THE REPUBLIC OF POLAND

THE SIXTH NATIONAL COMMUNICATION AND THE FIRST BIENNIAL REPORT TO THE CONFERENCE OF THE PARTIES TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

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SUMMARY

1. Introduction

As a Party to the Kyoto Protocol, the Republic of Poland undertook to reduce its greenhouse gas emissions by 6% in 2008–2012 relative to the emissions in the base year, for which 1988 was adopted for the three basic gases, i.e. carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), whereas 1995 was adopted as the base year for the industrial gases of the groups of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

One of the challenges which Poland faced was the need to reconcile its economic growth with the care of the environment, including reductions in the emissions of greenhouse gases and other air pollutants. Poland successfully achieved these objectives, as indicated by a reduction in the greenhouse gas emissions by about 29% relative to the base year, while, at the same time, its GDP grew by about 103%. The last two decades saw the continuous growth of the Polish economy. The accession to the European Union in 2004 proved to be particularly significant in the context of the national development, contributing to more dynamic modernisation processes in the Polish economy. At the same time, the commitments which Poland made in the field of environmental protection pose a large challenge for our country, in particular for the Polish energy sector.

The Sixth National Communication to the Conference of the Parties to the United Nations Framework Convention on Climate Change was prepared in accordance with Decision UNFCCC/CP/1999/7 (Part II). The Communication presents information for the period of 2008-2011. At the same, fulfilling the decisions of the Conference of the Parties concerning the preparation of biennial reports by developed countries (Decision 19/CP.18), CTF tables prepared in accordance with the guidelines of the Conference of the Parties are featured in the Annexes.

2. Poland's circumstances with respect to greenhouse gas emissions and removals

Poland is in a specific economic situation in view of its substantial coal resources which constitute the basis for the operation of the national economy. In 2008, the share of hard coal and lignite in the primary energy consumption was 59.4%, to fall to 55% in 2011. The energy supply from renewable sources grew from about 7% of the total primary energy production in 2008 to about 11% in 2011. In the next few decades, coal will remain the basic energy raw material. Given the scarce resources of other primary energy sources and the absence of nuclear power generation, the achievement of significant greenhouse gas emission reductions was the result of efforts taken by the State towards the modernisation of the economy and the related greenhouse gas emission reductions.

The electricity generation in Poland is based to a significant degree on main activity power plants. The total installed capacity of power plants in 2011 was 37,595.2 MW, while their output was 163,548 GWh. At present, almost 15% of the electricity generated is used to meet the own needs of the energy sector and lost in transmission and distribution. Transmission networks are in an appropriate technical condition enabling the implementation of the functions assigned to them. The distribution network in Poland, the average age of which is about 30 years, needs expansion and modernisation.

The potential of the Polish heating industry is very fragmented. The heating business is carried out by main activity and autoproducer heat and power plants, main activity and municipal heating plants, local production and distribution companies, and individual households, particularly in rural areas. In this subsector, investment projects are carried out to replace coal-fired boilers by gas-fired ones and different types of modernisation works are also conducted to meet the requirements of environmental protection. The share of heat generated as a result of biomass combustion grows. 30% of the heat generated is used by its producers to meet their own heating needs. The other part of it is discharged into heating networks. After the transmission losses are considered, slightly more than 60% of the heat produced reaches the users connected to the networks.

Industry remains the dominating factor which generates the economic growth in Poland. The highest growth rate can be found in the manufacturing industry which determines the growth rate of industry as a whole. In most of industrial sectors, the energy efficiency of the production improved, having a direct effect on the decrease in greenhouse gas emissions. In the case of energy intensive industrial sectors, energy efficiency has improved to the greatest extent in the chemical industry. Among the low energy intensive sectors, the greatest improvement in energy efficiency has been achieved in the machine, food, textile and transport equipment industries.

The increase in gross outlays on fixed assets which has been observed in Poland since 2004 has been correlated with the gross value added of construction. Since 2004 the share of construction in the GDP generation increased, while at the same time, in recent years there was a decrease in the unit energy consumption in dwellings, as a result of the implementation of the thermal modernisation programme in buildings, a reduction in losses in heating networks and improved efficiency of the new equipment installed. Despite this, at the national level, households are some of the largest energy consumers – representing about 20% of final energy.

The most conspicuous change in the structure of the transport of both passengers and cargo by different transport modes is the growing importance of road transport. In the transport sector, in 2010 the final energy consumption grew by about 50% relative to 2000. The electricity consumption in 2001-2011 varied, with a distinct fall in energy consumption in recent years compared to that in the early 21st century. A positive trend in the transport sector is a decrease in the energy intensity indices of the means of transport.

In 2010, in Poland, the total area of farms in Poland was about 18 million ha, representing about 58% of the total national territory. Agricultural land represented almost 87% of the total area of farms. The private sector dominates in the structure of user groups – with 99.8% of the agricultural land area in 2010. In terms of numbers, small farms dominate among private farms, with an area of up to 5 ha. Commercial farms, generating almost 90% of the national Standard Production, represent about 32.4%. The energy consumption in the agriculture sector systematically decreases, with the electricty consumption falling by 65% in 2001–2011.

In 2011, the forest area in Poland represented 29.2% of the national territory. Public forests dominate in the structure of forests, representing 81.3%. The forest cover rate grew by 10% from 1946 to 2011 (from 20.8%). The target forest cover rate in Poland is 33%. The national forest policy contributes to CO_2 removals through increased afforestation and the sustainable management of timber resources.

The quantity of waste generated in the Polish territory in 2000-2011 fell within the range between 120 and 137 million Mg annually. Waste management processes are primarily sources of methane emissions. Industry remains the largest waste producer, as it generates more than 90% of the total waste generated. Over recent years, the quantities of industrial waste subjected to the processes of recovery (more than 70%) and disposal (about 0.3%) remained at similar levels. 17–22% of generated industrial waste is disposed of at landfills. The average quantity of municipal waste generated per capita remains at a similar level of 315–319 kg and systematically falls. The number of municipal waste landfills in operation decreases, with a growing number of landfills with a gas removal system.

Over recent years there was a decrease in the quantity of sludge arising in wastewater treatment plants as a result of a substantial reduction in the quantity of sewage sludge generated in industrial wastewater treatment plants, despite the growing quantity of sewage sludge generated in municipal wastewater treatment plants. In the last ten years, there was a decrease in the energy intensity of wastewater treatment plants, primarily as a result of a change of technology.

After the economic transformation in Poland the processes of the restructuring and modernisation of the economy are most important for the environment, as they contribute to reducing pressures on it. In recent dozen years or so, the energy and material intensity of production was reduced, changes were introduced in the system of financing environment-friendly activities and protection standards were adjusted to those of the European Union. At the same time, the Natura 2000 network was established, including a substantial part of areas which had already been covered by other forms of protection.
The inventory of greenhouse gas emissions and removal

3. The inventory of greenhouse gas emissions and removals

The National Centre for Emissions Management at the Institute of Environmental Protection - National Research Institute is the unit responsible for preparing the greenhouse gas inventory. The Centre was established pursuant to the *Act of 17 July 2009 on the System to Manage the Emissions of Greenhouse Gases and Other Substances (Official Journal of the Laws No. 130, Item 1070, as amended)*.
Pursuant to Article 11 of the abovementioned Act, the National Centre prepares and forwards to the Minister responsible for the environment annual inventories of the emissions of greenhouse gases and substances laid down in the Convention on Long-Range Transboundary Air Pollution (UNECE CLRTAP). The tasks of the National Centre also include the preparation of information sets, including those on emissions, for the purposes of the public statistics.
The national inventory of greenhouse gases is compiled every year and submitted in the format and at the date required by the Climate Convention. The last National Report submitted in 2013 presented the results of the national inventory of greenhouse gas emissions and removals in Poland in 2011, along with their trend since 1988.

The national inventory and the accompanying tables in the Common Reporting Format (CRF) are prepared in accordance with the updated *Reporting Guidelines on Annual Inventories* (FCCC/SBSTA/2006/9) and other documents. In accordance with the IPPC Guidelines in effect, in order to obtain more exact data on emissions, where possible, the national methodology for estimating emissions was applied.

In 2011, the aggregated emissions of all the estimated greenhouse gas emissions amounted to 399.4 million tonnes of CO2 equivalent (excluding Sector 5. Land Use, Land Use Change and Forestry). In turn, the balance of greenhouse gas emissions and carbon dioxide removals in Sector 5 was estimated at – 21.9 million tonnes of CO2, equivalent, where CO2 removals (mostly by forest lands) amounted to 31 million tonnes of CO2, while the emissions were 9.1 million tonnes of CO2 equivalent. The sector of Energy had the largest share in the total greenhouse gas emissions (expressed as CO2 equivalent) in Poland in 2011, i.e. more than 81%, where fuel combustion dominated.

Carbon dioxide dominated in the total greenhouse gas emissions in 2011, as its share in the total emissions was 82.7%. Methane represented 8.9%, while the share of nitrous oxide was 6.8%. Industrial gases accounted for 1.6% of the aggregated greenhouse gas emissions. In 1988–2011, the greenhouse gas emissions fell by 29.1%, with the emissions decreasing, respectively, by 29.6% for carbon dioxide, by 33.8% for methane and by 32.5% for nitrous oxide. From 2008 the emissions stabilised, except for their marked fall in 2009 which was caused by a global economic slowdown.

The detailed results of the inventory of greenhouse gas emissions and removals for 1988–2011 by the IPCC sectors are presented in Annex 2.

The National Centre for Emissions Management administers the Polish registry, which is connected to the Independent Transaction Log (ITL), and carries out its functions in respect of accounting for the commitments under the Kyoto Protocol. At present, the Polish registry of units is managed together with those of the other Member States of the European Union. The registry is connected by a communication link with the International Transaction Log (ITL) administered by the Secretariat of the United Nations Framework Convention on Climate Change and the European Union Transaction Log (EUTL) which plays the role of an additional transaction log.

Both the participants in the emissions trading scheme and the administrator can access the registry through a secured website:
https://ets-registry.webgate.ec.europa.eu/euregistry/PL/index.xhtml.

The database of the registry stores information on the entities participating in the scheme, installations, verified emissions, national holding accounts, operator holding accounts and person holding accounts. The current information and changes in the national registry are presented annually in the National Inventory Report (NIR) submitted to the Secretariat.

4. Policies and measures

Poland will achieve the national reduction target under Annex B to the Kyoto Protocol (6% in 2008–2012). It will also fulfil the commitment to reduce greenhouse gas emissions by 20% in 2020 relative to 1990, which was made in 2007 within the framework of the European climate and energy package.

In recent years, the Government launched many initiatives to ensure strategic programming in Poland and to create a comprehensive system for managing its development. The foundations were developed for a new system of strategic documents laying down a vision and directions of the development of the country both in a long term until 2030 (the document ***The Long-***

term National Development Strategy for Poland 2030. The Third Wave of Modernity.)), and in the nearest decade (the document **The *National Development Strategy 2020*** and **9 integrated strategies, including the project of Strategy for Energy Security and Environment**).

Supporting all the activities aimed at reducing the pollution of the environment, Poland places special emphasis on effective reductions in greenhouse gas emissions, primarily through national activities, apart from which the mechanisms of the Kyoto Protocol play a an additional role.
The basic institutional and financial mechanism supporting the implementation of Polish climate policy is the system for funding measures for the environment, based on the resources from the National Fund for Environmental Protection and Water Management, the Voivodeship Funds for Environmental Protection and Water Management and the European funds.
A comprehensive monitoring of the implementation of policies and measures leading to greenhouse gas emission reductions is not carried out in Poland. The monitoring only covers those measures that have been financed with public resources or the European Union funds.

The projects which are most often co-financed include:

- the modernisation and construction of heating networks,
- the modernisation of boiler-houses,
- the thermal modernisation of public utility buildings,
- the limitation of low emissions,
- investment projects at installations using renewable energy sources,
- energy saving in urban heat supply systems (only within the framework of the competition for energy saving in heating systems),
- the use of biomass for energy generation purposes in the municipal and domestic sector and at industrial enterprises,
- the economic use of biogas from the agricultural sector, from municipal waste landfills and from wastewater treatment plants,
- the use of solar energy (photovoltaic panels and solar collectors within the framework of the system of subsidies),
- the use of shallow geothermal sources (heat pumps),
- the promotion of fuel cell technology,
- the use of energy from waste incineration.

The climate and energy package was adopted in December 2008, implementing the assumptions adopted by the European Council in 2007 concerning the tackling of climate change which provided that by 2020 the European Union would:

- reduce greenhouse gas emissions by 20% relative to the emission levels in 1990;
- enhance to 20% the share of renewable energy in the final energy consumption;
- improve energy efficiency by 20% relative to the predictions for 2020 (a non-obligatory target); and
- enhance the share of biofuels in the total consumption of transport fuels to at least 10%.

In accordance with the relevant decisions, Poland is obliged to reduce, within the EU ETS scheme, in 2013-2020 its greenhouse gas emissions by 21% relative to 2005 and may increase its emissions from the non-ETS sectors by 14%. Moreover, Poland has undertaken to increase the share of the final electricity production from renewable energy sources by 15%, to achieve a 10% share of biofuels in the transport fuel market and to improve the energy efficiency of the economy by 2016 to the level of 9% of the average annual national final energy consumption.

In the sectors covered by this Communication, the following directions of measures to reduce the national greenhouse gas emissions have been identified:

In **the energy sector**:
- Improvement in energy efficiency;
- Enhanced security of fuel and energy supplies;
- Diversification of the electricity generation structure;
- Enhanced use of renewable energy sources, including biofuels.

In **industry**:
- Improvements in technical standards of installations and equipment;
- Measures intending to reduce emissions of Fluorinated greenhouse gases;
- Implementation of the best available techniques;
- Reductions in methane emissions from fuel production and distribution processes;
- Promotion of environmentally friendly and effective practices and technologies in industrial activities and support for the development of environment-friendly and technically cost-effective methods for greenhouse gas emission reductions;
- Technological modernisation at industrial plants.

In **transpor**t:
- Reduction in the environmental annoyance of road transport;
- Enhanced share of alternative fuels in transport;
- Modernisation of rail infrastructure;
- Purchase of modern rolling stock and the modernisation of the existing stock;
- Support for more energy efficient technical solutions on ships;
- Launch of organisational measures in air transport;
- Improvements in public transport in cities;
- Development of intermodal transport;
- Promotion of the bicycle as a means of transport.

In **construction and housing management**:
- The requirements related to the energy standard in construction;
- The assessment of the energy performance of buildings;
- The promotion of the use of renewable energy sources;
- Thermal modernisation of buildings;
- The raising of the awareness of managers, owners and users of buildings concerning energy savings.

In **agriculture:**

- The rationalisation of the use of fertilisers, including nitrogen fertilisers;
- The rationalisation of energy management in agriculture, including energy production from biomass from waste, liquid manure and solid manure;
- The afforestation of agricultural land and non-agricultural land;
- Preferences for crops with high CO_2 capture;
- The rational management of farmland;
- Improvements in animal feeding techniques and feed management;
- Improvements in livestock keeping systems and reductions in methane emissions from animal excreta;
- The elimination of gaseous pollutants emitted from poultry buildings by using phytomediation and solar ventilation.

In **waste management**:

- Enhanced recycling of municipal waste;
- Waste as a source of energy;
- The reduction of the quantity of waste, including biodegradable waste, going to landfills of non-hazardous and inert (municipal) waste.

In **forestry**:

- Taking action against land use change;
- The rationalisation of forest management, incentives and measures supporting afforestation and the protection of the ecological stability of forests.

The table summing up the impact of national measures on greenhouse gas emissions illustrates the extent of the availability of quantitative information on the effects of the measures which have been implemented.

5. Projections of greenhouse gas emissions and removals and the effects of policies and measures

The national projections covered the anticipated greenhouse gas emission levels until 2030 (broken down into those in 2015, 2020, 2025 and 2030), taking into account the effects of the policies and measures adopted and implemented to reduce greenhouse gas emissions. These projections are the so-called scenario "with measures". The main assumptions for the projections were laid down by the Energy Policy of Poland until 2030, which was drawn up in 2009 by the Ministry of the Economy. The emission projections covered all the gases listed in Annex A to the Kyoto Protocol, from 5 sectors.

The sources of information used as data inputs to the emission projections primarily included official activity forecasts, including the *Projection of the demand for fuels and energy until 2030* in the energy sector, and also information on the production of industrial goods, agricultural production, the quantities of waste generated etc. arranged by years and by the types of sources.

The national population size forecast was taken from a publication of the Central Statistical Office, entitled "The Population Projection for Poland for 2008-2035".

The emission projection provided for the implementation of the basic directions of Poland's energy policy, taking into account the requirements of the European Union. The main assumptions of the macroeconomic forecast included the projection of economic growth until 2030, taking into account an adjustment for the financial crisis in 2008 and the anticipated slowdown of the economy in successive years.

The projected greenhouse gas emissions, primarily those of CO_2, decrease until 2020, to subsequently grow in 2025 and 2030. This is consistent with the trend of the forecast demand for fuels and energy. CO_2 will have the greatest share of the emissions, i.e. more than 81%, with the shares of CH_4 and N_2O being, respectively, about 9.2% and 7.5%, while those of industrial gases will represent about 2.1% of emissions.
The total greenhouse gas emissions for all the years covered by the projections in the present Communication are higher than those in the *Fifth National Communication to the Conference of the Parties to the United Nations Framework Convention on Climate Change.* Compared with the *Fifth National Communication* the now projected emissions grow, respectively, by 2.4%, 3.2% and 2.7% in 2015, 2020 and 2030. In general, the projected emissions presented in the Fifth National Communication were lower for CO_2 and industrial gases, but higher for CH_4 and N_2O.

Different expert studies, which have not been authorised by the Government, indicate that the greenhouse gas emissions in Poland can be reduced by 55% by 2050 with negative costs and without using technologies which are expensive and hardly explored. The expert studies identify the policies and measures which are most beneficial in economic terms and enable the achievement of this target.

The use of the Kyoto Protocol mechanisms

Three mechanisms under the Kyoto Protocol have been introduced into the Polish legal regime:

- Joint Implementation,
- the Clean Development Mechanism,
- international emissions trading.

By the end of 2011, 19 Joint Implementation projects (under Article 6 of the KP) had been approved in Poland. The expected total greenhouse gas emission reductions from the implementation of these projects in 2008-2011, determined on the basis of project design documents (PDDs), was 15,647,682 t CO2 eq.

The Clean Development Mechanism (under Article 12 of the KP) is not used in Poland.

Poland takes an active part in the international emissions trading under Article 17 of the Kyoto Protocol). To the end of 2011 the Minister of the Environment has signed seven agreements on the sales of Assigned Amount Units (AAUs) for the total price of about 130 million EUR. Negotiations are underway with other partners interested in the purchase of a surplus of AAUs from Poland.

AAUs are sold within the framework of the National Green Investment Scheme (GIS), which derives from the emissions allowance trading mechanism. The GIS is used for the sales of AAUs to countries or entities which need the units to achieve their reduction target under the Kyoto Protocol. The GIS guarantees that the proceeds from the abovementioned sales will be allocated to objectives related to environmental protection and, in particular, to measures designed to reduce the adverse impacts of climate change and leading to further greenhouse gas emission reductions.

6. Vulnerability assessment, climate change effects and adaptation

Since the *Fifth National Communication to the Conference of the Parties to the United Nations Framework Convention on Climate Change* there has been significant progress in the adaptation of the Polish economy and society to the current and expected impacts of climate change. In 2009, the preparations for the development of the first strategy for adaptation to climate change (the *Strategic Adaptation Plan*) began. These measures were based on the Government's Position adopted on 3 July of 2009 by the European Committee of the Council of Ministers to implement the provisions of a strategic document of the European Commission (COM 2009 147) – *A White Paper on adapting to climate change.*

The last two decades of the 20th century and the first decade of the 21st century have been the warmest periods in the history of instrumental observations in the Polish lands. The growing temperature trend since the mid-19th century has been accompanied by large annual variability. Until 2000, the growing temperature trend was 0.058^{o}C/10 years, while over the last 12 years the temperature has grown by 0.12^{o}C. As the temperature grows, the frequency of the occurrence of heat waves and strong winds increases.
The precipitation structure in the prevailing part of Poland has changed. The change consisted in a distinct increase in the number of days with very intensive precipitation. Since, as the climate changes, very intensive precipitation takes place more often the frequency of the occurrence of flash foods and inundations also grows. As the frequency of the occurrence of periods without precipitation increases the frequency of the occurrence of droughts and low water levels in rivers grows.

As the air temperatures grow and the thickness and resilience of snow cover diminish, the frequency of the occurrence of meltwater and winter floods, which depend on the climate conditions, decreases and will continue to decrease.
In the subsequent decades of the 21st century, further warming can be expected in all the seasons of the year, which will be distinctly greater in the last 30 years. Summer periods become longer, while the frosty periods become shorter. In the case of the annual precipitation total, the trend is not clear, although it can be seen that winter precipitation will grow and summer precipitation will fall at the end of the century.

Water resources, water management, spatial development, agriculture, the coastal zone, cities and transport infrastructure demonstrate particular vulnerability to the observed and expected climate change.

