutions in this regard, including: – development of electrically propelled rail traction (metro, tram, urban railway networks) which takes over the functions of the individual and bus transport modes; Warsaw, Cracow and Poznań exemplify the cities which can decidedly implement transport policy of such type, – development of trolleybus traction as an alternative for bus transport, while Gdynia, Tychy and Lublin are the Municipalities managing such a strategy. A number of various strategies are applied to reduce emissions of exhaust gases from buses: – purchase of hybrid buses which provide for up to 30% savings in energy consumption, – application of Compressed Natural Gas (CNG) and Liquefied Petroleum Gas (LPG) as propellants in buses, – application of biofuels, – purchase fleet compliant with the standards higher than those currently required, – purchase fleet reduced in relation to that currently used where the passenger streets are less intensive. Many municipal transport utilities used to apply fuel specially produced by the PKN Orlen – brand name City Diesel which provides for improvement in combustion parameters of bus engines, when compared against commonly accessible fuels. Preventing both the drop in the mean traffic speed and the reduction of traffic homogeneity in towns is an essential method to reduce the quantity of fuels consumed. Attribution of the traffic priority to municipal transport vehicles (e.g. in Cracow) leads to smooth traffic streams of all vehicles while encouraging the inhabitants to desist of their individual transport means. Also, projects type *"PARK&RIDE*" parking places write well into this strategy and result in reduced traffic in city centres. Warsaw holds a leading position in this field. Considerable reduction in environmental burden could be achieved by means of applying new rational solutions in management of bus depots, while the one of the most efficient is to install equipment for rapid refilling pneumatic systems before the bus leaves the depot, i.e. at the bus parking stands (e.g. at the Municipal Transport Utility in Zielona Góra). This provides for avoidance of unnecessary engine run for loading the tanks with compressed air. Optimization of the transport offer by means of a better harmonisation of the buses' time-schedules and their course-routes (including the initial and final runs from and to depot) have positive effects on efficiency of municipal transport. Measures of such type are applied throughout Poland and include also some new forms of transport services, such as a telephone bus-hot-line (e.g. "Telebus" at the Municipal Transport Utility in Cracow).	CO_2, N_2O	legal--administrative	implemented	Minister responsible for transport				
Introduce speed limits in towns	The legislative speed limits were introduced for urban areas in the daytime up to 50 km/h, and up to 60 km/h between 23.00 and 5.00 hrs	CO_2, N_2O	legal--administrative	implemented	Minister responsible for transport				

AGRICULTURE									
Manage rational use of fertilisers, including nitrogenous fertilisers	Restriction on the amount of natural fertiliser dose to 170 kg N/ha year is imposed and the ban on applying natural fertilisers in the period from the late November by the early March is introduced. Other measures include mandatory attendance of training courses by farmers applying fertilisers, the ban on applying fertilisers on waterlogged, snowed and frozen soil and in the fields on slopes inclined by >10%. For large commercial farms, the requirement is introduced to have in place a fertiliser management plan. Agricultural consultancy system is commonly pursued. Consumption of fertilisers in Poland is still considerably lower than in West European countries. However, the further enhancement of application of fertilisers is anticipated in Poland with the aim to increase its agricultural productivity. That means the rational use of fertilisers is to become a matter of agricultural priority.	N_2O	prganisational--legal	implemented	– research institutes – Chemical-Agricultural Stations – farmers			no data available	no data available
Manage rational energy consumption in agriculture, including energy generation from waste biomass and solid and liquid manure	Following "The directions for construction of agricultural biogas plants in Poland up to 2020" the biogas output in 2020 has to achieve 2 billion m^3, and near 700 thousand ha agricultural land area is to be appropriated to this end. Currently, 8 biogas plants are implemented with 8.6 MW their total combined capacity. The use of solid biomass expanded (from 170,056 TJ in 2004 to 189,586 TJ in 2007), bio-ethanol (from 1,589 TJ in 2005 to 3,356 TJ in 2007), and bio-diesel fuel (from 657 TJ in 2005 to 1,072 TJ in 2007). Biogas production grew in 2004–2007 from 1,941 TJ to 2,708 TJ. The share of renewable energy in the total primary energy grew in 2004–2006 from 5.5% to 6.4% including solid biomass accounting for more than 91%. Adaptation of the local boilers to firing by the wood and straw biomass by-products is carried out in the framework of rationalisation of agricultural energy management. 500 wood-fired boiler plants, each capacity of 100 kW, and 50 straw-fired ones capacity 100 kW, on average, were built.	CO_2, CH_4	organisational--legal	implemented	– local authorities – operators – farmers			no data available	CO_2 – by 3.47424 Gg CH_4 – by 0.01302 Gg
Support implementation of other targets for using other renewable energy sources in agricultural production	Various support forms were applied that resulted in about 1,200 m^2 solar water and 200 m^2 air collectors were constructed in agricultural sector.	CO_2	legal--organisational	implemented	– local authorities – farmers			no data available	CO_2 – by 0.2108 Gg
Carry out technical modification of agricultural farms	The modification measures were focused primarily at adaptation of agricultural farms to meet the relevant Community standards. Methane emission reductions obtained through application of these measures relate mainly to construction of manure slabs for animal excreta and liquid and solid manure tanks.	CH_4	legal--organisational	implemented	farmers			no data available	no data available
Improve the animal feeding systems and fodder management in farms	The animal breeding programmes and specific feeding standards implemented while coupled with growing effectiveness and resultant stock reduction caused abatement of gaseous emissions.	CO_2, CH_4	legal--organisational	implemented	farmers			no data available	CO_2 – by 0.800 Gg and CH_4 – by 0.100 Gg