In order to effectively implement the strategy for adaptation to climate change, measures which need to be taken to mitigate the adverse impact of climate change were identified and their costs were estimated for the following sectors: water management, agriculture, spatial development, health care, urban areas, construction, transport, the energy sector, the coastal

zone, biodiversity conservation, forestry and the protection of historic monuments. In most cases, the adopted directions of the measures are horizontal in character and affect the sectors considered to a varying degree.

Moreover, the directions of scientific research to reduce gaps in knowledge on the impacts of climate change and adaptation methods were proposed.

7. Development cooperation and technology transfer under Articles 4.3, 4.4 and 4.5 of the Climate Convention

The Republic of Poland is not one of the Parties listed in Annex II to the Climate Convention; therefore, it is not obliged to fulfil the commitments under Articles 4.3, 4.4 and 4.5 of the Convention. However, Poland carries out many assistance projects, discerning and understanding the need to support the sustainable development in developing countries and in countries with economies in transition. As a Member State of the European Union, Poland provides most of its assistance as a contribution to its general budget.

In 2008–2011, its multilateral assistance systematically grew from 274 to 330 million USD, while its bilateral assistance varied between 84 and 104 million USD.

In 2012, the value of Poland's climate-related assistance was 7.546 million EUR. The activities implemented within the framework of bilateral assistance had the total value of 6.656 million EUR. Poland continued its project in the area of adaptation to climate change which was implemented in China in 2012 with the value of 5.816 million EUR. Other adaptation projects were carried out in Armenia, Ethiopia, Kenya, Kyrgyzstan, Nigeria and Palestine with the total value of 380,000 EUR.

Projects to mitigate greenhouse gas emissions were also carried out in the Crimean Autonomous Republic, Egypt, Moldova, Tanzania and Ukraine with the value of 400,000 EUR. Projects dedicated to both adaption and mitigation with the value of 60,000 EUR were implemented in Azerbaijan and North Korea.

The overwhelming majority of the activities financed by Poland concerned adaptation to climate change; some of them were investment projects, while others aimed at developing the basic organisational resources in developing countries (the so-called capacity building).

8. Research and systematic observations

Climate change research is carried out in the following areas:
- research on the climate change in the past,
- modelling of climate processes and the development of scenarios of predicted change,
- the impact of climate change on the natural environment, the economy and society,
- the impact of human activities on the climate,
- the social and political aspects of climate change.

Many climatologists in Poland are interested in the climate change in the past. This research is limited only to analyses of the variability of thermal and pluvial characteristics.

Research in the scope of climate change modelling and the attempts to forecast it systematically intensify. The research on the impact of climate change on human activities

focuses mainly on several areas which are most vulnerable to climate change, such as: water resources, agriculture, the coastal zone, ecosystems, forestry and the energy sector. Since 1994 about 100 research projects have been implemented on climate change and the global warming process.

The research on the areas located at high latitudes has a very special position in Polish scientific research – the issues related to global climate change dominate. The research in the scope of oceanography and the physics and chemistry of the atmosphere basically focuses on the issues related to water circulation, the energy and mass transport to the high latitudes of the Northern Hemisphere, the transport of solar energy into the depths of the ocean, aerosols and the related changes in the optical properties of the atmosphere, as well as tropospheric and stratospheric ozone and changes in UV radiation. The research on the concentrations of greenhouse gases in the atmosphere has an important position.
This part of the Communication also deals with Poland's participation in international research programmes (IGBP, WCP, GCOS and others), the system of observations and measurements of the atmosphere, the sea, the biosphere, hydrosphere and the land surface, satellite research and the monitoring of greenhouse gas concentrations in the ground and upper layers of the atmosphere.

Research in the scope of the monitoring of selected Essential Climate Variables is carried out by research institutes. The advancement of the development of the individual components of the observing system is different. It is markedly higher in the field of systems for terrestrial measurements of essential climate variables in the scope of meteorology (on land, in oceans and in upper layers of the atmosphere) and hydrology (the monitoring of snow cover, rivers and lakes). The degree of the utilisation of satellite systems to monitor meteorological and oceanographic variables is very high, whereas it is lower in the scope of hydrological variables and other terrestrial characteristics.

9. Education, training and public awareness

The need to raise the environmental awareness of citizens is emphasised in all the strategic documents concerning broadly understood environmental protection, indicating the following directions of measures: school education should be developed in the scope of environmental protection, access to information on the environment should be facilitated and behaviour consistent with the principle of sustainable development should be promoted. They also include consumer education, recommending that a nationwide public campaign should be carried out to shape sustainable consumption patterns, and closer cooperation with journalists on the education of all the social groups. Environmental education covers the entire society, all the age and professional groups, as well as the power elites at the national and local levels, in a process conducted by institutions established for this purpose, environmental nongovernmental organisations and the media.

The responsibility for environmental education, including the education in the field of climate protection, rests on the Minister of National Education and the Minister of the Environment, as the leading entities, with the participation of all the other Ministers. Many activities are conducted by the Ministry of the Environment or under the patronage of the Minister, such as the educational and promotional campaign on climate change announced by the European Commission, the campaign called the *European Day Without Cars*, the *World Earth Day* and the *World Environment Day*. For many years information on climate change related to human

activities has been regularly provided to the public in the information bulletin called *Zmiany klimatu (Climate Change).*

An important educational base is a network of regional environmental education centres managed by local governments or nongovernmental organisations and centres operating at national and landscape parks. They conduct diverse forms of activities which involve local communities and support formal education. The individual activities of the different nongovernmental organisations which are engaged in the popularisation of knowledge about the threats related to climate change have been strengthened by the cooperation within the framework of the Climate Coalition.

Among the many portals and websites on environmental education, including climate education, the following ones should be mentioned: the information portal www.ekoportal.gov.pl, the educational website addressed to children http://dzieci.mos.gov.pl, the portal www.ekoszyk.pl, promoting the fashion for the appropriate consumer behaviour, and the information and educational portal klimada.mos.gov.pl dedicated to the issues of adaptation to climate change. Recently many new specialist portals were also launched, such as www.ekoedu.uw.edu.pl, www.ekologia.pl, www.koalicjaklimatyczna.org and www.chronmyklimat.pl.

CHAPTER 1. INTRODUCTION

The Sixth National Communication to the Conference of the Parties to the United Nations Framework Convention on Climate Change (hereinafter referred to as the Climate Convention) was prepared in accordance with Decision UNFCCC/CP/1999/7, Part II. At the same, fulfilling the decisions of the Conference of the Parties (Decision 19/CP.18) concerning the preparation of biennial reports by developed countries, CTF tables prepared in accordance with the guidelines of the Conference are featured in the annex.

The submitted communication presents information from 2008–2011 concerning greenhouse gas emissions and removals. Chapter 2 describes the socio-economic situation in the country, indicating several key elements, which are: a systematic decrease in the population, a gradual increase in the GDP, the value of which gradually regained the previous level after the crisis period (in 2009), and a diminishing share of the consumption of hard coal in the national economy.

The results of the 2011 inventory of greenhouse gas emissions and removals, along with the trend of their change since 1988, are presented in Chapter 3 and Annex 2. The political and economic transformation unfolding in Poland since 1990 have contributed to a significant decrease in the national greenhouse gas emissions and brought their level much below the one adopted for Poland in the Kyoto Protocol. In 2011, the national greenhouse gas emissions (excluding Sector 5. *Land Use, Land Use Change and Forestry*) were lower by 29.6% than in the base year 1988, as a result of the implementation of a whole set of measures, aimed primarily at improving energy efficiency and a change in the consumption structure of fuels and energy. In the period covered by the reporting (2008–2011), after a period when they fell, the greenhouse gas emissions, expressed as carbon dioxide equivalent, began to slightly grow – by 1.9%. This was caused by the economic growth and the structure of the fuels used (hard coal and lignite) hampering a further reduction in the emissions.

Supporting all the measures to diminish the pollution of the environment, Poland places a special emphasis on the effective greenhouse gas emission reductions, primarily through national measures, apart from which the mechanisms of the Kyoto Protocol play an additional role. Chapter 4. Policies and Measures and Annex 2 give detailed information on this subject, along with an assessment of such measures.

The national **projections of greenhouse gas emissions and removals presented in Chapter 5** cover their forecast values until 2030 (broken down into 2015, 2020 and 2030), taking into account the policies and measures adopted and implemented to reduce greenhouse gas emissions. The projections were made for the following greenhouse gases: carbon dioxide, methane, nitrous oxide, HFCs, PFCs and sulphur hexafluoride and for the following five sectors, according to the IPCC classification of sources: *Energy (including Transport)*, *Industrial Processes*, *Solvent and Other Product Use*, *Agriculture* and *Waste*. In the case of the Sector of *Land Use, Land Use Change and Forestry* (so-called LULUCF), the projection only covered the value of the balance of the CO_2 emissions and removals for the activities carried out under Article 3.3 (afforestation, reforestation and deforestation) and the additional activities selected by Poland under Article 3.4 (forest management) of the Kyoto Protocol, without estimating such a balance for the whole Sector 5. LULUCF.

Since the Fifth National Communication there has been significant progress in the adaptation of the Polish economy and society to the current and expected impacts of climate change. In 2010–2012, the national strategy for adaptation to climate change until 2020 was prepared, covering vulnerable sectors and areas (the Strategic Adaptation Plan SPA 2020). It is described in Chapter 6.

The Republic of Poland is not one of the Parties listed in Annex II to the Climate Convention; therefore, it is not obliged to fulfil the commitments under Articles 4.3, 4.4 and 4.5 of the Convention. Joining the EU in 2004, the Republic of Poland took on international commitments concerning the level of development assistance and its quality. Poland carries out many assistance projects, discerning and understanding the need to support the sustainable development in developing countries and in countries with economies in transition. Chapter 7 presents the scope and scale of this assistance.

Research and observations on climate change and climate processes are carried out at many Polish research centres. Within the framework of international programmes, Polish centres participate in the world systems of meteorological and atmospheric observations. Chapter 8 is devoted to national research and observations regarding climate change.

Education is the basis for the creation and enhancement of the capacity to solve the problems of environmental protection and for the implementation of sustainable and sustained development. Chapter 9 presents the measures taken to raise the public awareness of climate change through the countrywide implementation of appropriate educational programmes, ensuring public access to information on the environment, staff training, cooperation and exchange of experiences at the international level.

CHAPTER 2. POLAND'S CIRCUMSTANCES WITH RESPECT TO GREENHOUSE GAS EMISSIONS AND REMOVALS

2.1. Organisation of the state

2.1.1. State governance

The Republic of Poland is a constitutional republic with a parliamentary and presidential system and a classical separation of powers into legislative, executive and judicial ones.

The legislative is power is exercised by a two-chamber parliament consisting of the Sejm (the Chamber of Deputies) and the Senate (the Chamber of Senators). The Sejm and the Senate sitting in a joint session constitute the National Assembly.

The executive power is exercised by the President and the Council of Ministers. The Government performs its duties through government administration authorities and units at the national level: the Ministries, central offices and foreign services, and at the regional level – voivodes (representatives of the Government in 16 voivodeships), Voivodeship Offices (subordinated to voivodes) and territorial units of integrated government administration.

Poland has a three-level territorial division. It consists of communes (gminas), counties (poviats) and provinces (voivodeships). Territorial self-government units are independent and their independence is subject to judicial protection. The basic self-government unit is a commune (gmina). As of 1 January 2012, in Poland there were 16 voivodeships, 314 rural poviats, 65 urban poviats and 2,479 communes[1].

2.2. Population profile

In 2012, Poland's population was 38,538,000 persons. The mean population density is 123 persons per 1 km^2. The population density in Poland is very differentiated depending on the location. The population density in the most urbanised region, i.e. Śląskie Voivodeship, is 375 persons per 1 km^2, while in the most sparsely populated Podlaskie Voivodeship it is 59 persons per 1 km^2.

At present, the rural population represents almost 60% of the national population, while since 2004 the number and share of urban residents in the total national population have diminished.

2.3. Geographic conditions

2.3.1. Geographical position

Poland is situated within the area of the North European Plain, with the South Baltic Coastland, the Saxon and Lusatian Lowlands and the Central Polish Lowlands. Within the borders of Poland, there are also a part of the East Baltic and Belarussian Lowlands, the belt

[1] Data from the Central Statistical Office (GUS).

of the Polish Uplands and the Ukrainian Uplands, parts of the Bohemian Massif and the Carpathians. In physical and geographical terms, Poland lies between Western and Eastern Europe. Due to such a position of Poland, its territory is differentiated in terms of its climate, landscape and nature.

2.3.2. Landscape differentiation and ecosystems

Lowlands are the dominating type of landscape: 54% of the national territory lies below 150 m a.s.l. and almost 37% is situated at 150-300 m a.s.l. Upland and mountain areas (above 300 m a.s.l.) occupy almost 8% of the Polish territory, with high mountains representing only 0.1%.

The coastland forms a belt along the southern coast of the Baltic Sea, with two curves of the coastline, i.e. the Gulf of Pomerania with the Szczecin Lagoon and the Gulf of Gdańsk with the Vistula Lagoon. In the Gdańsk Coastland, there is a delta landscape with the well-shaped mouth of the Vistula, i.e. the so-called Żuławy (Marshlands) of the Vistula. This area is one of those sites that are most vulnerable to changes in the sea level in the Polish coastal zone (the lowest point in the delta of the Vistula lies 1.8 m below the sea level).

The southern border of Poland runs along the ridges of the Sudety Mountains and the Carpathians. In both of these ranges, there are the water-head areas of the largest rivers (the Vistula in the Carpathians and the Odra in the Sudety Mountains). The Carpathians and the Sudety Mountains are areas with high natural values covered by different forms of protection. Poland's geographical position in the transition climate zone with impacts of oceanic and continental air masses, the differentiated relief of the terrain and hydrographic system and the variability of soils contribute to the natural richness of Poland.

In the Polish territory, there are 485 plant assemblages; 12% of them are frequently encountered ones, while 22% of the assemblages seldom occur and can be found only on few sites. The most valuable natural and semi-natural habitats are vast wetlands, including peat-bogs, extensive meadows and pastures in river valleys as well as mountain and xerothermic grasslands with many endemic species. The most valuable ecosystems also include large dense forest complexes, which, although they have been transformed by man and are still used, constitute the most important refuges of many flora and fauna species in Poland.

2.3.3. Natural resources

The topographic features favour the economic use of the Polish territory, as the percentage share of wasteland, also including natural wastelands, such as coastal dunes and bare rocks in the high parts of the mountains, is slight (1.6%). The dominant land uses include farmland (about 60% of the national territory), forests, woodland and shrubland (about 30%). Table 2.1.shows the changes in the use of the national territory in recent years.

Table 2.1. The directions of the use of Poland's area in 2000 and 2008–2011 [in thousand ha]

Specification	Years				
	2000	2008	2009	2010	2011
Total national area	31,269	31,267	31,268	31,268	31,268
Farmland	18,558	19,025	18,981	18,931	1,8870
Forest land, woodland and shrubland	9,104	9,273	9,496	9,531	9,570
Land under waters	833	638	641	640	645

Built-up and urbanised lands	2,049	1511	1529	1550	1,572
Ecological sites	10	33	34	34	35
Wasteland	500	487	486	482	480
Others	216	300	102	100	96

Source: GUS.

Poland's natural resources also consist of mineral deposits, including thermal waters, curative waters and brines. The extracted minerals include, e.g.: hard coal, lignite, oil and natural gas, the ores of copper, zinc and lead, sulphur, halite and rock raw materials. Table 2.2 shows the balance of selected resources as of 2011.

Table 2.2. The resources of selected minerals (as of 2011).

Specification	Resources [million Mg]		Number of deposits	
	Economic	Developed	Evidenced	Developed
Hard coal	48,540.84	17,606.03	145	49
Lignite	22,663.08	1,668.42	90	12
Crude oil	25.58	24.94	84	67
Natural gas	142.66	119.57	283	198
Copper ore	1,810.44	1,494.85	14	6
Zinc and lead ores	79.01	19.42	20	3
Sulphur	512.31	26.43	18	5
Halite	84,978.01	15,124.64	18	5
Natural aggregate (sand and gravel)	17,232.56	4,715.38	8628	3387

Source: GUS.

In Poland, there are also technically and economically available renewable energy resources, primarily biomass and wind energy. In 2010, in Poland the share of energy from renewable sources in the total primary energy was 10.2% (20.1% in EU-27), of which 85.6% was energy from solid biomass, 6.7% energy from biofuels, 3.7% hydro-energy, 2% wind energy and 2% energy from the other renewable energy sources[2].

Poland is one of the European countries with the poorest water resources. The renewable resources amount to about 1,600 m^3 per capita per year, i.e. they are three times lower than the European average and several times lower than the global average. This situation is aggravated by their large seasonal variability and the substantial spatial differentiation of water resources; as a result, many regions of the country are threatened by a periodical deficit or surplus of water. Retention reservoirs can retain a slight part of the annual flow and do not ensure adequate protection against either drought or flood. Almost 85% of water used is withdrawn from surface water resources, more than 14% of it is groundwater and almost 1% of it comes from mines (from their drainage)[3].

2.4. Climate

As a result of the impact of climate types and the different amounts of energy reaching the Earth in the individual seasons of the year, ensuing from the different horizontal altitude of the Sun related to the latitude, there are climate zones in Poland. The mean air temperature varies from close to 7°C in North-eastern Poland to about 10°C in its Southwest[4].

[2] Data from GUS.
[3] Data from GUS.
[4] Data from GUS.

Just as in many regions of the world, in recent years climate change could be seen in Poland, manifested primarily by: higher mean annual air temperatures, a change in the structure of precipitation and a large number of extreme events. Irrespective of the region of the country, the mean air temperature can be seen to grow (Fig. 2.1.). The greatest increase in the temperature can be observed in winter, while the largest growth rate is demonstrated by the minimum temperature.

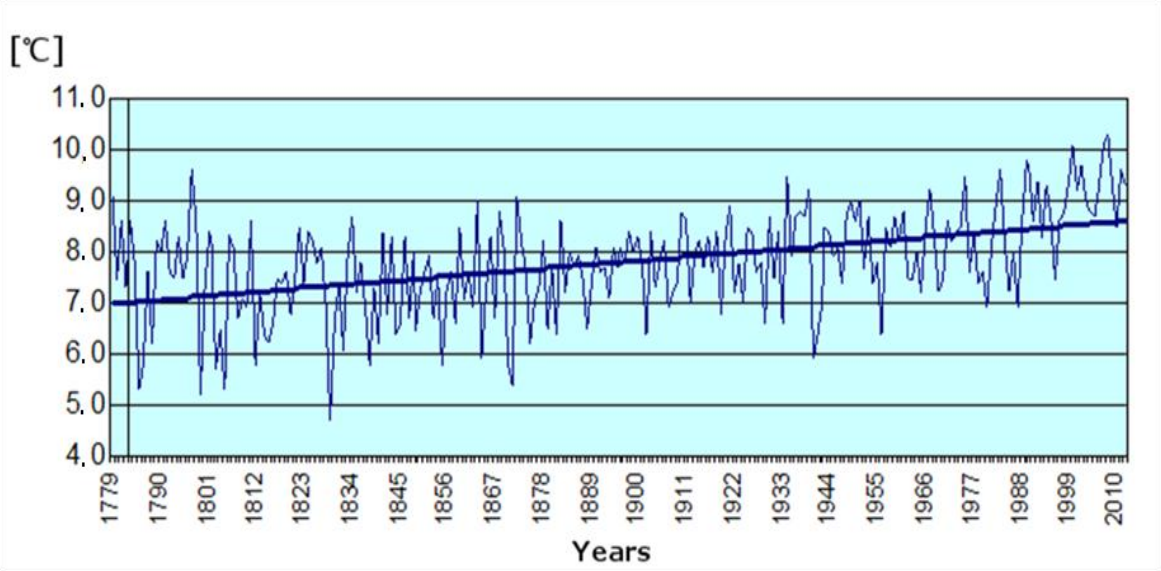

Fig. 2.1. Mean annual air temperature at the Warsaw Observatory in selected years in 1779–2010. Source: IMGW-PIB.

The annual precipitation totals vary between about 550 mm in the middle part of Eastern Poland and in South-western Poland, about 700 mm on the coast and more than 1,000 in the mountains, with the summer rainfalls greater than the winter precipitation[5]. The precipitation totals do not show a distinct trend of change, but their structure changes, particularly in summer, when the frequency of heavy rains and prolonged droughts increases.

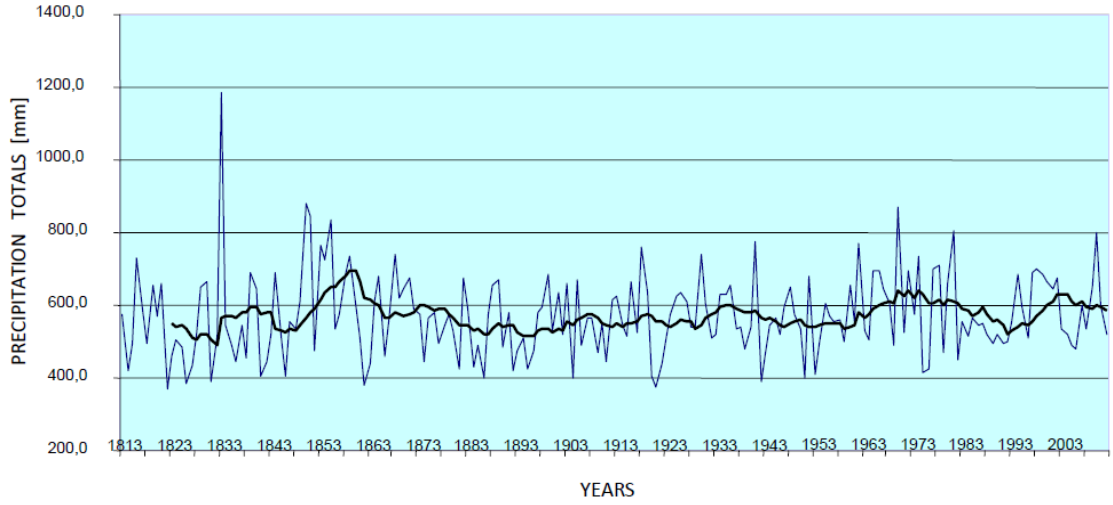

Fig. 2.2. Annual precipitation totals in Warsaw in 1813-2012. Source: IMGW-PIB.

[5] Data from GUS.

In recent years, in Poland the frequency of the occurrence of events related to higher water levels in rivers could be seen to grow from year to year (mainly in the mountain and submontane areas and in Żuławy). In turn, in the lowlands and the Lublin Upland there are water deficits which are already considered permanent. Apart from the risks of floods and droughts, the observed effects of climate change in Poland also include the enhanced forest fire risk in forests, the lowering of the groundwater level, the related waning of wetlands and the stepping of natural habitats.

2.5. The socio-economic situation

2.5.1. General characteristics

Poland's economic development slowed down in 2008-2012 as a result of the global economic crisis on the financial and banking markets (Table 2.3.). However, in 2013 signs of a change in the unfavourable development trend could be seen and there was gradual economic growth.

Gross Domestic Product
In 2007, Poland was one of the fastest growing countries of the European Union. Its Gross Domestic Product grew by 6.6%, whereas the GDP of EU-27 increased by 2.9%. Faster economic growth could be seen from 2003 when the GDP growth rate exceeded 3%.

Table 2.3. GDP in Poland in 2007–2012

Specification	Years					
	2007	2008	2009	2010	2011	2012
GDP [million PLN, current prices]	1,176,736.7	1,275,508.3	1,344,505.1	1,416,585.3	1,528,127	1,595,264
GDP growth rate [Previous year = 100]	106.8	105.1	101.6	103.9	104.3	101.9

Source: GUS.

2.5.2. The energy sector

The energy sector in Poland is based on:

- hard coal – in recent years the hard coal extraction fell, as a result of old and unprofitable mines and the application of energy-saving technologies and machinery by energy producers and users; hard coal occurs in the Upper Silesian, Lower Silesian and Lublin Basins,
- lignite – extracted in open cast mines in the Konin, Turoszów and Bełchatów Basins,
- crude oil – the oil production in Poland is slight and Poland imports crude oil from Russia, Arab countries and the North Sea basin,
- natural gas – the domestic extraction meets about 30% of Poland's demand for gas, while the other demand is satisfied by gas imports from Russia and Ukraine,
- the shares of the other energy sources, including renewable energy, i.e. hydro, geothermal and wind energies, biogas (including agricultural biogas) and solar radiation – grow from year to year.

Table 2.4 shows the data on the levels and structure of the primary energy consumption in Poland by carriers.

Table 2.4. The levels and structure of the primary energy consumption in the national economy in 2008–2011 by carriers.

Specification	Years			
	2008	2009	2010	2011
Total primary energy consumption [TJ]	4,203,248	3,980,408	4,387,524	4,507,724
Shares of individual sources [%]				
Hard coal	46.7	44.8	45.8	43.4
Lignite	12.7	12.8	11.0	11.6
Crude oil	21.3	21.7	22.1	22.8
Natural gas	13.4	13.7	13.3	13.1
Other [1)]	6.0	7.1	7.7	9.1

[1)] Fuel wood, peat, waste fuels, renewable energy generation and heat pumps.

Source: GUS.

For many years the consumption of hard coal and lignite as energy sources has fallen in favour of petroleum-based fuels, although in the nearest several dozen years coal will remain a raw material of strategic character.

On the initiative of the Minister of the Economy, the National Low-Emission Economy Programme is being developed to improve the energy efficiency of the economy and to reduce the emissions of pollutants, including greenhouse gases.

The currently used sources of renewable energy, which represents 7.22% of the total primary energy (Table 2.5.), primarily include biomass, particularly wood and wood waste (more than 85%), and hydro-energy (about 3%), while the share of energy generated from the wind grows (to 3.5%). Both the production and consumption of renewable energy increase.

Table 2.5. The production and consumption of renewable energy in Poland by its generation sources.

Specification	Years			
	2008	2009	2010	2011
Share of renewable energy carriers in energy supply from renewable sources [%]:				
Solid biomass	87.48	85.77	85.29	85.57
Geothermal energy	0.23	0.24	0.20	0.16
Wind energy	1.33	1.53	2.08	3.55
Hydro-energy	3.42	3.37	3.65	2.58
Share in total energy production [%]	7.24	8.99	10.2	11.19
Share in total energy consumption [%]	5.23	6.37	6.56	7.22

Source: GUS.

Shale formations are now explored as a source of natural gas and crude oil in Poland. Depending on the source, Polish shale gas resources are estimated at 0.3–5.3 trillion m^3 of gas[6].

Changes occurred in the final energy consumption in the sectors of the economy corresponding to the development of the individual sectors (Fig. 2.3). First of all, there was a increasing in the energy consumption in industry and, in households (about 20%). The energy consumption grew also in the developing services and transport. In 2000-2008, the rate of improvement in energy efficiency in Poland was twice as high as that in the European Union. According to the Eurostat data, in 2010, the energy intensities of the Polish and EU

[6] Turowski P. (2012): Gaz łupkowy w Polsce – szanse, wyzwania i zagrożenia (Shale gas in Poland – opportunities, challenges and risks – in Polish), *BEZPIECZEŃSTWO NARODOWE* No. 21, I – 2012

economies were: 373,9 kgoe/1000 euro00 for Poland and 168 kgoe/1000 euro00 for the UE[7]. This indicator does not reflect the real difference in view of the differences in purchasing power, since the price levels of market and non-market goods and services in the individual countries are differentiated (the purchasing power of the euro is greater in Poland than on average in the EU).

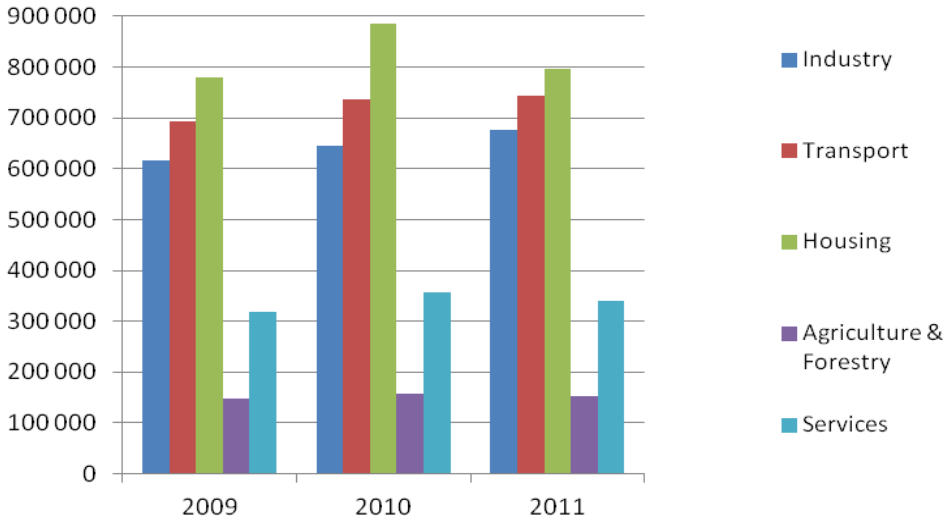

Fig. 2.3. The final energy consumption by sectors in 2008–2011. Source: GUS

The energy sector in Poland consists of the electricity, heating, gas and oil subsectors.

The electricity subsector

The electricity generation in Poland is based to a significant degree on main activity power plants. The total installed capacity of power plants in 2011 was 37,595.2 MW, while their output was 163,548 GWh[8].

The main causes of the high CO_2 emission intensity of this sector include primarily a large share of highly emission-intensive coal-based technologies in electricity generation, the low efficiency (compared with other technologies) of electricity generation processes based on traditional coal-based technologies.

At present, almost 15% of the electricity generated is used to meet the own needs of the energy sector and lost in transmission and distribution.

In 2011, 14,024 GWh of electricity was used to meet the own needs of thermal power plants and heat and power plants, while the losses and statistical differences in transmission and distribution amounted to 10,638 GWh, representing altogether 15.1 % of the total national electricity production (Fig. 2.4). In turn, the losses in transmission and distribution alone in 2011 represented about 6.5 %; they were at a level comparable to that in the countries neighboring on Poland. The difference occurring in certain estimates between the losses in Poland and those in the other countries results from the methodology applied to calculate losses or from the comparison of only certain segments of the whole system. The correct

[7] Heat generation in figures – 2010. Energy Regulatory Office 2011.
[8] Source: Statistics of the Polish Electricity Sector 2012, Ministry of the Economy/ARE S.A.

methodology is based on the calculation of the difference between the energy introduced into the system and the energy obtained from the system.

The losses and statistical differences in electricity networks are shown in Fig. 2.4.

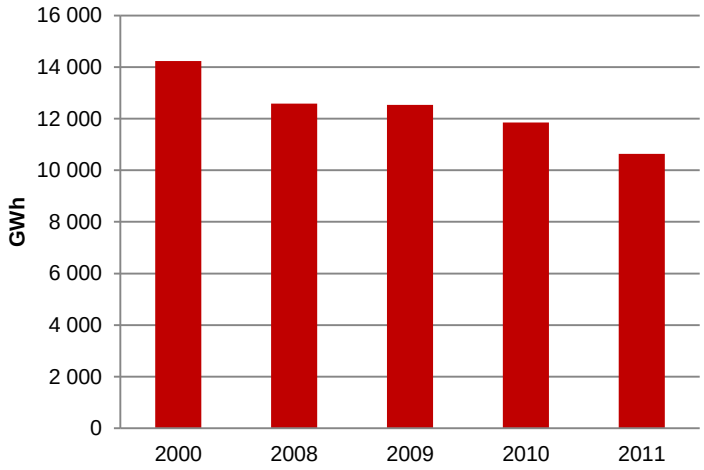

Fig. 2.4. Losses and statistical differences [GWh] in electricity network.
Source: Ministry of the Economy.

Transmission networks are in an appropriate technical condition enabling the implementation of the functions assigned to them. In order to maintain the elements of the electricity transmission system in an appropriate technical condition, in the course of each year planned operational works are carried out, including the clear-cutting of trees and repair works, and so are ad hoc works in case of the threat of a breakdown or the occurrence of a breakdown.

The most important investment projects in the scope of transmission networks are carried out in Northern, North-Eastern and Western Poland, including primarily investment projects to connect and take power from new generating units; *inter alia*, traditional power plants and RES. The aim of investment projects related to the operational security of the network and its expansion is to change the voltage from 220 kV to 400 kV, to close the rings and to expand the transmission networks round big city agglomerations. In turn, the aim of the expansion of transboundary connections is to enhance transboundary transmission capacity.

In turn, the average age of a distribution network is about 30 years. It is estimated that about 30% of the national distribution network should be modernised in view of its technical condition. In general, the distribution network in Poland needs expansion and modernisation. Recently, there was a distinct increase in investment outlays on the development of networks at distribution companies.

The heating subsector

Heat supply consists of the production, distribution and trade in district heat. The potential of the Polish heating industry subsector is very fragmented. The heating business is carried out by main activity and autoproducer heat and power plants, main activity and municipal heating plants and local production and distribution companies. In 2010, about 73% of heating companies were state-owned, of which 89 % entities were owned by territorial self-

government units[9]. The other entities are owned by the private sector, of which 15% belongs to foreign operators.

Hard coal (75% in 2010) is the basic fuel used for heat production; nevertheless, in this subsector, too, investment projects are carried out to replace coal-fired boilers by gas-fired ones and different types of modernisation works are conducted to meet the requirements of environmental protection. The share of heat recovered as a result of biomass combustion grows; it more than doubled in 2002-2010 (Fig. 2.5).

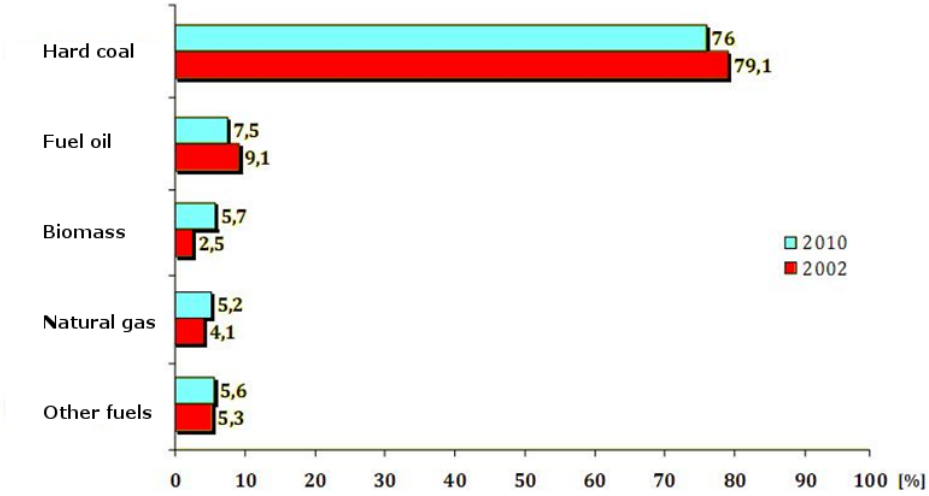

Fig. 2.5. Comparison of the structure of heat production by fuels used in the heating subsector in 2002 and 2010. Source: Heat generation in figures - 2010, Energy Regulatory Office 2011.

30% of the heat generated is used by its producers to meet their own heating needs. The other part of it is discharged into heating networks. After the transmission losses are considered, slightly more than 60% of the heat produced reaches the users connected to the networks.

The technical capacity of the licensed heating companies is characterised by large fragmentation and geographical diffusion. In 2010, the installed capacity of the licensed heating companies was 59,263.5 MW (the generating capacity was 58,097.7 MW); in 2007 62,752.3 MW (the generating capacity was 60,530.5 MW); and in 2002 70,952.8 MW (the generating capacity was 67,285.4 MW)[10]. Just as in the previous years, one third of the generating capacity of the heating subsector was concentrated on a permanent basis in two voivodeships – Śląskie and Mazowieckie.

In 2010, the licensed heating companies generated (including recovery) 462,500 TJ (in 2007, almost 435,000 TJ of heat). In 2010, more than 62% of the heat generated (269,900 TJ) was produced in cogeneration with electricity at main activity power plants and heat and power plants and main activity and autoproducer heat and power and heating plants.

Changes in the energy consumption in the industry sector

Fig. 2.6 shows the final energy consumption in the major sectors of industry. The largest energy consumption takes place in the chemical, mineral, iron and steel and food industries

[9] Heat generation is figures – 2010, Energy Regulatory Office 2011.
[10] Heat generation in figures – 2010. Energy Regulatory Office 2011.

(about 60% of the total energy consumption). Energy consumption has fallen in the iron and steel and textile industries, while it has grown e.g. in the mineral and chemical industries.

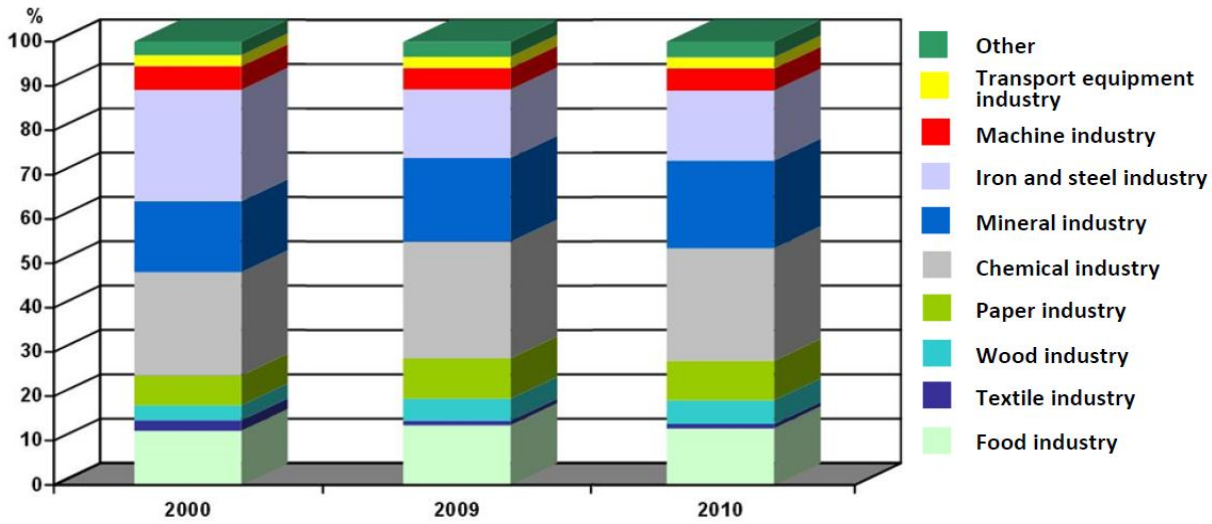

Fig. 2.6. The sectoral structure of the energy consumption in industry in Poland in 2000, 2009 and 2010. Source: GUS.

The energy efficiency of the production in most of industrial sectors (both energy intensive and hardly energy intensive) improved, having a direct effect on the decrease in greenhouse gas emissions (Figs. 2.7 and 2.8).

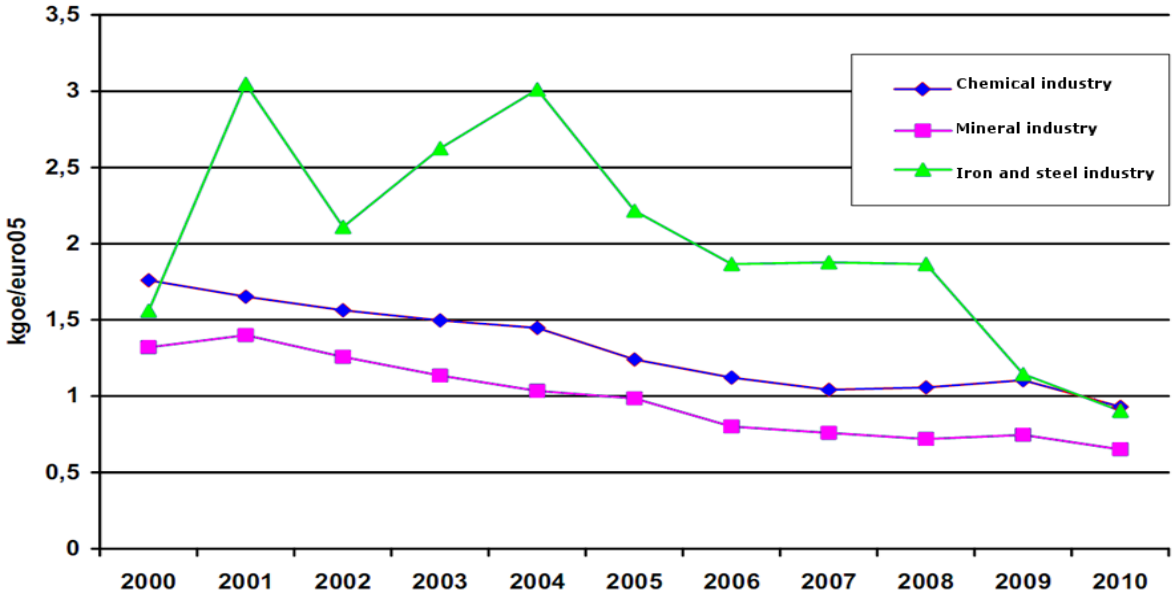

Fig. 2.7. Changes in the final energy intensity rate of the most energy intensive sectors of the Polish industry in 2000–2010. Source: Heat generation in figures – 2010, Energy Regulatory Office 2011.