Manage afforestation of arable land and other land	In-forest CO_2 potential removal increased in result of afforestation of arable land having lesser agricultural importance.	CO_2	legal--organisational	implemented					
Provide preference to crops featuring by the high CO_2 removal potential	The EU donations amounting to 45 EURO/ha are granted to plantations of perennial and annual plants cultivated for energy purposes. The Agricultural Market Agency provides domestic resources in form of the support payments to setting up permanent plantations that are calculated as the percentage of the lump sum of 1 ha plantation setting costs. That covers plantations of energy willow (*Salix* sp.) – 50%, poplar (*Populus* sp.) – 30%, miscanthus (*Miscanthus* sp.) – 40%, and Pennsylvanian mallow *(Sida hermaphrodita)* – 40%. Donations to research and implementation activities in the field of crops featuring by a high CO_2 capture factor is particularly important.	CO_2	legal-economic	implemented	– Agricultural Property Agency – farmers			no data available	CO_2 – by 16.640 Gg

Change the structure of fuels applied currently into hydrocarbon fuels and reduce consumption of fuel oil	Studies in the field of change in field work technology are carried out to reduce in motor fuel consumption, including mainly simplifying soil cultivation methods, the opportunities to form machine sets an the change in crop technology, particularly sugar beet. However, although consumption of fuel oil per production unit declined from about 450 G per cereal unit in 2005 to about 400 GJ per cereal unit in 2008, the use of this fuel per area unit still remains on stable level about 18 GJ/ha, amounting to about 1800 thousand tonnes/year globally in agricultural sector. Thus, despite applying the aforementioned measures the further growth in rural motorization caused that the total CO_2 emission has grown.	CO_2	research and implementation, information and education	implemented	– research institutes – farmers			no data available	no data available
Develop new technology for cultivation of and harvesting the plant biomass intended for use as renewable energy sources and industrial raw materials	Technology of cultivation and crops of willow, miscanthus and Pennsylvanian mallow was further improved and work was begun to develop technology and implement for cultivation new species of energy plants, including poplar, black locust, big bluestem (*Andropogon gerardi Vitman*), prairie cord grass (*Spartina pectinata*), and switchgrass (*Panicum virgatum*). The total combined cultivation acreage of these plants is estimated at 10 thousand ha and it shows an upward trend. Moreover, research is carried out in the field of technology agricultural plant (maize, sorghum, and sugar beet) cultivation intended as substrata for biogas generation.	CO_2, CH_4	research and implementation, information and education	implemented	– research institutes – farmers			no data available	no data available
Improve the farm animal breeding systems and reduce methane from animal excrements	Research and implementation activities were carried out on development of new technology systems in farm buildings and new methods for breeding farm animals. The change in pig growing techniques from high-emission traditional ones into low-emission technology (emission per stand amounting to 0.8 kg CH_4/year and 0.65 N_2O/year) that consisted in partial grating of coops and increase in pavement inclination angle (to accelerate excreta outflow) caused reduction in emissions from animal production by 15% in relation to that in 2004. The progress in implementation of the legal provisions in the field of storage and utilisation of animal excreta resulted in reduction of methane emission. These measures led to reduction in CH_4 emission.	CH_4, N_2O	research and implementation	implemented	– research institutes – farmers				CH_4 – by 0.600 Gg and N_2O – by 1.000 Gg
Eliminate gaseous pollutants emitted from poultry breeding premises through application of phytoremediation and solar ventilation methods	Research was carried out on making assessment and choice of the plants mostly suitable for such type crops. Moreover, design for modified poultry houses provided with solar ventilation is planned with their CO_2 emission reduction level estimated at 30–40%.	CO_2	research	implemented	research institutes			no data available	no data available
Halt mineralization of organic soil used in form of meadows and pastures through their irrigation and reduction in groundwater outflow	Long-term research work on setting out position of the ground water table, as optimum in view of halting organic mass deficiencies in peat-muck soil, provided for preparation of guidelines in this regard. Reconstruction and modification of drainage systems to restore adequate moisture content of organic soil that limits its mineralization would have led to 22% reduction in CO_2 emissions from such soil.	CO_2	research--education	implemented	– research institutes – agricultural advisers – farmers			no data available	no data available
FORESTRY									
Counteract change in the land use mode	The significance of transformation of forest land into that for non-forest purpose is inconsiderable when compared to continuously expanding total forest acreage.	CO_2		implemented	The "State Forests" National Holding				
Manage forest in a rational way, including provision of the incentives and measures supporting afforestation and preservation of forests environmental stability	This refers to afforestation of non-forest land, re-afforestation and expansion of forest resources standing, and to logging trees which must not exceed 50–60% annual stand increment. In 2006, the total acreage of 16.9 thousand ha was afforested, including 4.5 thousand ha land being the State Treasury property; in 2007, that was 13,3 thousand ha and 3.0 thousand ha area, respectively.	CO_2		implemented	The "State Forests" National Holding				
Utilise wood for energy purpose	Maintained at a stable level amounting to about 500 thousand m^3 annually.	CO_2		implemented	Minister responsible for economy				
Survey the level of elementary carbon removal	Two research projects were launched in 2007 including “Carbon balance in tree biomass of the major forest-forming species in Poland” and “Climate change versus forest ecosystems: CO_2 removal and change in forest structure and functions”.	CO_2		implemented	– Forest Research Institute – The "State Forests" National Holding