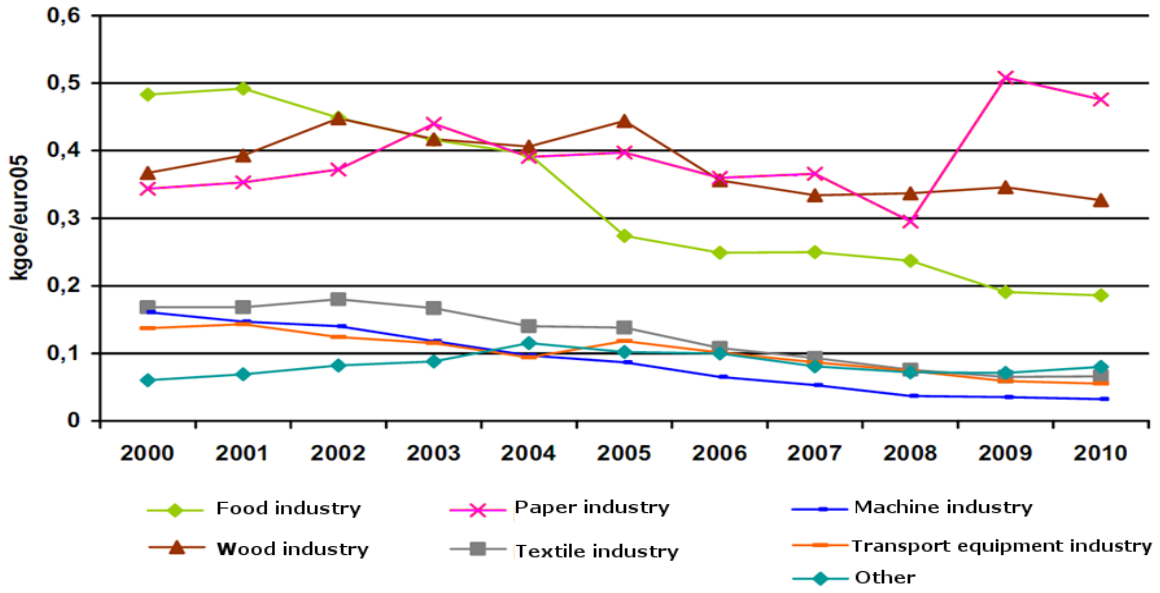

Fig. 2.8. Changes in the final energy intensity rate of the low energy intensive sectors of the Polish industry in 2000–2010. Source: Heat generation in figures – 2010, Energy Regulatory Office 2011.

In the case of energy intensive industrial sectors, energy efficiency has improved to the greatest extent in the chemical industry. Among the low energy intensive sectors, the greatest improvement in energy efficiency has been achieved in the machine, food, textile and transport equipment industries.

Changes in the energy consumption in the service sector

In 200–2 010, the energy intensity of the service slightly varied, with a growing trend in 2000–2003 and 2008–2010 (Fig. 2.9). Compared with 2000, in 2010 the final energy intensity in the service sector grew by about 20% (from about 0.041 to 0.051 kgoe/euro05).

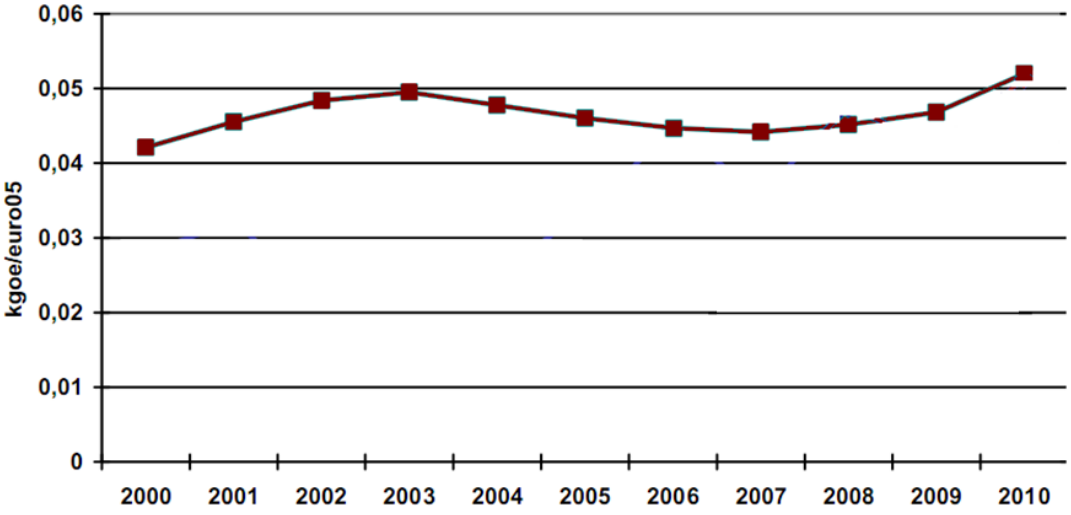

Fig. 2.9. The energy intensity of the value added in the service sector in 2000–2010. Source: Heat generaton in figures – 2010, Energy Regulatory Office 2011.

Changes in the energy consumption in the transport sector

From 2003 the final energy consumption systematically grew in the transport sector, to reach about 17,000 ktoe in 2010 (an increase by about 50% relative to 2000)[11]. The electricity consumption in 2001–2 011 varied, with a distinct fall in energy consumption in recent years compared to that in the early 21st century (from 5,678 GWh in 2001 to 4,245 GWh in 2011, Fig. 2.10).

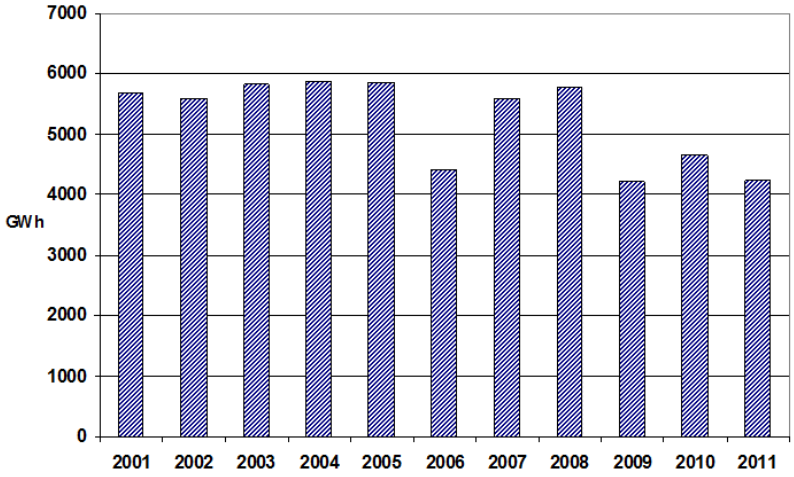

Fig. 2.10. The electricity consumption in the transport sector in 2001-2011. Source: Local Data Bank.

Changes in the energy consumption in the agricultural sector

From 2005 the energy consumption in the agricutural sector diminished from about 4,500 ktoe in 2005 to 3,500 ktoe in 2007. In 2001–2011, the electricity consumption varied. In 2011, it was lower by 65% than in 2001 (falling from 4,610 GWh in 2001 to 1,595 GWh in 2011, Fig. 2.11[12]).

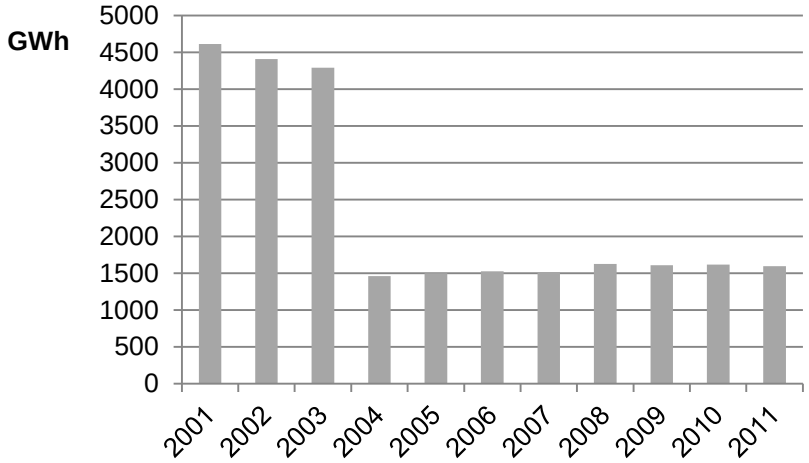

Fig. 2.11. The electricity consumption in the agricultural sector in 2001–2011. Source: Local Data Bank.

[11] Heat generation in figures – 2010. Energy Regulatory Office 2011.

[12] Since 2004 the electricity consumption in agriculture has included only the consumption for agricultural activities, excluding the energy consumption for domestic purposes.

2.5.3. Industry

Industry remains the dominating factor which generates the economic growth in Poland. The growth rate of the sold production of industry varied: in 2009–2011 it changed relative to the previous year by -4.5% in 2009, by +9% in 2010 and by +7.7% in 2011. In 2011, the sold production of industry was higher by more than 43% compared with that in 2005[13].

The trends in the growth rate of industrial production are consistent with those in economically developed countries. The highest growth rate can be found in the manufacturing industry which determines the growth rate of industry as a whole. A positive phenomenon is the growth to be seen in the production of divisions and groups of industry that are regarded as drivers of technological progress which is faster than in the other divisions. Another important trend can be seen in the structure of sectors; it consists in the growing significance of the private sector, which generated in 2011 almost 86% of the value of the total sold production of industry. Table 2.6 shows the trends of changes in industry.

Table 2.6. The sold production of industry in Poland in selected years in 2000–2011.

Specification	**Years**			
	2008	**2009**	**2010**	**2011**
Total sold production (million PLN)[1)]	918,281.9	896,379.8	985,715.9	1,137,372.8
Sold production per capita (PLN))[1)]	24,092	23,494	25,592	29,522
Sold production by ownership sectors (%)				
Public sector	-	15.4	15.1	14.1
Private sector	-	84.6	84.9	85.9
Growth rate of sold production (constant prices)*	3.6	-4.5	9	7.7
Growth rate of sold production by sections and divisions[1)] (%)				
	Previous year =100			
Mining and quarrying	103.3	88.4	98.8	105.1
Manufacturing by sections and divisions:	104.0	96.1	109.9	108.6
Manufacture of food products	100.6	104.5	104.6	104.2
Manufacture of beverages	104.4	99.2	91.5	101.8
Manufacture of clothes	96.2	84.3	99.6	109.0
Manufacture of wood, cork, straw and wicket products	101.8	94.5	107.6	103.1
Manufacture of coke and refined petroleum products	108.4	96.2	97.9	106.5
Manufacture of chemicals and chemical products	97.0	98.0	113.1	109.2
Manufacture of rubber and plastic products	103.8	96.4	115.7	110.8
Manufacture of metals	97.0	74.5	119.3	113.6
Manufacture of metal products	108.7	91.1	113.3	119.5
Manufacture of machinery and equipment	110.6	90.6	96.8	101.2
Manufacture of motor vehicles, trailers and semi-trailers	107.4	87.8	116.8	113.5
Manufacture of furniture	104.1	99.8	94.2	115.4
Electricity, gas, steam and hot water production and supply	98.3	91.3	103.0	99.9

[1)] Current prices
* Growth (+) or fall (-) relative to the previous year [in %
- not available
Source: GUS, Local Data Bank.

The transformations of the ownership structure of industry and the sectoral structure of production are accompanied by organisational, technical and technological changes in the manufacturing processes, contributing, at the same time, to improvements in energy

[13] Data from GUS.

efficiency and, thereby, to a decrease in the energy intensity of industrial production and greenhouse gas emissions.

2.5.4. Transport

Since the beginning of economic transformations revenues from the total sales of services of enterprises carrying out transport operations have grown in Poland. The greatest revenues are generated by the private sector, the share of which in the sales of transport and storage services has grown since the early 1990s, to reach about 80% in 2011[14].

Since 2004 there have been changes in the structure of transport modes, both in passenger and cargo transport. However, these changes were not so dynamic as those at the turn of the 20th and 21st centuries. Table 2.7 shows the data on the levels and structure of cargo and passenger transport in Poland.

Table 2.7. The levels and structure of cargo and passenger transport in Poland in selected years in 2000–2012.

Specification	**Years**			
	2008	**2009**	**2010**	**2011**
Cargo transport (thousand Mg)				
Total	1,655,965 (100%)	1,691,015 (100%)	1,838,500 (100%)	1,912,172 (100%)
Rail transport	248,860 (15%)	200,820 (11.9%)	217,000 (11.8%)	248,606[1)] (13%)
Road transport	1,339,473 (80.9%)	1,424,883 (84.3%)	1,551,800 (84.4%)	1,596 209[2)] (83.5%)
Pipeline transport	49,029 (3%)	50,242 (3%)	-	54,482 (2.8%)
Maritime transport	10,447 (0.6%)	9,378 (0.6%)	8,400 (0.5%)	7,737[3)] (0.4%)
Inland waterway transport	8,109 (0.5%)	5,655 (0.3%)	5,100 (0.3%)	5,093 (0.3%)
Air transport	47 (0.003%)	37 (0.002%)	-	45[4)] (0.002%)
Passenger transport (billion passenger-kilometers)[5)]				
Total	325.1 (100%)	332.3 (100%)	323.7 (100%)	356.6 (100%)
Passenger cars	273.5 (84.1%)	285 (85.8%)	279.9 (86.5%)	313.2 (87.9%)
Buses and coaches	26.8 (8.2%)	24.4 (7.3%)	21.6 (6.7%)	20.7 (5.8%)
Railways	20.2 (6.2%)	18.6 (5.6%)	17.9 (5.5%)	18.2 (5.1%)
Tramways and the underground	4.6 (1.4%)	4.3 (1.3%)	4.3 (1.3%)	4.4 (1.2%)

[1)] Excluding manoeuvring transport
[2)] Partly estimated data
[3)] With own and leased ships
[4)] Including cabotage
[5)] Scheduled and non-scheduled

Source: GUS and EU transport in figures. European Commissio[(4 & 5)].

[14] Data from GUS.

In the case of cargo transport, the most conspicuous change in the structure of the individual transport modes is the growing importance of road transport. In the case of passenger transport, in recent years the importance of rail transport decreased, while the share of road transport increased.

In the road transport, the fuel consumption grew and the number of cars increased (Table 2.8.). Still, a positive sustained trend in the transport sector was a decrease in the energy intensity indices of the means of transport. The energy efficiency index ODEX was 100 in 2000, 71.5 in 2004 and about 84 in 2010[15].

Table 2.8. Registered motor vehicles and tractors in Poland in selected years in 2000–2011 [number of vehicles].

Vehicles	Years				
	2000	2008	2009	2010	2011
Total, including:	14,106	2,1337	22,025	23,037	24,189
Passenger cars	9,991	16,079	16,495	17,240	18,126
Buses	82	92	95	97	98
Lorries	1,879	2,512	2,595	2,767	2,892
Motorcycles	803	909	974	1013	1069
Agricultural tractors	1,253	1,422	1,530	1,565	1,613

Source: GUS, Local Data Bank.

In recent years, the passenger air transport was the most dynamically developing transport mode in Poland, primarily as a result of Poland's accession to the European Union. Due to a surge in the demand for air transport, the investment needs in the scope of infrastructure greatly increased. This involved both the development of airfields and the need to ensure a quick and efficient access by road and rail to airports.

The share of maritime and inland waterway transport in cargo and passenger transport is lower than 1% of the total transport. In Poland, navigation faces many problems, the most important of which include the obsolescence of fixed assets and the lack of good access to ports, particularly from the land. The inland transport is in a difficult situation. The condition of the inland waterway infrastructure is the main barrier impeding the development of water transport in Poland.

2.5.5. Construction and housing

A more dynamic growth of investment, among others due to the inflow of assistance funds from the European Union, gave rise to higher trends in, and a greater growth rate of, gross outlays on fixed assets. The increase in gross outlays on fixed assets which has been observed in Poland since 2004 has been correlated with the gross value added of construction. Since 2004 the share of construction in the GDP generation increased. In 2011, the gross value added in construction grew by more than 40% relative to 2007[16]. Table 2.9 gives the data on buildings commissioned in selected years in 2000–2011.

[15] http://www.odyssee-indicators.org
[16] Data from GUS.

Table 2.9. Buildings commissioned in selected years in 2000–2011.

Specification	Years				
	2000	2008	2009	2010	2011
Number of new commissioned buildings	50,205	105,470	91,421	91,459	92,010
Urban areas	28,429	41,624	36,476	34,602	34,003
Rural areas	21,776	63,846	54,945	56,857	58,007
Cubic space of commissioned buildings (dam^3)	80,795	165,131,971	15,180,609	127,719,363	131,319,208
Urban areas	57,812	95,317,342	89,908,857	71,789,956	70,085,331
Rural areas	22,983	69,814,629	61,897,240	55,929,407	61,233,877

Source: Local Data Bank.

In 2011, the indicator of the number of dwellings per 1,000 inhabitants was 352, causing Poland to take the last place in Europe[17]. A problem of housing in Poland is also the standard of dwellings, including their furnishing with sanitary and technical systems. The largest number of dwellings (about 97%) have a water supply system, while fewer have a flushed toilet and bathroom (respectively, 93.9% and 91.5%)[18]. Installation of gas in 2011 was connected in 57.7% of dwellings, and central heating in 81.7%.. Dwellings in rural areas are distinctly worse equipped with the abovementioned systems than those in urban areas.

In recent years, there was a decrease in the unit energy consumption in dwellings, as a result of the implementation of a thermal modernisation programme, a reduction in losses in heating networks and improved efficiency of the new equipment installed. Despite this, at the national level, households are some of the largest energy consumers – representing about 20% of final energy. Almost 70% of energy is used for space heating, while about 15% of it heats water[19]. About 15% of energy consumed is used for lighting, preparing meals and supplying electric household appliances.

[17] Data from GUS.
[18] Data from GUS.
[19] Data from GUS.

2.5.6. Agriculture

Polish agriculture is characterised by ample land resources, with a simultaneous large share of poor and acidified soils, a substantial fragmentation of farms and persisting traditional production methods.

According to the information collected as a result of the General Agricultural Census carried out in 2010 in Poland, the total area of farms in Poland in 2010 was about 18 million ha, representing about 58% of the total national territory[20]. Agricultural land represented almost 87% of the total area of farms[21].

The private sector dominates in the structure of user groups – with 99.8% of the agricultural land area in 2010[22]. In 2010, as a total there were 2,278,000 farms in operation (Table 2.10), of which commercial farms, generating almost 90% of the national Standard Production, represented about 32.4%.[23] In terms of numbers, small farms dominate among private farms, with an area of up to 5 ha (representing 69.3 % of the total number of private farms). Farms with more than 15 ha of agricultural land, including the largest ones, represent about 8.5 %.

Table 2.10. Private farms in Poland in selected years in 2000–2011.

Specification	**Years**				
	2000	**2008**	**2009**	**2010**	**2011**
Number of farms (thousand)	2,859	2,566	2,501	2,278	2,253
Average area of agricultural land per farm (ha)	6.49	7.41	7.59	7.95	8.37
Farms with a given area of agricultural land [as a percentage]					
0-1 ha	34.1	29.5	29.3	31.4	26.5
1-3 ha	25.1	27.1	27.3	25.2	28.8
3-5 ha	12.1	13.1	13.1	12.7	13.7
5-10 ha	15.7	16.1	15.6	15.4	15.2
10-15 ha	6.5	6.4	6.7	6.7	7
15-20 ha	2.9	3.0	3.1	3.2	3.3
20-50 ha	3.2	3.8	3.9	4.3	4.4
≥ 50 ha	0.4	1	1	1.1	1.1

Source: GUS.

Apart from the fragmentation of farms, the traditional character of Polish agriculture is reflected by the still moderate (in terms of European standards) levels of mineral fertilisation and consumption of chemical plant protection agents. In 2010/2011, the total consumption of mineral and chemical fertilisation for crops was 1,954,400 Mg[24], i.e. 126.6 kg per 1 ha of agricultural land. A distinct falling trend persisted in the consumption of calcium fertilisers (Table 2.11).

[20] Data from GUS.
[21] Local Data Bank.
[22] Local Data Bank.
[23] The Farm Accountancy Data Network – FADN 2012.
[24] Data from GUS.

Table 2.11. The consumption of mineral and calcium fertilisers in Poland in selected years in 2000–2011 (in terms of pure ingredient).

Specification	Years				
	1999/2000	2004/2005	2008/2009	2009/2010	2010/2011
Mineral or chemical fertilisers as a total [in thousand Mg], including:	1,526.5	1,628.4	1,899.4	1,776.9	1,954.4
Nitrogen fertilisers	861.3	895.3	1,095.4	1,027.6	1,091.1
Phosphorous fertiliser	296.8	324.3	375.3	352.6	408.4
Potassium fertilisers	368.4	408.8	428.7	396.7	454.9
Calcium fertilisers	1,693.9	1,455.6	529.8	591.5	568.3

Source: GUS.

In Polish agriculture, plant and animal outputs are balanced. In terms of the total value of agricultural output, plant production prevails (56.3% in 2011), whereas in terms of market output animal production is greater, representing 53.4% in 2011 (Table 2.12)[25].

Table 2.12. Total and market agricultural outputs in Poland in selected years in 2000–2011.

Specification	Years				
	2000	2008	2009	2010	2011
Total agricultural output					
Total (million PLN), including:	55,985.4	83,126.5	79,907.9	84,484.2	100,671.7
Plant production (%)	53.2	56.3	52.4	53.2	56.3
Animal production (%)	46.8	43.7	47.6	46.8	43.7
Market agricultural output					
Total (million PLN), including:	33,491.4	56,265.0	56,378.9	59,357.1	71,263.1
Plant production (%)	37.4	45	43,7	44	46,6
Animal production (%)	62.6	55	56,3	56	53,4
Share of total market output in total agricultural output (%)	59.8	68,6	70,6	70,3	70,8
Agricultural output per 1 ha of agricultural land (PLN)					
Total output	3,143	5,146	4,957	5,449	6,519
Market output	1,880	3,483	3,497	3,829	4,615

Source: GUS.

Slaughter livestock (e.g. pigs and poultry) and cow milk are the most important items of animal production. The structure of plant production is dominated by the production of cereals, industrial plants, fruit and vegetables. The cultivation of non-food plants, including energy plants, increasingly gains in importance. The area of agricultural land allocated to the cultivation of plants for energy purposes has increased: it was about 6,990 ha in 2006 and about 29,264 ha in 2009[26].

2.5.7. Forestry

As of 1 January 2011, the forest area in Poland was 9,343 ha[27], representing 29.2% of the national territory[28] (Table 2.13). Public forests dominate in the structure of forests (81.3%).

[25] Data from GUS.
[26] FundEko: Wpływ wspólnej polityki rolnej i polityki spójności na rozwój obszarów wiejskich. Raport końcowy (The Impact of Common Agricultural Policy and Cohesion Policy on Rural Development, Final Report – in Polish), 2011.
[27] Data from GUS as of 1 January 2011, GUS Environmental Protection.
[28] Raport o stanie lasów (Report on the State of Forests – in Polish) 2012, General Directorate of State Forests 2013.

Most of them are managed by the State Forests National Forest Holding (State Forests). Private forests occupy 18.7%.

The forest cover rate grew by 10% from 1946 to 2011 (from 20.8%). The target forest cover rate in Poland is 33%. The forest cover rate varies across the country: from 21.9% in Łódzkie Voivodeship (Central Poland) to about 51.3% in Lubuskie Voivodeship (Western Poland).

Table 2.13. The forest area and forest resources in Poland in selected years in 2000–2011

Specification	Years				
	2000	2008	2009	2010	2011
Forest area (thousand ha)[1)]	8,865	9,066	9,089	9,121	9,343
Forest cover rate (%)	28.4	29.0	29.1	29.2	29.2
Total standing timber resources (gross large timber) of State Forests (million m^3)	1,466.1	1,676.2	1,713.7	1,747.8	1,772.5
Large timber logged (thousand m^3)					
Total	26,025	32,407	32,701	33,568	34,877
Coniferous large timber	19,540	24,544	24,529	25,579	26,278
Deciduous large timber	6,485	7,863	8,172	7,989	8,599
Total in the forests of State Forests	24,097	30,695	31,188	31,882	32,789

[1)] As of 1 January

Source: GUS Environmental Protection.GUS Yaerbook Forestry 2013

The forest area grows as a result of the tree planting on lands used for agricultural purposes or wastelands through artificial afforestation and the classification of other lands overgrown by forest vegetation as forests (an effect of supporting the natural succession). In 2009–2011, a total of 16,700 ha of lands were afforested (Table 2.14). The balance of the forest area is affected to a slight extent by the conversion of lands for non-agricultural and non-forestry purposes (604 ha were so converted in 2011).

Table 2.14. The levels of the conversion of forest land in Poland for other purposes and the levels of afforestation in selected years in 2000–2011.

Specification	Years				
	2000	2008	2009	2010	2011
Afforestation (thousand ha)	23.404	7.876	5.611	5.864	5.277
Conversion (thousand ha)	0.7	0.6	0.6	0.55	0.6

Source: GUS Environmental Protection.

The share of deciduous trees in the total forest area has grown for 50 years (in 1945–2007, the area of deciduous tree-stands grew from 13 to 24%). At present, the aim of afforestation projects, appropriately guided by administrative and financial instruments, and the manner of forest management is to gradually rebuild the structure of tree-stands so that they match the natural conditions.

The economic function of forests dominates (e.g. in about 51% of the forests of State Forests)[29]. About 38% of forests play a protective function. Primarily, these forests include those that protect waters, occupying more than 1,490,000 ha, forests around cities (635,000 ha), forest in areas under the impact of industry (about 461,000 ha) and forests which protect soils (324,000 ha)[30]. In 2011, forest lands in national parks occupied 194,900 ha, representing

[29] Information Centre of State Forests: The State Forests in Figures 2012
[30] Data from GUS.

about 61% of the area of the parks; in landscape parks there were about 1,308,000 ha of them, representing about 50% of the parks, while in forest reserves their area was 66,500 ha, which represented about 40% of the area of the reserves[31].

The supply of timber harvested by State Forests and used for industrial energy generation in 2010–2012 varied between 800,000 m^3 and 1.0 million m^3. At the same time, it should be noted that, in accordance with the principles of sustainable forest management, the mean annual logging levels in forests do not exceed the real increments in the volume of tree-stands, thus enabling an unthreatened development of forest resources.

2.5.8. Waste and wastewater management

The quantity of waste generated in the Polish territory in 2000-2011 fell within the range between 120 and 137 million Mg annually (Table 2.15)[32]. The greenhouse gas emissions from waste management processes represented about 2% of the total emissions of these gases. Waste management processes are primarily sources of methane emissions.

Table 2.15. The waste generated [thousand Mg] in the individual years.

Specification	Years			
	2008	2009	2010	2011
Total generated waste	124,974	121,113	123,523	135,653
including:				
Industrial waste	114,938	111,060	113,479	123,524
Municipal waste	12,195	12,053	12,039	12,129

Source: GUS.

Industry remains the largest waste producer, as it generates more than 90% of the total waste generated. Over recent years, the quantities of industrial waste subjected to the following processes remained at similar levels (Table 2.16):

- recovery, representing more than 70% (e.g. using waste a means of energy generation or regeneration of a substance),
- disposal – about 0.3% (incineration processes, composting).

17–22% of generated industrial waste is disposed of at landfills.

Table 2.16. Industrial waste [thousand Mg] generated and disposed of in the individual years.

Specification	Years				
	2000	2008	2009	2010	2011
Generated waste; including:	125,484	114,938.2	111,060.2	113,478.8	123,524.1
Subjected to recovery processes	96,489	86,124.8	81,532.2	84,287.3	88,657
Disposed of (incineration processes, composting)	25,118	561.3	323.1	308.5	431
Landfilled		20,289.7	21,369.2	20,694	26,601.3

Source: GUS.

Municipal waste (selectively collected, e.g. glass, paper and cardboard, garden waste, waste from market places, or waste from the cleaning of streets and squares) represents 8–9% of the total generated waste (Table 2.17). According to estimated data, the average quantity of

[31] Data from GUS.
[32] Data from GUS.

municipal waste generated in kg per capita remains at a similar level; it was 319 kg in 2005; 316 kg in 2009 and 315 kg per capita in 2010–2011, with the quantity of waste collected in kg per capita representing about 80% of the waste generated[33].

Table 2.17. Municipal waste [thousand Mg] collected and disposed of in the individual years.

Specification	Years			
	2008	2009	2010	2011
Collected waste; including:	10,036.4	10,053	10,044	9,827.6
Incinerated	62.7	101.1	102.5	98.3
Disposed of biologically (at composting plants)	262.4	508.3	608.5	365.6
Landfilled	8,693.2	7,859.4	7,368.7	6,967.1

Source: GUS.

The quantity of municipal waste disposed of in a different way than deposition at landfills can be seen to grow; the quantities of waste landfilled in the early 20th century represented about 90% of the total collected waste, whereas in 2009–2011 its proportions were, respectively, 85%, 73.4% and 70.9%.

The number of municipal waste landfills in operation decreases, with a growing number of landfills with a gas removal system. In 2005, 23% of landfills in operation were equipped with a gas removal system, while in 2011 their proportion was already 74% (Table 2.18). In 2010–2011, the number of illegal waste dumps diminished, respectively, by 11% and 26%.

Table 2.18. Data on municipal waste landfills in the individual years.

Year	Municipal waste landfills						
	Number of landfills with a gas removal system				Total number of landfills		
	Total	As percentage of those in operation [%]	Including those where gas is disposed of by combustion		In operation	Closed (operation has ended)	Illegal dumps
			Without energy recovery	With energy recovery			
2005	233	23	8	38	1025	57	2,583
2008	340	39	29	53	879	70	3,481
2009	386	48	38	60	803	94	4,373
2010	403	64	46	65	633	169	3,875
2011	428	74	93	69	578	58	2,539

Source: GUS, Local Data Bank.

Carbon dioxide and nitrogen oxide emissions from waste management processes remain at similar levels and do not exceed several percent (Annex 2).The share of CH_4 emissions (%) from waste in total emissions (thousand Mg) in a given year diminished from 30% in 2005 to about 14% in 2010[34].

[33] Data from GUS.
[34] Data from GUS.

In waste management, in the case of carbon dioxide the main source of emissions are waste management processes, while in the case of nitrous oxide they originate from wastewater management. Methane emissions come primarily from waste landfills, followed by wastewater management processes. Specifically, emissions share from waste landfills is 20% of total emissions, while emissions from wastewater management processes is 3%. The methane emission levels are affected to a slight extent by combustion of agricultural waste, representing less than 1% of total emissions.

There was an increase in the quantity of municipal wastewater discharged into wastewater collection networks which was subjected to treatment processes from 83% in 2000 to almost 96% in 2011 (Table 2.19).

Table 2.19. Data on municipal wastewater management in the individual years.

Specification	Years									
	2000		2008		2009		2010*		2011*	
	million m^3/year	%	million m^3/year	%	million m^3/year	%	million m^3/year	%	million m^3/year	%
Total waste discharged into wastewater collection network, including:	1,494	100	1,254.4	100	1,224.7	100	1,297.8	100	1,258.8	100
Total treated wastewater	1,243.4	83.2	1,169.4	93.2	1,181	96.4	1242.4	95.7	1,203.1	95.6
- untreated	250.6	16.8	85.0	6.8	43.6	3.6	55.4	4.3	55.7	4.4

* In 2010, there was a change in the methodology of identifying the quantity of wastewater discharged into wastewater collection network (the data from 2010-2011 are not fully comparable with those from the previous years).

Source: GUS.

Wastewater is treated in mechanical, mechanical and biological treatment plants and those with enhanced nutrient removal. The quantity of mechanically treated wastewater decreased from 7% to less than 1% in 2009. In recent years, most of municipal wastewater was treated in biological processes (almost 100%), while the quantity of wastewater subjected to enhanced nutrient removal grew by more than 40% of the total treated wastewater.

Over recent years there was a decrease in the quantity of sludge arising in wastewater treatment plants. The quantity of sewage sludge generated in industrial wastewater treatment plants decreased, while the quantity of sewage sludge generated in municipal wastewater treatment plants increased (Table 2.20).

Table 2.20. The quantity of sewage sludge [thousand Mg dry weight] generated and disposed of in the individual years.

Specification	Years				
	2000	2008	2009	2010	2011
Sludge generated in industrial wastewater treatment plants	703.3	411.6	345	368.4	397.6
Sludge generated in municipal wastewater treatment plants,including:	359.8	567.3	563.1	526.7	519.2
sludge applied in agriculture	-	112.0	123.1	109.3	116.2
sludge used to reclaim land, including the land for agricultural purposes	-	105.8	77.8	54.3	54.4
sludge applied to cultivate plants for compost production	25.5	27.5	23.5	30.9	31
sludge incinerated	5.9	6.0	8.9	19.8	41.6
sludge landfilled	151.6	91.6	81.6	58.9	51.4
TOTAL sludge from industrial and municipal treatment plants	1,063.1	978.9	908.1	895.1	916.8

- Not available
- *Source: GUS.*

There was an increase in the quantity of sewage sludge applied in agriculture and disposed of in incineration processes, while there was a decrease in the quantity of sewage sludge applied to reclaim land and the quantity of sewage sludge deposited at landfills.

In the last ten years, there was a decrease in the energy intensity of wastewater treatment plants, primarily as a result of a change of technology and the introduction of BAT, the use of energy-saving equipment, the introduction of systems controlling its work, adapted to the actual loads of pollutants in the wastewater being treated, and the use of biogas from the sludge digestion processes to produce heat and electricity to meet the needs of the wastewater treatment plants.

2.5.9. The state of the environment

After the economic transformation in Poland the processes of the restructuring and modernisation of the economy are most important for the environment, as they contribute to reducing pressures on it. At present, Poland pursues the National Environmental Policy[35], the implementation of which brings effects in the form of the improving state of the individual elements of the environment and also raises the environmental awareness of the public. Finally, another important factor conducive to the reasonable use of the environment and making it possible for Poland to catch up in environmental protection are the legal, administrative and financial institutions operating in Poland.

In 2011, the outlays on environmental protection (on fixed assets for environmental protection) amounted to 12.1 billion PLN (compared with 7.5 billion PLN in 2007), including 3.1 billion PLN for air and climate protection[36]. In recent years, the share of these expenditures on environmental protection in the investment outlays in the national economy remained at the level of about 5% and it represented the level of about 0.8% of the gross domestic product.

2.6. Special circumstances of the fulfilment of its commitments by Poland

In accordance with 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 the purposefulness of a flexible approach to fulfilling its commitments under the Climate Convention in the following matters:

- Poland has assumed 1988 as the base year for the assessment of its commitments,
- the 1990 emissions can be used only to assess the state of global emissions, but it cannot provide the basis for accounting for Poland's fulfillment of its commitments under the Convention.

The reason why Poland has adopted the assumption concerning the change in the base year from 1990 to 1988 is the fact that 1990 was in Poland the first year following the fundamental political and economic changes, and, in consequence, also political ones which clearly undermined the stability of the Polish economy[37]. It was exactly 1990 that saw a temporary

[35] In 2003, the Polish Parliament adopted the document entitled "The National Environmental Policy for 2003–2006 with an Outlook for 2007–2010". Since 2008, Poland has implemented "The National Environmental Policy" covering 2009–2012, with an outlook until 2016.

[36] Data from GUS.

[37] A detailed justification of Poland's adoption of 1988 as the base year was given in the First National Communication to the Conference of the Parties to the Convention (1994).

collapse of the economy. Therefore, the greenhouse gas emission levels in 1900 do not correspond to either the normal emission levels, or the actual economic potential of Poland. Thus, 1990 as the base year is not adequate for the assessment of the potential and condition of the Polish economy.

Additional information required under Article 7.2 of the Kyoto Protocol was presented in the different sections of this Communication, while its detailed list is given in Annex 2.

CHAPTER 3. THE INVENTORY OF GREENHOUSE GAS EMISSIONS AND REMOVALS

3.1. Information on the inventory

One of the major commitments ensuing from the ratification of the Kyoto Protocol by Poland is a 6% reduction in greenhouse gas emissions in 2008-2012 compared with the base year for which 1988 was adopted in accordance with the provisions of Article 4.6 of the Climate Convention and Decision 9/CP.2. The year 1995 was adopted as the base year for the following gases and groups of gases: HFCs, PFCs and SF_6.

The national inventory of greenhouse gases is compiled every year and submitted in the format and at the date required by the Climate Convention. The last National Report submitted in 2013 presented the results of the national inventory of greenhouse gas emissions and removals in Poland in 2011, along with their trend since 1988. The national inventory covers the following greenhouse gases:

- carbon dioxide (CO_2),
- methane (CH_4),
- nitrous oxide (N_2O),
- HFCs (hydrofluorocarbons: HFC-23, HFC-32, HFC-43-10mee, HFC-125, HFC-134a, HFC-143a, HFC-152a, HFC-227ea),
- PFCs (perfluorocarbons: perfluoromethane - CF_4, perfluoroethane - C_2F_6, perfluorobutane - C_4F_{10}) and sulphur hexafluoride (SF_6).

The national inventory and the accompanying tables in the Common Reporting Format (CRF) are prepared in accordance with the updated *Reporting Guidelines on Annual Inventories* (FCCC/SBSTA/2006/9). The Guidelines used to calculate greenhouse gas emissions and removals are consistent with the methodology recommended in the basic publications of the Intergovernmental Panel on Climate Change (IPCC), specifically: the *Revised 1996 Guidelines for National Greenhouse Gas Inventories*, *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* and *Good Practice Guidance for Land Use, Land Use Change and Forestry*. In accordance with the IPPC Guidelines in effect, in order to obtain more exact data on emissions, where possible, the national methodology for estimating emissions was applied.

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

- data on the activities of emission sources come from the statistical publications of the Central Statistical Office and the Eurostat database, while in the case of categories for which there are no official statistical data the results of commissioned specialist studies or experts' assessments are used,
- the emission factors for the main emission sources are developed on the basis of national research, while in the case where there are no national factors or if they involve large uncertainty the default IPCC factors are used (e.g. for CH_4 and N_2O emissions from combustion at stationary sources),
- all the data on activities, emission factors and results are stored at the KOBiZE database, which is successively expanded.

3.2. The 2011 inventory results and emission trends

In 2011, the aggregated emissions of all the estimated greenhouse gas emissions amounted to 399.4 million tonnes of CO_2 equivalent (excluding Sector 5. Land Use, Land Use Change and Forestry). In turn, the balance of greenhouse gas emissions and carbon dioxide removals in Sector 5 was estimated at – 21.9 million tonnes of CO_2, equivalent, where CO_2 removals (mostly by forest lands) amounted to 31 million tonnes of CO_2, while the emissions were 9.1 million tonnes of CO_2 equivalent.

The data presented in this Chapter concerning the shares of the individual sectors and gases in the total aggregated emissions do not include the greenhouse gas balance in Sector 5. *Land Use, Land Use Change and Forestry*.

The sector of Energy had the largest share in the total greenhouse gas emissions (expressed as CO_2 equivalent) in Poland in 2011, i.e. more than 81%, where fuel combustion dominated. The shares of the main sectors in the national emissions are given below, according to the IPCC classification of sources:

- **1. Energy 81.4%**, including**:**
  - **1.A**. Fuel Combustion – 95.2%
    - **1.A.1.** Energy Industries – 53.7%,
    - **1.A.2.** Manufacturing Industries and Construction – 9.6%
    - **1.A.3.** Transport – 15.0%
    - **1.A.4.** Other Sectors – 16.9%
  - **1.B.** Fugitive Emissions from Fuels – 4.8%,
- **4. Agriculture – 8.8%,**
- **2. Industrial Processes – 7.2%,**
- **6. Waste – 2.4%,**
- **3. Solvent and Other Product Use – 0.2%.**

Carbon dioxide dominated in the total greenhouse gas emissions in 2011, as its share in the total emissions was 82.7%. Methane represented 8.9% of the aggregated greenhouse gas emissions, while the share of nitrous oxide was 6.8%. Industrial gases accounted for 1.6% of the aggregated greenhouse gas emissions.

The inventory results indicate that in 1988–2011 the greenhouse gas emissions fell by 29.1%, with the emissions decreasing, respectively, by 29.6% for carbon dioxide, by 33.8% for methane and by 32.5% for nitrous oxide. A particularly marked fall in the greenhouse gas emissions came in 1988–1990, as a result of significant changes in the Polish economy, particularly in the heavy industry. This situation resulted from the launched political transformation and the transition from a centrally controlled to a free market economy. The fall in emissions lasted until 1993 and, subsequently, the emissions started to grow, to reach a local maximum in 1996, e.g. as a result of both the modernisation of the heavy industry and a dynamic economic growth. The successive years were characterised by a slow fall in the emissions until 2002, which was accompanied by programmes and measures to improve energy efficiency. After 2002, there was a slight increase in the emissions, to last until 2007. From 2008 the emissions stabilised, except for their marked fall in 2009 which was caused by a global economic slowdown (Table 3.1.).

Table 3.1. The emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) in 1988-2011 expressed as CO_2 equivalent

GHG	1988*	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]
CO_2 (with LULUCF)	461 277.49	437 704.75	353 746.11	350 479.75	350 467.76	350 058.44	348 211.13	350 447.29	362 655.03	353 757.57	325 835.63	315 323.80
CO_2 (without LULUCF)	469 073.95	449 431.81	372 288.35	370 479.67	361 097.07	361 410.39	357 130.66	358 302.29	371 682.59	362 466.34	335 326.82	326 065.72
CH_4 (with LULUCF)	55 062.55	54 417.43	49 362.87	47 862.47	45 801.77	45 365.80	45 657.31	45 613.49	45 685.96	46 011.73	44 661.45	44 528.69
CH_4 (without LULUCF)	52 872.47	52 222.97	47 166.41	45 686.82	43 418.00	43 156.35	43 445.64	43 410.47	43 445.54	43 805.65	42 469.64	42 314.05
N_2O (with LULUCF)	40 088.78	42 102.69	37 453.55	30 967.64	28 805.22	28 981.07	29 351.55	30 390.65	30 089.71	30 292.72	30 314.33	29 386.34
N_2O (without LULUCF)	40 071.30	42 085.69	37 437.00	30 956.80	28 748.17	28 965.36	29 335.75	30 378.30	30 070.45	30 281.46	30 306.87	29 368.29
HFCs	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	189.90	292.49	415.91	505.30	724.26
PFCs	127.55	127.77	122.88	122.40	116.61	125.47	132.33	148.96	139.45	149.56	150.87	145.27
SF_6	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	13.91	30.53	24.95	24.02	25.09	24.64
TOTAL (with LULUCF)	**556 556.37**	**534 352.64**	**440 685.41**	**429 432.26**	**425 191.36**	**424 530.79**	**423 366.23**	**426 820.82**	**438 887.58**	**430 651.51**	**401 492.67**	**390 133.00**
TOTAL (without LULUCF)	**562 145.27**	**543 868.23**	**457 014.65**	**447 245.69**	**433 379.85**	**433 657.57**	**430 058.30**	**432 460.44**	**445 655.46**	**437 142.93**	**408 784.60**	**398 642.23**

GHG	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]	CO_2 eq. [Gg]
CO_2 (with LULUCF)	305 018.53	298 552.68	286 198.95	297 553.04	297 590.37	294 146.08	304 269.83	308 549.37	300 308.23	284 431.97	305 309.21	306 138.93
CO_2 (without LULUCF)	315 539.64	312 083.43	300 519.43	312 481.07	316 204.78	318 019.54	331 550.47	332 612.82	326 847.15	311 773.19	332 573.75	330 309.43
CH_4 (with LULUCF)	41 567.84	40 927.07	39 900.64	40 344.32	40 092.68	40 547.64	40 953.95	40 243.46	39 355.20	38 189.86	38 682.41	37 787.07
CH_4 (without LULUCF)	39 361.03	38 742.34	37 701.27	38 056.54	37 885.74	38 325.61	38 723.15	38 023.22	37 127.90	35 959.16	36 448.45	35 537.91
N_2O (with LULUCF)	29 193.09	29 337.84	28 407.77	28 590.99	28 897.62	29 287.76	30 497.23	31 402.22	30 960.80	27 313.07	26 868.99	27 249.62
N_2O (without LULUCF)	29 176.30	29 328.65	28 392.43	28 558.89	28 883.07	29 271.96	30 483.24	31 392.31	30 950.55	27 302.49	26 860.62	27 240.63
HFCs	1 127.78	1 717.39	2 221.21	2 723.42	3 482.23	4 424.87	5 053.80	5 641.57	5 114.06	5 453.34	5 694.34	6 210.80
PFCs	151.88	168.74	177.61	172.31	175.86	160.65	166.08	158.41	139.85	59.24	56.13	49.88
SF_6	24.18	23.96	24.41	21.72	23.44	28.09	34.80	32.66	34.46	39.42	37.07	40.90
TOTAL (with LULUCF)	**377 083.30**	**370 727.68**	**356 930.59**	**369 405.80**	**370 262.20**	**368 595.09**	**380 975.69**	**386 027.69**	**375 912.60**	**355 486.89**	**376 648.14**	**377 477.20**
TOTAL (without LULUCF)	**385 380.81**	**382 064.51**	**369 036.35**	**382 013.94**	**386 655.12**	**390 230.71**	**406 011.53**	**407 860.99**	**400 213.95**	**380 586.83**	**401 670.35**	**399 389.55**

* The emissions for 1988 estimated along with the whole series until 2011 in order to ensure consistency of the data and the methodology applied. These emissions are different from those approved for the purposes of accounting for the national reduction target under the Kyoto Protocol.
Source: KOBiZE, Institute of Environmental Protection-National Research Institute.

The detailed results of the inventory of greenhouse gas emissions and removals for 1988–2011 by the IPCC sectors are presented in Annex 2.

Carbon dioxide

In 2011, the basic source of the carbon dioxide emissions in was Fuel Combustion in Sector 1. Energy, accounting for 92.2% of the emissions, including: Energy Industries (1.A.1.) – 52.6%, Manufacturing Industries and Construction (1.A.2.) – 9.4%, Transport (1.A.3.) – 14.5%, Other Sectors (1.A.4.) – 15.7%. Industrial Processes, i.e. Sector 2, were responsible for 6.4% of the CO_2 emissions (Fig. 3.1). The balance of the CO_2 emissions and removals in Sector 5 in 2011 was estimated at about 24.2 million tonnes. This means that about 7.3% of the total CO_2 emissions were absorbed by forests.

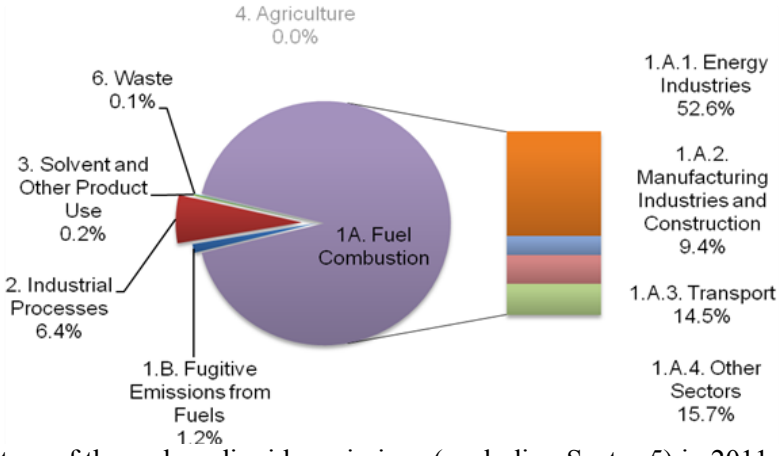

Fig. 3.1. The structure of the carbon dioxide emissions (excluding Sector 5) in 2011, by the IPCC categories. Source: KOBiZE, IOS-PIB

In 1988–2011, the CO_2 emissions (excluding Sector 5) fell by about 29.6% compared with the base year. The greatest decrease, exceeding 20%, occurred in 1988–1990. In 1988–2011, there were the following changes in the structure of fuel consumption:

- the share of solid fuels fell from 82.1% in 1988 to 55.4% in 2011,
- the share of liquid fuels grew from 11.1% (1988) to 23.9% (2011),
- the share of gaseous fuels grew from 6.0% (1988) to 11.8% (2011).

Methane

In 2011, the share of methane in the total national GHG emissions was 8.9%. Three categories were the main sources of methane emissions: *Fugitive Emissions from Fuels* (1.B.), *Agriculture* (4.) and *Waste* (6.). Their shares in the national methane emissions in 2011 were, respectively, 32.9%, 34.1% and 23.6% (Fig. 3.2). The emissions in the first of the categories listed above consisted of the emissions from *Underground Mining* (1.B.1) (about 20.2% of the total CH_4 emissions) and the emissions from *Oil and Natural Gas* (1.B.2) (as a total, about 12.7% of the emissions). The emissions from the Sub-Category *Enteric Fermentation* (4.A*)* were the dominating source of emissions in the Category *Agriculture*, with a share of about 26.1% in the methane emissions in 2011. The emissions from *Waste-water Handling* (6.B) amounted to 3.1% of the national emissions, while those from *Solid Waste Disposal on Land* (6.A) represented about 20.5% of the national methane emissions.

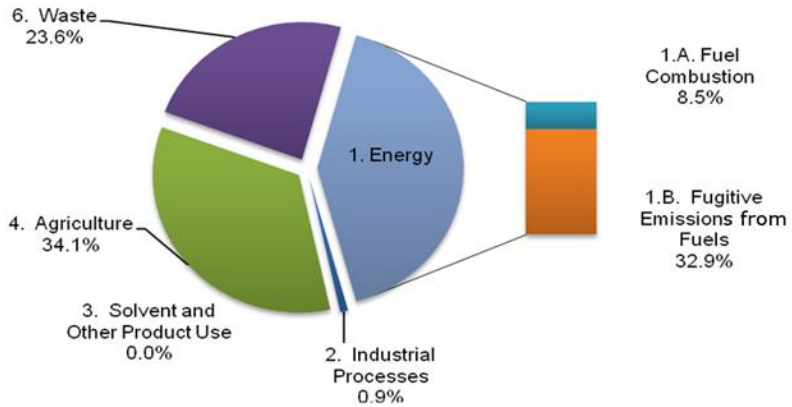

Fig. 3.2. The structure of methane emissions (excluding Sector 5) in 2011, by the IPCC categories. Source: KOBiZE,IOS-PIB

In 2011, methane emissions (excluding Sector 5) fell by about 33.8% compared with the base year. The emissions were reduced primarily because of the fall in emissions from *Enteric Fermentation* by 40.9% which was caused by a substantial decrease in the number of livestock (Sector 4. Agriculture) and a fall in *Fugitive Emissions* (1.B.) by 48.6%, ensuing from the restructuring of the mining sector and the reduction of coal extraction (Sector 1. Energy). An increase in methane emissions from *Waste* (Sector 6) by 26.2% was caused by a change in methodology, since the waste outside of the waste management system (illegal dumps etc.) was taken into account.

Nitrous oxide

The share of nitrous oxide emissions was 6.8% of the total GHG emissions in 2011. The shares of the main sources of N_2O emissions in 2011 amounted to: 65.0% from *Agricultural Soils* (4.D.), 18.8% from *Manure Management* (4.B.), 3.9% from the *Chemical Industry* (2.B) and 7.7% from *Fuel Combustion* (1.A) – (Fig. 3.3).

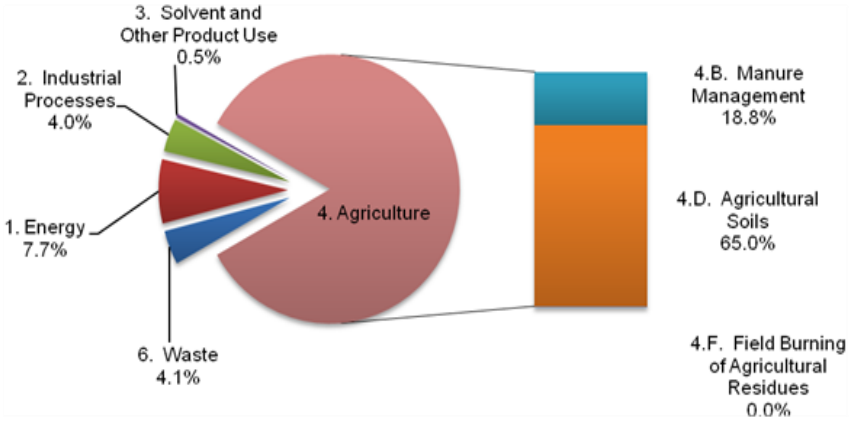

Fig. 3.3. The structure of nitrous oxide emissions (excluding Sector 5) in 2011, by the IPCC categories. Source: KOBiZE, IOS-PIB

The N_2O emissions (excluding Sector 5) in 2011 were lower by about 32.5% than in the base year. The share of the Sub-Category *Manure Management* (4.B) in the total emissions fell from 23.1% in 1988 to 18.8% in 2011, that of the Sub-Category *Agricultural Soils* (4.D) grew from 55.5% (1988) to 65.0% (2011), while that of the Sub-Category *Chemical Industry* (2.B) decreased from 12.4% in 1988 to 3.9% in 2011.

Industrial gases

In 2011, the emissions of HFCs were 235 times higher than in 1995. Such a significant increase in emissions in this group of gases was caused by higher emissions from the use of refrigeration and air-conditioning equipment. The emissions of PFCs in 2011 were lower by 80.1% than in the base year (1995). Changes in emissions depend on the level of aluminium production (the main source of PFCs) and the use of C_4F_{10} in extinguishers. In 2011, SF_6 emissions were higher by 72.1% than in 1995. The main source of SF_6 emissions was leakage from electrical equipment in the course of its use and production. Such a substantial growth of the emissions of industrial gases relative to the base year did not have a significant effect on the national emissions trend since the total share of these gases in the national emissions was about 1.6% in 2011.

3.3. The evaluation of the uncertainty of data on greenhouse gas emissions

The estimated GHG emissions were evaluated in accordance with the *Good Practice Guidance* (IPCC 2000) in effect, at Tier 1. After the input data were analysed and the error propagation was simulated for 2011, the following uncertainties were determined for the total emissions:

CO_2 – 3.1%	CH_4 –22.2%	N_2O – 48.8%
HFCs – 48.7%	PFCs – 78.6%	SF_6 – 90.0%

The analysis of the results obtained shows that they coincide with those found in other countries where the uncertainties of CO_2 emissions vary between 0.2 and 10%, those of CH_4 emissions between 5 and 50% and those of N_2O emissions between 5 and 300%.

The relatively low uncertainty for the total CO_2 emissions (3.1%) is caused by the fact that a substantial part of CO_2 emissions comes from Sector 1.A characterised by relatively high accuracy of activity data (2–5%) and CO_2 emission factors (1–5%). The higher uncertainty for the total CH_4 emissions (22.2%) is determined by the fact that that a substantial part of the emissions of this pollutant comes from the *Agriculture* Sector, 4.A and 4B, characterised by relatively high uncertainty of emission factors (about 50%). There was large uncertainty of data on the total emissions in Poland, just as in other countries, in the case of N_2O (48.8%). This is caused by the large uncertainty of the factor in the dominant categories, e.g. *Manure Management* in Agriculture, 4.B.11 and 4.B.12 (150%).

The high uncertainties of emission factors are caused e.g. by uncertainties of measurements and analyses on the basis of which they have been determined or the poor knowledge of the process which generate emissions. The uncertainty of activities often ensues from the absence of relevant analyses and the method chosen for statistical processing in the public statistics. The uncertainty of inventory data can be diminished by commissioning detailed studies on emission factors; first, choosing the factors with the highest uncertainties attributed to the key sources.

3.4. The key sources of greenhouse gas emissions

The evaluation of the greenhouse gas emission levels, excluding Sector 5, classified 17 sources as the key ones in 2011. The most important sources include:

- Stationary Combustion – Solid Fuels,
- Road Transport
- Stationary Combustion – Gaseous Fuels.

The greenhouse gas emissions from these sources represented 70.5% of the total national emissions, expressed as CO_2 equivalent. The CO_2 emissions from the stationary combustion of solid, liquid and gas fuels represented 63.2% of the total national emissions, while those from solid fuel combustion accounted for 52.5% of the total national emissions (Table 3.2).

Table 3.2. The assessment of the greenhouse gas emission levels excluding Sector 5 in 2011

		IPCC Source Categories	Direct GHG	Emission in 2011	Level Assessment	Cumulative Total
1	1.A.1, 2, 4	Stationary Combustion - Solid Fuels	CO_2	209 678.76	0.5250	0.52
2	1.A.3.b	Transport Road Transportation	CO_2	47 001.15	0.1177	0.64
3	1.A.1, 2, 4	Stationary Combustion - Gaseous Fuels	CO_2	24 722.14	0.0619	0.70
4	1.A.1, 2, 4	Stationary Combustion - Liquid Fuels	CO_2	17 997.79	0.0451	0.75
5	4.D.1	Direct Soil Emissions	N_2O	12 480.23	0.0312	0.78
6	4.A	Enteric Fermentation	CH_4	9 286.65	0.0233	0.80
7	2.A.1	Cement Production	CO_2	7 379.39	0.0185	0.82
8	6.A	Solid Waste Disposal on Land	CH_4	7 290.34	0.0183	0.84
9	1.B.1.a	Coal Mining and Handling	CH_4	6 991.31	0.0175	0.86
10	2.F.1	Refrigeration and Air Conditioning Equipment	HFC	6 044.53	0.0151	0.87
11	2.C.1	Iron and Steel Production	CO_2	5 465.93	0.0137	0.89
12	4.B	Manure Management	N_2O	5 108.51	0.0128	0.90
13	4.D.3	Indirect Soil Emissions	N_2O	4 757.65	0.0119	0.91
14	1.B.2.b	Natural Gas	CH_4	4 444.00	0.0111	0.92
15	1.A.1, 2, 4	Stationary Combustion - Other Fuels	CO_2	4 181.79	0.0105	0.93
16	2.B.1	Ammonia Production	CO_2	3 968.43	0.0099	0.94
17	4.B	Manure Management	CH_4	2 809.12	0.0070	0.95

Source: KOBiZE, IOS-PIB

3.5. The National Greenhouse Gas Inventory System

The National Centre for Emissions Management (KOBiZE) at the Institute of Environmental Protection-National Research Institute is the unit responsible for preparing the greenhouse gas inventory. The Centre was established pursuant to the *Act of 17July 2009 on the System to Manage the Emissions of Greenhouse Gases and Other Substances (Official Journal of the Laws 2013, Item 1107, as amended)* at the Institute of Environmental Protection – National Research Institute in Warsaw.

The *Act on the System to Manage the Emissions of Greenhouse Gases and Other Substances* has created the legal basis for managing the national cap of the emissions of greenhouse gases and other substances in a manner which will ensure that the Republic of Poland can fulfil its international and Community commitments and will enable the cost optimisation of pollutant reductions. The scope of tasks covered by the Act includes e.g.:

- carrying out tasks relating to the functioning of the National System for Emissions Management, including the keeping of the National Database on the Emissions of Greenhouse Gases and Other Substances,
- developing the methodology for determining the emission levels for particular types of installations or activities and the methodology for determining emission factors,
- drawing up reports and forecasts of the emission levels of air pollutants,
- keeping the National Registry of the Kyoto Units,
- keeping the list of the Joint Implementation projects carried out in the territory of the Republic of Poland for which the Letters of Endorsement or the Letters of Approval have been issued,
- administering the greenhouse gas emission allowance trading scheme (ETS).

Pursuant to Article 11 of the abovementioned Act, 30 days prior to the deadlines under the provisions of the European Union law or international environmental agreements the National Centre prepares and forwards to the Minister responsible for the environment annual inventories of greenhouse gases, prepared in accordance with the guidelines under the Climate Convention, and substances laid down in the Convention on Long-Range Transboundary Air Pollution (UNECE CLRTAP). The tasks of the National Centre also include the preparation of information sets, including those on emissions, for the purposes of the public statistics (Article 3(3)(3)).

The work on greenhouse gas emission inventories, including emission calculations, the selection and development of methodologies, the choice of activities and emission factors, is done by the Emission Balancing and Reporting Unit (ZBIRE) set up in the National Centre for Emissions Management. In preparing inventories, the Centre cooperates with individual experts and institutions, including e.g.: the Central Statistical Office (GUS), the Energy Market Agency (ARE SA), the Institute for Ecology of Industrial Areas (IETU), the Motor Transport Institute (ITS) and the Office for Forest Planning and Management (BULiGL). The abovementioned institutions are involved primarily in providing activity data. KOBiZE experts have access to data submitted by the enterprises participating in the Community Emissions Trading Scheme (EU ETS). These verified data are used in certain sectors in greenhouse gas inventories (e.g. in the sub-sectors of Industrial Processes).

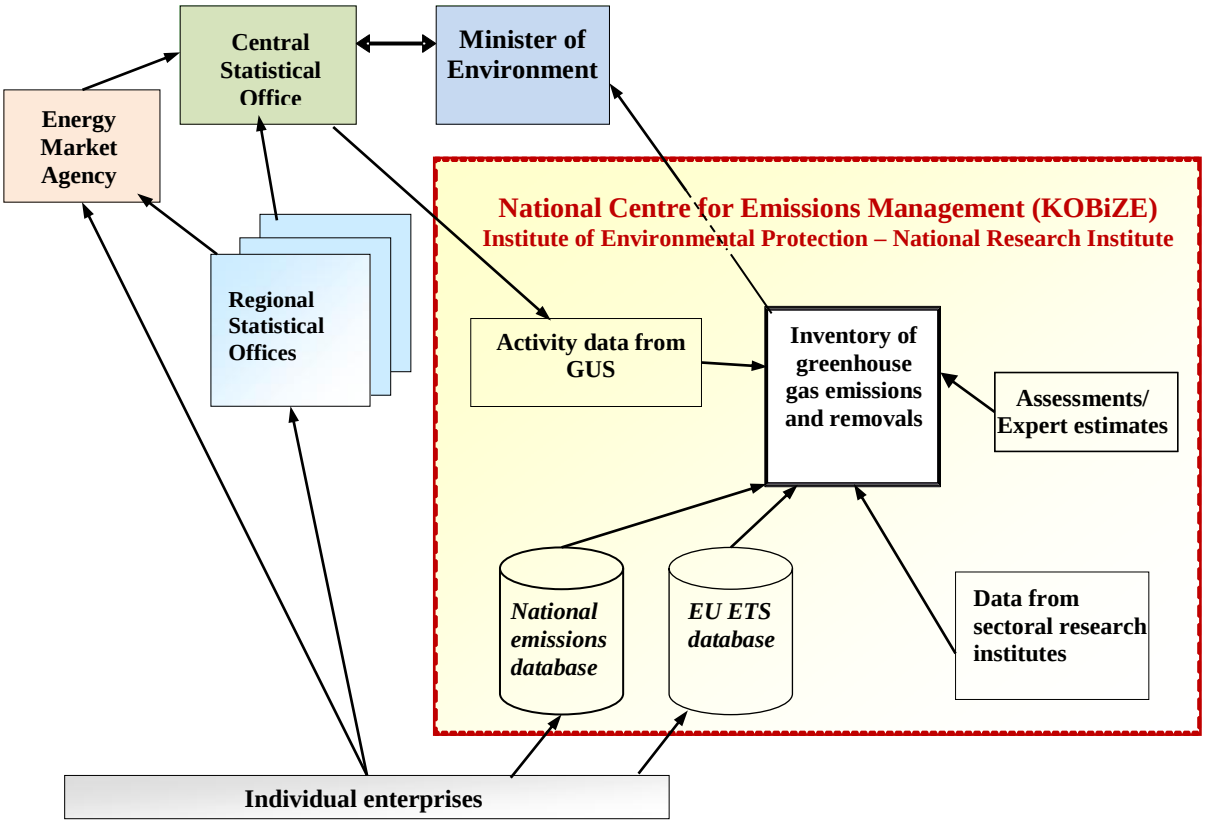

Fig. 3.4. A schematic flow chart of the national system for preparing greenhouse gas inventories.
Source: KOBiZE, IOS-PIB

The Minister responsible for the environment exercises supervision over the execution of the tasks carried out by KOBiZE (Fig. 3.4). Before its official submission the national inventory undergoes an internal approval process. The Minister of the Environment is the entity responsible for approving the results of the inventory.

3.6. The national registry

The Polish registry was set in operation in July 2006 and since 2008 it has been connected to the Independent Transaction Log (ITL). Its function is to account for the commitments under the Kyoto Protocol. Pursuant to national regulations, the registry is administered by the National Centre for Emissions Management, operating within the Institute of Environmental Protection – National Research Institute in Warsaw. The database of the registry stores information on the entities participating in the scheme, installations, verified emissions, national holding accounts, operator holding accounts and person holding accounts.

At present, the Polish registry of units is managed together with those of the other Member States of the European Union. The amended regulations of the European Union, in particular the EU ETS Directive 2009/29/EC, which was adopted in 2009, provides for centralisation of the EU Emissions Trading Scheme (EU ETS) in one European Union registry and also for inclusion of the aviation sector in the trading scheme from the beginning of 2012.At the same time, in order to improve the operational efficiency of national registry, 25 Member States of the European Union (which are also Parties to the Kyoto Protocol), as well as Iceland, Liechtenstein and Norway, decided to integrate their national registries into one consolidated registry, in accordance with the decisions to establish national registries, in particular Decision 13/CMP.1 and Decision _/CP.8. In consequence, the national registries of the Member States of the European Union were consolidated in June 2012. As a result of the consolidation, both the location of the Polish registry, the software used until then and all the technical procedures followed previously were changed. The European Commission is the supplier and technical operator of the common registry in the scope of software and infrastructure. The registry is connected by a communication link with the International Transaction Log (ITL) administered by the Secretariat of the United Nations Framework Convention on Climate Change and the European Union Transaction Log (EUTL) which plays the role of an additional transaction log.

Both the participants in the emissions trading scheme and the administrator access the registry through a secured website:
https://ets-registry.webgate.ec.europa.eu/euregistry/PL/index.xhtml.

The consolidated registry was established under the following assumptions:

1. In the countries (including Poland), the organisations which play the roles of the administrators of the national registries still continue to operate and they remain responsible for the fulfilment of all the commitments of the Parties implemented through the common registry.

2. Each Kyoto unit issued in the Polish part of the Union Registry has a unique serial number including the identifier of origin of the Party.
3. Within the Union Registry, Poland as a Party has its national accounts. Each of these accounts has been assigned a unique number, consisting of the identifier of the Party ("PL") and a unique number in this part of the Union Register.
4. Transactions involving the use of Kyoto units are transferred and checked by the Independent Transaction Log (ITL), which continues to be responsible for verification of the correctness and validity of these transactions.
5. The data in the individual parts of the new registry and the Independent Transaction Log continue to be compared so as to ensure the consistency of the data and to enable automatic checks of the ITL.
6. All the parts of the Union Registry are situated on a consolidated IT platform, sharing the same infrastructure technology. However, the selected architecture of the system ensures the security, separateness and the possibility of unambiguously identifying a given part of the registry. This is implemented on the basis of the following guidelines:
   - In relation to an exchange of data, each part of the Union Registry administered by a given Party to the Kyoto Protocol has a direct, separate and secure communication link through a unified communications channel (a VPN tunnel).
   - The ITL remains responsible for the authentication of the national registries, finally registers all the transactions involving the use of Kyoto units and also verifies other administration processes in such a manner that the completed operations cannot be questioned and rejected.
   - In relation to data storage, the consolidated platform guarantees that the data stored on it are confidential and protected against unauthorised access.
   - The data storage architecture also ensures that the data referring to the Polish part of the Union Registry are distinguishable and unambiguously identifiable with relation to the data related to the other parts of the consolidated registry.
   - Moreover, each of the parts of the Union Registry has a separate URL and different principles of authorisation and configuration.

After the platform of the Union Registry – the Consolidated System of European Union Registries (CSEUR) – had been successfully set in operation, 28 national registries were accredited (certified under the UNFCCC). The process of the certification of the consolidated registry included the testing of connections, the testing of the reliability of connections, the testing of separateness and the testing of interoperability, designed to demonstrate its conformity to the data exchange standard (DES). All the tests were carried out with positive results, leading to the completion of the certification process on 1 June 2012.

For the purposes of the new registry system, a technical support team (EU ETS Service Desk) was established with the task of ensuring technical assistance to the administrators of the individual Member States in relation to the functioning of the Union Registry. It is a second tier of support with respect to the local teams established in the Member States. The EU ETS

Service Desk also plays a key role in communications with the ITL Service Desk, particularly as regards the problems with connection or the execution of daily comparisons of databases.

As regards publically available information, the National Centre for Emissions Management provides the required information (in accordance with Part of Annex I to Decision 13/CMP.1) via the link http://www.kobize.pl/rejestr-uprawnien/raporty-publiczne.html. The website is fully controlled by the Polish administrator.
The following data have been placed on the website and are updated once a month:
- information on accounts (in accordance with paragraph 45 in Part E of the Annex to Decision 13/CMP.1),
- information on the projects defined in Article 6 (in accordance with paragraph 46 in Part E of the Annex to Decision 13/CMP.1),
- information on units and their transfers (in accordance with paragraph 47 in Part E of the Annex to Decision 13/CMP.1) – prepared on the basis of a SEF report,
- a list of entities authorised by a given country (in accordance with paragraph 48 in Part E of the Annex to Decision 13/CMP.1).

It should be noted that some of the data required in accordance with the abovementioned Decision were not disclosed (e.g. the holdings of individual accounts, the personal data of the representatives of accounts etc.) in view of the national security requirements, pursuant to Article 110 of Commission Regulation (EU) No 389/2013 of 2 May 2013 establishing a Union registry pursuant to Directive 2003/87/EC of the European Parliament and of the Council, Decisions No 280/2004/EC and No 406/2009/EC of the European Parliament and of the Council and repealing Commission Regulations (EU) No 920/2010 and No 1193/2011 (OJ L 122 of 03.05.2013, p.1).

The current information and changes in the national registry are presented annually in the National Inventory Report (NIR) submitted to the UNFCCC Secretariat before 15 April.

CHAPTER 4. POLICIES AND MEASURES

4.1. The national reduction target

Poland will achieve the national reduction target under Annex B to the Kyoto Protocol (6% in 2008–2012 relative to the base year, which is 1988 for Poland).

The base year 1988 applies to the emissions of the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), whereas 1995 is the base year for the industrial gases of the group of F-gases[38], i.e. hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

In 1988–2011, there was a significant reduction in the greenhouse gas emissions (excluding Sector 5. Land Use, Land Use Change and Forestry), which were lower by almost 29% relative to the base year (Fig. 4.1). The change in emissions was achieved due to the implementation of a whole set of measures, designed primarily to improve energy efficiency and to change the structure of the use of fuels and energy.

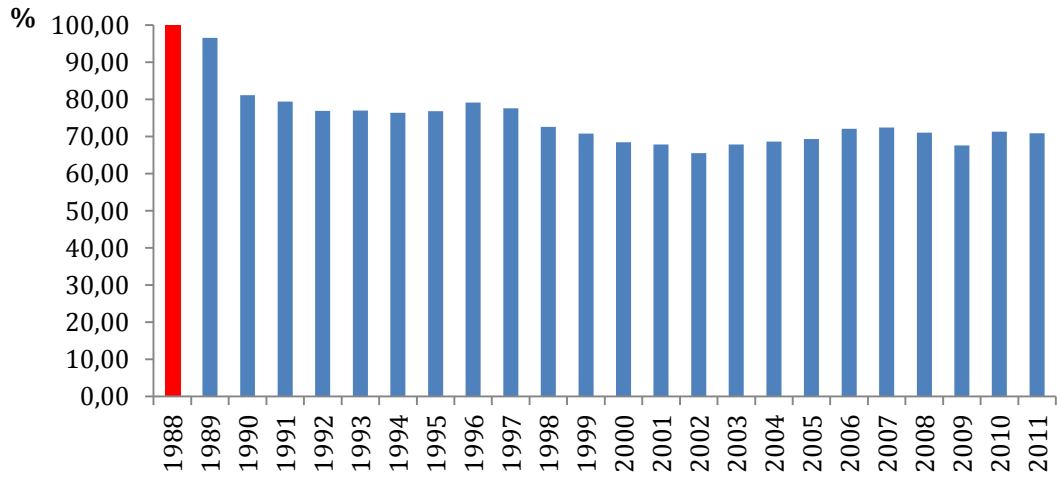

Fig. 4.1. Changes in greenhouse gas emissions in Poland relative to the base year 1988.
Source: KOBiZE, Institute of Environmental Protection (IOŚ)-NRI

4.2. The political framework for the process

In recent years, the Government launched many initiatives to ensure strategic programming in Poland and to create a comprehensive system for managing its development. The foundations were developed for a new system of strategic documents laying down a vision and directions

38 Fluorinated greenhouse gases (HFCs, PFCs and SF_6) are chemical substances which contain fluorine in their particles and are characterised by a high or very high global warming potential (GWP), which is from 140 to almost 23,000 times stronger than GWP of CO_2, and their production and consumption in the world (including the EU and Poland) grow very quickly. They are the only greenhouse gases covered by the Kyoto Protocol that do not occur naturally, but are created by man and used e.g. as refrigerants in refrigeration and air-conditioning, foaming agents for the production of foams and products containing foams, extinguishing agents in fire protection, solvents for cleaning metal parts and elements of electronic systems, an insulating gas in high-voltage switchboards (SF_6 only) and propellants for the production of aerosols.

of the development of the country both in a long term until 2030 (the document ***The Long-term National Development Strategy for Poland 2030. The Third Wave of Modernity.***), and in the nearest decade (the document **The *National Development Strategy 2020*** and **9 integrated strategies**).

4.2.1. Poland's strategic documents

National development strategies

The main strategy for a stable development of the country in a medium term is **The *National Development Strategy 2020 – An Active Society, a Competitive Economy and an Efficient State*** adopted on 25 September 2012 by the Council of Ministers. This document sets out three strategic areas: *An Efficient and Effective State, A Competitive Economy* and *Social and Territorial Cohesion* where the major activities will be concentrated, and describes interventions in a medium term which are necessary to speed up the development processes. Thus, the main goal of the Strategy is *the strengthening and utilisation of the economic, social and institutional potential ensuring a faster and sustainable development of the country and an improvement in the quality of life of its population.*

The Strategy provides the basis for 9 integrated strategies which should contribute to the implementation of the objectives laid down in the Strategy, while the measures designed in them should expound and specify the reforms indicated in the Strategy.

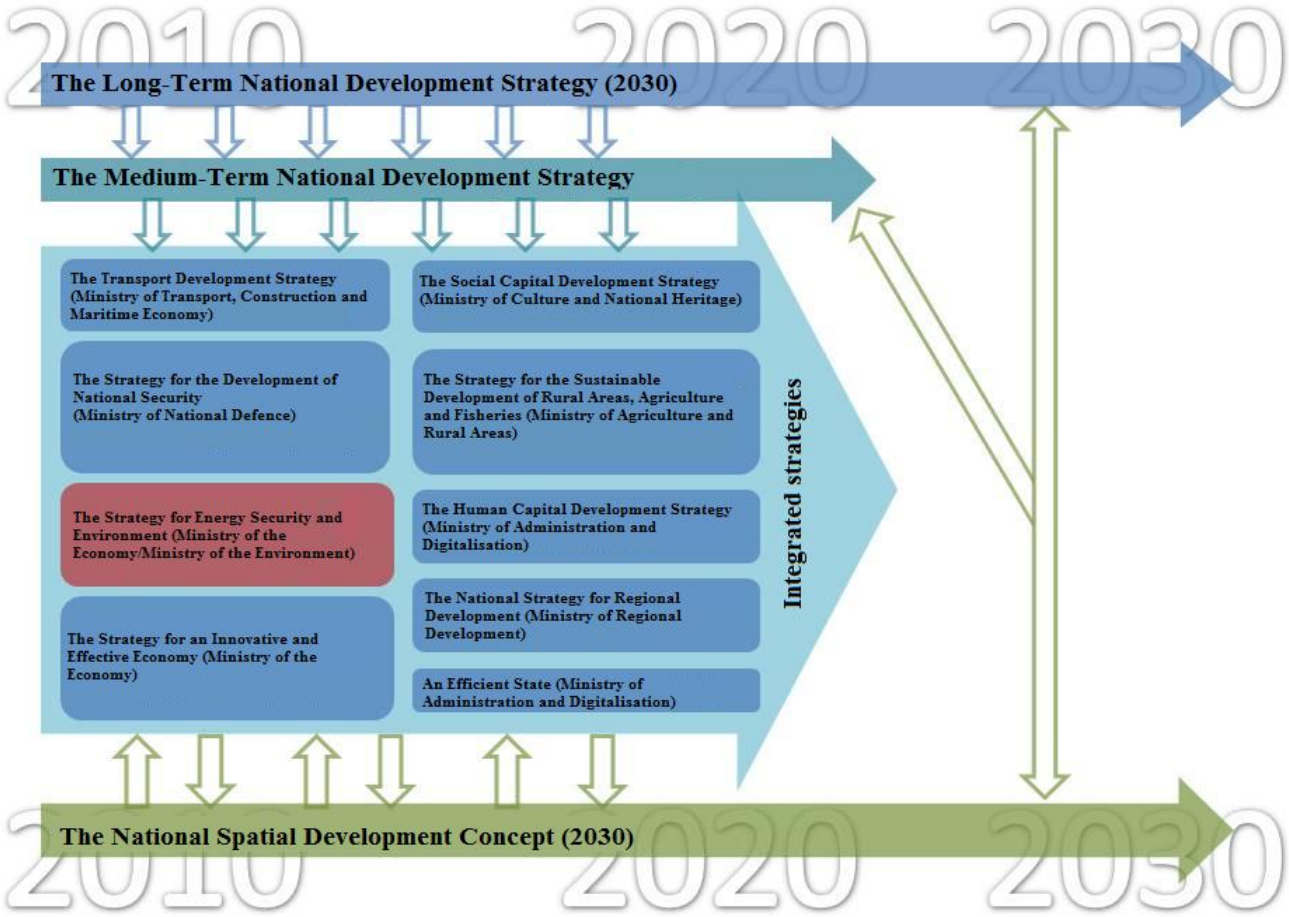

Fig. 4.2. A new system of national strategic documents.

The basic government document which formulates the national environmental policy is the project of **Strategy for Energy Security and Environment**, one of the nine integrated development strategies. It responds to the most important challenges that Poland will face in the timeframe until 2020 in the scope of the environment and the energy sector, which ensue from the objectives of the Europe 2020 strategy, and the challenges defined in the medium-term national development strategy. The main goal of the Strategy is to ensure a high quality of life of the present and future generations, taking into account the protection of the environment, and to create the conditions for the sustainable development of a modern energy sector which would be able to ensure the energy security for Poland and a competitive and energy efficient economy. The main goal thus formulated will be implemented through three detailed objectives and directions of interventions:

- sustainable management of environmental resources (including the resources of minerals, water, biodiversity and space);
- ensuring a secure and competitive energy supply for the national economy (*inter alia*, through an improvement in energy efficiency, modernisation of the energy sector, the development of competition on the fuel and energy market and ensuring the security of energy imports);
- an improvement in the state of the environment (including the protection of waters and the air, national waste management, the promotion of environmental technologies and environment-friendly behaviour).

The implementation of the abovementioned detailed objectives should make it easier for Poland to achieve "green" (environment-friendly) economic growth. Moreover, consideration given to the development of prosumer energy generation will be an important element of the development of power networks.

The Strategy sets out the priorities in the scope of environmental protection, primarily in such areas as:

- the limitation of air pollutants,
- a reform of the water management system.

In the area of the limitation of air pollutants, along with the simultaneous growth of the electricity and heat production, the emissions into the air of such pollutants as nitrogen and sulphur compounds, carbon oxide or carbon dioxide must be reduced. This task will be implemented e.g. through the modernisation of the energy and heating sector and the limitation of the so-called low emissions through the enhancement of the mechanisms for providing financial support for such investment projects. The Strategy also indicates the need to consider the issues of adaptation to the climate change already taking place.

In the area of the protection of water resources, the key objective is to ensure the necessary quantity and quality of water and flood protection. These tasks will be carried out, *inter alia*, through the construction of new wastewater treatment plants and the modernisation of existing ones, the preparation of flood hazard maps and flood risk management maps and the promotion of good agricultural practices.

The National Programme for the Development of a Low-Emission Economy (NPRGN), the assumptions for which were adopted by the Council of Ministers in August 2011, will be the executive programme for the 9 integrated strategies, in particular for the Strategy for Energy Security and Environment and the Strategy for an Innovative and Effective Economy.

The National Programme was developed in response to the need to reduce the emissions of greenhouse gases and other substances released into the air from all the sectors of the economy. The achievement of the reduction effect will entail the rational spending of financial resources. The core aim of the Programme is to ensure economic, social and environmental benefits (in accordance with the principle of sustainable development) from activities designed to reduce emissions, gained, *inter alia*, through higher innovativeness and the implementation of new technologies, lower energy intensity and job creation, and, in consequence, contributing to the enhancement of the competitiveness of the economy.

The assumptions for the National Programme defined its main goal as:

- the development of a low-emission economy, while ensuring the sustainable national development,

  as well as its detailed objectives:
  - the development of low-emission energy sources,
  - an improvement in energy efficiency,
  - an improvement in the management of raw and other materials,
  - the development and use of low-emission technologies,
  - waste prevention and an improvement in waste management,
  - the promotion of new consumption patterns,

setting out the areas where activities which would make an important contribution to the required reduction in the emission levels should be taken.

It is assumed that the final effect of the National Programme will be a set of activities designed to directly or indirectly reduce greenhouse gas emissions and also instruments which will help all the participants in the implementation of the Programme in the transition to a low-emission economy. The National Programme will be addressed to entrepreneurs in all the sectors of the economy, economic and territorial self-governments, organisations of the business environment and nongovernmental organisations. The Programme will also be directly addressed to all the inhabitants of the Republic of Poland, in order to shape their correct attitudes and to induce public activity in this scope. At the same time, at the Ministry of the Environment work is underway to support green technologies. It is planned that in 2014 the Polish platform for a low-emission economy and green technologies will be established, on the basis of which the environmental protection technologies available in the country will be identified.

The National Reform Programme for the Implementation of the Europe 2020 Strategy

The Europe 2020 Strategy adopted in 2010 is implemented by the National Reform Programmes (KPR). The initial Polish document was *The National Reform Programme for the Implementation of the Europe 2020 Strategy*, adopted by the Council of Ministers on 26 April 2011, which defined how Poland would fulfil in the timeframe until 2020 its commitments within the framework of the five main goals of the Europe 2020 Strategy; moreover, taking into account the specific national circumstances and directions of actions set out in the Polish strategic documents. In the National Reform Programme, the Polish Government decided that it was necessary to focus on three priority areas:

1. Infrastructure for sustainable growth;
2. Innovation for smart growth;
3. Actions for inclusive growth.

The 2013/2014 Update of the National Reform Programme takes into account the priorities set out in the *Annual Growth Survey for 2013* and confirmed in the Conclusions of the European Council of 14-15 March 2013 concerning fiscal consolidation, measures to reduce unemployment, particularly among young people, support for economic growth and competition on the single market and a reduction in regulatory burdens.

4.2.2. Major legal regulations and their instruments

The most important aim of the activities in the scope of air protection, including those designed to combat climate change, is to reduce pollutant emissions and to improve air quality. The basic Polish legal acts related to air protection, including climate protection, are given in Table 4.1.

Table 4.1. The basic Polish legal acts related to air protection, including climate protection.

Title of document	Description of document
The Act of 27 April 2001 on the Environmental Protection Law (Official Journal of the Laws of 2013, Item 1232).	The Act contains regulations concerning air protection which aim to ensure the best possible air quality.
The Act of 17 July 2009 on the System to Manage the Emissions of Greenhouse Gases and Other Substances (Official Journal of the Laws of 2013, Item 1107).	The Act sets out the tasks of the National Centre for Emissions Management, the principles of the functioning of the National System for Emissions Management, the principles of the management of the emissions of greenhouse gases and other substances, the principles of the functioning of the National Registry of Kyoto Units, the principles of trading in and managing Kyoto units, the principles of the functioning of the National Green Investment Scheme and the Climate Account, the conditions and principles of the implementation of Joint Implementation projects in the territory of the Republic of Poland, as well as the conditions and principles of the implementation of Joint Implementation and Clean Development Mechanism projects outside the territory of the Republic of Poland.
The Act of 20 July 1991 on the Inspectorate for Environmental Protection (Official Journal of the Laws of 2013, Items 686 and 888).	The Act establishes the state environmental monitoring system and sets out the rights and obligations of the state related to the control of the state of the environment and the enforcement of the provisions of environmental law concerning all the elements of the environment (including the air, nature, noise, electromagnetic fields and waste).
The Act of 3 October 2008 on the Provision of Information on the Environment and Its Protection, Public Participation and Environmental Impact Assessments (Official Journal of the Laws of 2013, Items 1235 and 1238).	The Act regulates the principles and procedures of the provision of information on the environment and its protection, the issues related to environmental impact assessments and the principles of public participation in environmental protection. Moreover, it establishes the authorities of the General Director for Environmental Protection and the Regional Directors for Environmental Protection, *inter alia*, for the purpose of improving the environmental management processes.
The Act of 28 April 2011 on the Greenhouse Gas Emission Allowance Trading Scheme (Official Journal of the Laws, No. 122, Item 695, and of 2013, Item 1238).	The Act repeals the previous provisions regulating the greenhouse gas emission allowance trading scheme and transposes the provisions of Directive 2003/87/EC, along with the amendments concerning e.g. aviation.

Source: Ministry of the Environment.

The air protection instruments resulting from the regulations discussed above include e.g.:

- the environmental quality standards, including air quality standards which must be met in a specific time for the environment as a whole or for the particular natural elements);
- the obligation to measure the contents of substances in the air (the air monitoring within the framework of the State Environmental Monitoring System (SEMS) encompasses surveys and assessments of air quality in terms of its pollutants, designed to observe phenomena of continental character, as well as research to observe phenomena of global character);
- the air quality assessment system;
- the air protection programmes to ensure that the limit and target levels of substances in the air are complied with;
- the emission standards for installations – the emission limit values;
- the obligation to measure pollutant emissions;
- the permits for the use of the environment;
- the environmental management systems – voluntary commitments of organisations (production and service companies, establishments of the sectors of finance, school education and health, public administration units etc.) to take measures to systematically reduce the impact of their operations on the environment;
- the charges for the release of gases and dust into the air (the proceeds from the charges are the revenues from the National Fund for Environmental Protection and Water Management and the Voivodeship Funds for Environmental Protection and Water Management, as well as the revenues of the budgets of counties and communes);
- administrative pecuniary penalties (to be paid for exceedances in terms of the quantity or type of substances laid down in the permit as their levels allowed to be released into the air);
- the carbon oxide emission allowances;
- environmental information.

4.2.3.Authorities and institutions involved in the implementation of climate policy

In Poland, the Minister of the Environment is responsible for the implementation of the tasks ensuing from the United Nations Framework Convention on Climate Change, adopted in New York on 9 May 1992 (Official Journal of the Laws of 1996, No. 53, Item 238) and the Kyoto Protocol to the United Nations Framework Convention on Climate Change adopted in Kyoto on 11 December 1997 (Official Journal of the Laws of 2005, No. 203, Item 1684), hereinafter referred to as the Kyoto Protocol. The Minister of the Environment approves the programme of the State Environmental Monitoring System, which is coordinated – pursuant to the Act on the Inspectorate for Environmental Protection – by the Chief Inspector for Environmental Protection.

The Minister of the Environment engages the research and development institutes which are subordinated to him in the implementation of Poland's tasks under the Climate Convention and the Kyoto Protocol. They include primarily:

- the Institute of Environmental Protection – National Research Institute (IOŚ-PIB); its structure includes the Climate Protection Laboratory and the National Centre for Emissions

Management which plays the role of the national coordinator for the Community GHG emission allowance trading scheme and prepares reports on the pollutant emissions into the atmosphere;
- the Forest Research Institute (IBL) – which carries out research on the issues related to carbon dioxide removals in the scope of land use, land use change and forestry (LULUCF);
- the Institute of Meteorology and Waster Management – National Research Institute (IMGW-PIB) – which carries out systematic climate change observations; its structure includes the National Focal Point for the Intergovernmental Panel on Climate Change.

At the national level, in addition to the Minister of the Environment, the following Ministers, who are responsible for the introduction of the sustainable development strategy, environmental policy and the national climate policy into sectoral policies, are competent in the scope of the Climate Convention. They include primarily:
- the Minister of the Economy, who is responsible for energy policy and industry, as well as for international economic cooperation,
- the Minister of Agriculture and Rural Areas, who is responsible for the implementation of the government policy in the field of agriculture and rural areas,
- the Minister of Infrastructure and Development, who is responsible for the transport and construction sectors and for the coordination and management of the resources from the European Union Funds.

The Central Statistical Office (GUS) is another authority which is important for the implementation of the tasks ensuing from the Climate Convention and the Kyoto Protocol. The Office carries out surveys and makes their results available within the framework of public statistics. The statistical data include aggregated data on the emissions of greenhouse gases and other air pollutants, statistical data on energy, production and fuel consumption, many other statistical data related to the Climate Convention and the data concerning the production, imports and exports of substances that deplete the ozone layer.

As independent entities, the National Fund for Environmental Protection and Water Management, together with the Voivodeship Funds, constitute the system for financing environmental protection in Poland. The National Fund is a source of funding for environmental projects at the higher than regional level, including the measures to reduce emissions.

4.3. Monitoring of the emissions and the implementation of the provisions of the Kyoto Protocol

Greenhouse gas emissions are monitored on an ongoing basis and the results are presented in the national inventory reports. The implementation of the provisions of the Kyoto Protocol is subjected to periodical analyses and presented in the national communications to the Conference of the Parties to the Climate Convention.

Both the emission levels of the substances covered by the Community emission allowance trading scheme and the emissions from Joint Implementation or GIS projects are strictly monitored.

The management of the National Database on the Emissions of Greenhouse Gases and Other Substances is one of the tasks entrusted by statute to the Institute of Environmental Protection

– National Research Institute, which carries out the functions of the National Centre for Emissions Management (KOBiZE). The users of the environment are obliged to prepare their reports for the previous calendar year and upload them into the database of the Centre. The report contains detailed information on the levels of the emissions of greenhouse gases and other substances into the air and on the parameters related to the generation of the emissions. For the first time the obligation to prepare the report applied to 2010. At present, the National Database collects the data concerning 2010, 2011 and 2012. By the end of February 2013, 21,000 plants had been registered in the database.

The data collected in the National Database are used to identify the emissions for certain activities and processes, *inter alia*, for the purposes of reporting to the Convention on Long-range Transboundary Air Pollution, Directive 2001/81/EC, the United Nations Framework Convention on Climate Change, Decision 280/2004/EC and the ETS scheme.

A comprehensive monitoring of the implementation of policies and measures leading to greenhouse gas emission reductions is not carried out in Poland. The monitoring only covers those measures that have been financed with public resources or the European Union funds.

4.4. Financial mechanisms supporting the measures to reduce greenhouse gas emissions

The basic institutional and financial mechanism supporting the implementation of climate policy, particularly in improving energy efficiency, the development of renewable energy sources and the modernisation of energy generation processes, is the system for funding measures for the environment, based on the resources from the National Fund for Environmental Protection and Water Management, the Voivodeship Funds and the European funds.

Depending on the programme, the financial support from the National Fund is given in the form of a subsidy to a credit or a grant e.g. for physical persons, housing communities or enterprises (Table 4.2).

Table 4.2. Programmes carried out by the National Fund for Environmental Protection and Water Management.

Aim	Programme	Financing	Beneficiaries
Solar collectors used to heat water	Subsidies for partial repayments of the principal of bank credits taken to purchase and assemble solar collectors	A subsidy of up to 45% of the credit principal	Natural persons, housing communities
The performance of energy audits	Energy efficiency Co-financing of energy and electricity audits at enterprises (a competition)	A grant of up to 70% of eligible costs	Entrepreneurs

Aim	Programme	Financing	Beneficiaries
An improvement in energy efficiency at newly built buildings (subsidies to credits for the construction of energy-saving houses)	Energy efficiency Subsidies to credits for the construction of energy-saving houses	A grant for the partial repayment of the principal of a bank credit	Natural persons
Thermal modernisation of public utility buildings	The Green Investment Scheme GIS Energy management in public utility buildings (the 6th competition)	A grant of up to 30% of eligible costs A loan of up to 60% of eligible costs	Public utility entities listed in the programme
Avoiding CO_2 emissions in connection with the design and construction of energy-saving public utility buildings	Energy efficiency LEMUR Energy-saving public utility buildings	A grant A loan	Self-governments, state budget-supported units, universities/research institutes, non-governmental organisations Other entities
Thermal modernisation of buildings, the replacement of ventilation and air-conditioning systems, the use of RES, the replacement of the internal lighting system Part A	The Green Investment Scheme GIS Energy management in the buildings of selected entities of the public finance sector	A grant of up to 100% of eligible costs	The Polish Academy of Sciences and research institutes, state cultural institutions, public sector enterprises, town and county fire service headquarters
Thermal modernisation of public utility buildings, along with the replacement of built-in lighting systems and the use of RES	PL04.Energy saving and promotion of renewable energy sources	A grant from 170,000 to 3 million EUR	Entities of the public finance sector, non-public entities (which implement public tasks)

Source: http://www.nfosigw.gov.pl/oze-i-efektywnosc-energetyczna/

Moreover, the Cohesion Policy resources were used to co-finance measures to improve energy efficiency, to enhance energy generation from renewable sources, those for thermal modernisation of buildings and waste management or the construction of modern transport infrastructure, including the sustainable development of urban transport. The general principle of the financing of projects to reduce greenhouse gas emissions consists in the provision of low-interest rate credits and grants to enterprises, self-governments and budget sector institutions. The projects which are most often financed include:

- the modernisation and construction of heating networks,
- the modernisation of boiler-houses,
- the thermal modernisation of public utility buildings,
- the limitation of low emissions,
- investment projects at installations using renewable energy sources,
- energy saving in urban heat supply systems (only within the framework of the competition for energy saving in heating systems),

- the use of biomass for energy generation purposes in the municipal and domestic sector and at industrial enterprises,
- the economic use of biogas from the agricultural sector, from municipal waste landfills and from wastewater treatment plants,
- the use of solar energy (photovoltaic panels and solar collectors within the framework of the system of subsidies),
- the use of shallow geothermal sources (heat pumps),
- the promotion of fuel cell technology,
- the use of energy from waste incineration.

4.5. The climate and energy package

The climate and energy package was adopted in December 2008, implementing the assumptions adopted by the European Council in 2007 concerning the tackling of climate change which provided that by 2020 the European Union would:

- reduce greenhouse gas emissions by 20% relative to the emission levels in 1990;
- enhance to 20% the share of renewable energy in the final energy consumption;
- improve energy efficiency by 20% relative to the predictions for 2020 (a non-obligatory target); and
- enhance the share of biofuels in the total consumption of transport fuels to at least 10%.

The climate and energy package consists of the following legal acts:

- Directive 2009/29/WE of the European Parliament and of the Council of 23 April 2009 *amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community* (the so-called EU ETS Directive) (OJ L 140 of 05.06.2009, p. 63);
- Decision 406/2009/EC of the European Parliament and of the Council of 23 April 2009 *on the efforts of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020* (the so-called non-ETS Decision) (OJ L 140 of 05.06.2009, p. 136);
- 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, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No (WE) 1013/2006* (the so-called CCS Directive) (OJ L 140 of 05.06.2009, p. 114);
- 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* (the so-called RES Directive) (OJ L 140 of 05.06.2009, p. 16);
- Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 *amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC*.

4.6. Sectoral policies

4.6.1. The energy sector and industry

The basic directions of the development of the Polish energy sector, set out in the *Energy Policy of Poland until 2030* adopted by the Council of Ministers on 10 November 2009, include:

1. Improvement in energy efficiency
2. Enhanced security of fuel and energy supplies
3. Diversification of the electricity generation structure by introducing nuclear energy
4. Development of the use of renewable energy sources (RES)
5. Development of competitive fuel and energy markets
6. Limitation of the environmental impact of the energy sector

The improvement in energy efficiency is treated as a priority, while progress in this field will be of key importance for the implementation of all the assumptions of the energy policy. The main goals in this area include the commitment to maintain the zero-energy economic growth and the consistent reduction of the energy intensity of the Polish economy to the level of the EU-15.

The rational and effective management of own deposits of energy raw materials provides the basis for Poland's energy security. Support will be given to the development of efficient and low-emission technologies enabling the supply of liquid and gaseous fuels from national raw materials.

The objectives in the scope of the national share of energy from renewable sources (cf. Chapter 2) in the transport sector, the electricity sector and the heating and cooling sector in 2020 were adopted on 7 December 2010 in the document called *The National Action Plan on Energy from Renewable Sources*. It defined the measures which needed to be taken in order to achieve general national objectives in the scope of the share of RES in the use of final energy. It was assumed that the pillars for the enhanced share of energy from renewable sources in Poland would be the greater use of biomass and electricity generated from the wind.

A integral element of the *Energy Policy of Poland until 2030* is the *Executive Action Programme for 2009-2012,* which provided for the implementation of more than 340 tasks. The implementation of this Programme was monitored on an ongoing and annual basis. At present, work is underway at the Ministry of the Economy to update the energy strategy until 2050.

The main tools for the implementation of the present energy policy include:

- legal regulations setting out the principles of the operations of the fuel and energy sector and establishing the relevant technical standards;
- systemic mechanisms of support for the implementation of measures to achieve the basic objectives of energy policy (e.g. the market of "certificates");
- the ongoing monitoring of the situation on the fuel and energy market by the President of the Office of Competition and Consumer Protection and the President of the Energy Regulatory Office and their launch of intervention measures in accordance with their competence;

- information measures carried out by the government authorities and the cooperating research and development institutions;
- support from public resources, including the European funds, for the implementation of projects of national importance in the scope of the energy sector (e.g. investment projects and research and development work).

The measures in favour of environmental technologies, leading to full utilisation of the potential of eco-innovation, are an important element strengthening both national environmental and innovation policies. Primarily, it is the development of clean technologies (including those that use fossil fuels), renewable energy sources or improvements in energy and material efficiency that is important for the growth of the economy and its ”greening” .

The priority directions of measures in industry include:
- the implementation of the best available techniques (integrated permits are granted to installations and plants which implement BAT/BEP);
- support for the development of environmentally friendly and technically cost-effective methods for reductions in greenhouse gas emissions;
- improvement in energy efficiency;
- the development of the use of renewable energy sources;
- the diversification of energy sources, primarily through the development of nuclear energy generation;
- energy saving;
- the diversification of fuels;
- the definition of the priorities for research and development work, material- and energy-saving production technologies and ensuring their financing;
- technological modernisation at industrial plants.

Table 4.3. The major documents on the energy sector ad industry in Poland

Title of document	Description of document
The Energy Policy until 2030, adopted by the Notice of the Minister of **t**he Economy of 21.12.2009 on the National Energy Policy until 2030 (M.P. No 2, Item 11).	The document contains a long-term development strategy for the energy sector, a forecast of the demand for fuels and energy and the executive action programme until 2012. The implementation of the solutions indicated in the document can meet the growing demand for energy, develop the production and transport infrastructure, reduce the dependence on external natural gas and oil imports and fulfil the international commitments in the scope of environmental protection.
The Act of 10 April 1997 on Energy Law (Official Journal of the Laws of 2012, Item 1059, as amended).	The Act introduces the regulations laying down the principles of energy generation and use and the saving of its resources, and supporting the use of renewable energy sources; in this respect, the so-called “green certificates” play an important role. The requirement for creating consistent development plans for enterprises and communes is of large importance. The plans must contain projects to use renewable energy sources. It also establishes the certificates of origin for energy generated in cogeneration[39].

[39] High-efficiency cogeneration is the generation of electricity or mechanical energy and useful heat in cogeneration which ensures primary energy savings. In accordance with the Act on Energy Law, support for high-efficiency cogeneration was available until 31 December 2012. At present, the Government of the Republic of Poland proposes to extend the support for high-efficiency cogeneration until 2015, i.e. support under the existing rules for electricity and heat generation using a high-efficiency cogeneration technology. The Council of Ministers adopted a draft amendment in this scope on 2 January 2013.

Title of document	Description of document
The Act of 15 April 2011 on Energy Efficiency (Official Journal of the Laws of 2011, No. 94, Item 551, as amended).	The Act lays down the national target for economical energy management until 2016 at the level of 9% of the average national final energy consumption, averaged from 2001-2005. Moreover, the Act formulates the principles of the preparation of national action plans on energy efficiency improvement, which will be submitted to the European Commission in order to verify the energy savings gained by using programmes and measures provided for in the Act. One of the basic mechanisms of the Act is the introduction of the system of energy efficiency certificates, the so-called "white certificates", which confirm that measures leading to specific energy savings have been taken. The system of white certificates supports efficiency-enhancing projects; in particular such as: the modernisation of local heating networks and heat sources, buildings, lighting systems, household appliances and equipment used in industrial processes.
The National Reform Programme for the Implementation of the Europe 2020 Strategy. The 2013/2014 Update adopted by the Council of Ministers on 25 April 2012.	The document sets out the most important measures for 2012-2013 which support economic growth, competitiveness and employment.
The Act of 25 August 2006 on Bio-components and Liquid Biofuels (Official Journal of the Laws of 2013, Item 1164).	On 1 January 2008, the obligation to ensure a specific share of bio-components on the transport fuel market was imposed on entrepreneurs carrying out economic activities in the scope of the production, import or intra-Community purchase of liquid fuels or liquid biofuels which sell them or use them for their own needs. The Act introduces solutions enabling the mobilisation of financial resources for supporting the production of bio-components and liquid biofuels. The proceeds from pecuniary penalties imposed pursuant to this Act are the revenues of the National Fund for Environmental Protection and Water Management, which define the minimum level of the long-term commitment of this Fund to allocate resources for supporting activities to produce bio-components and liquid biofuels or other renewable fuels and for promoting their use. The Act is being amended to implement the provisions of Directive 2009/28/EC *on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC* in the scope of biofuels.
The Act of 25 August 2006 on the System for the Monitoring and Control of Fuel Quality (Official Journal of the Laws, No. 169, Item 1200, as amended).	As from 1 January 2007, the Act allowed for the use of biofuels with an enhanced share of bio-components in vehicles and machinery (a group of at least 10 types of vehicles).
The Act of 27 May 2011 Amending the Act on the System for the Monitoring and Control of Fuel Quality and Certain Other Acts (Official Journal of the Laws, No. 153, Item 902, as amended) **and the Regulation of the Minister of the Economy of 7 February 2012 amending the Regulation on the quality requirements for liquid fuels (**Official Journal of the Laws, Item 136**).**	It introduced the possibility of using diesel oil containing up to 7% of fatty acid methyl esters (so-called B7 fuel).
The Act of 6 December 2008 on the	The Act lays down the excise tax rates for motor petrol and diesel oil

Title of document	Description of document
Excise Tax (Official Journal of the Laws of 2011, No. 108, Item 626, as amended).	and a reduced excise rate for bio-components.
The Long-term Program to Promote Biofuels or Other Renewable Fuels for 2008–2014, adopted by the Council of Ministers on 24 July 2007.	The aim of the Programme is to create the conditions for the cost-effective production and use of biofuels in Poland. The Programme covers primarily two types of measures: those to support the production of bio-components and liquid fuels and those to stimulate the demand for them. The decision was taken that, in order to achieve the objectives related to the development of the market of bio-components and liquid biofuels, it would be necessary to elaborate a completely new document, which would cover a much longer timeframe than the programme now in effect, i.e. until 2020. The period covered by the new programme should be correlated with the timeframe under the objectives and obligations provided for by the content of Directive 2009/28/EC *on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC* as well as the successive financing period within the framework of the European funds. The need to elaborate a new programme ensues primarily from the fact that the provisions of the EU legislation on liquid biofuels have been significantly amended, as a result of which the national legislation in this area will also be amended. Due to these amendments, the entities operating on the market of bio-components and liquid biofuels will function under completely new legal and economic conditions.
The Programme for Polish Nuclear Energy Generation – it is planned that its draft will be adopted by the Council of Ministers in the 4th quarter of 2013/1st quarter of 2014	The aim of the Programme is to set out a detailed scope and timetable for measures to set in operation the first nuclear power plant in Poland. The draft Programme envisages e.g. measures to ensure the widest possible involvement of the national industry in its implementation and a system for ensuring and developing staff for the institutions and enterprises related to nuclear energy generation, including e.g. training courses delivered in cooperation with foreign institutions. The draft also considers the issues related to the legal environment of the investment projects, the required changes in the transmission system, the need to ensure fuel supplies to the power plant, the development of technical services and research and development work for the Polish nuclear energy generation, as well as the communication with the public. The draft Programme also contains economic analyses, including the potential to reduce greenhouse gas emissions related to the development of nuclear energy generation in Poland.

Source: Ministry of the Environment.

The measures in the energy sector

Improvement in energy efficiency

The energy efficiency of the GDP in recent 10 years fell by 30%; however, the efficiency of the Polish economy, calculated as the GDP (based on the exchange rate of the EUR) per unit of energy, continued to be twice as low as the European average. The economic growth, resulting from the use of new technologies, causes a substantial increase in electricity consumption with a relative decrease in the consumption of other types of energies.

The industry sector made the greatest contribution to an improvement in energy efficiency; the sectoral indicators improved and there were also favourable structural changes. The majority of improvements ensued from the independent decisions of entities which were guided by the economic calculus.

The measures to improve energy efficiency include:
- the stimulation of the development of cogeneration;
- the modernisation of local heating networks and the connection of heat users;
- the modernisation of heat sources;
- the modernisation of industrial installations;
- the modernisation of lighting systems.

Enhanced security of fuel and energy supplies

The main goal is to ensure stable fuel and energy supplies at a level which would ensure the satisfaction of the national needs, at prices acceptable to the economy and society, under the assumption of the optimum use of the national resources of energy raw materials and through the diversification of the sources and directions of supplies of crude oil and liquid and gaseous fuels.

The existing forecasts concerning the possibility of meeting the future national electricity demand indicate the need to expand the present capacity. The commitments to reduce greenhouse gas emissions make it necessary for Poland to seek low-emission solutions in electricity generation. Electricity is generated in the national system with scarce possibilities of its international exchange – now below10%. Therefore, apart from the development of the capacity to generate electricity and the transmission and distribution capacities of electricity networks, the major directions of energy policy also provide for enhancing the possibility of exchanging electricity with the neighbouring countries.

The measures to ensure enhanced fuel and energy supplies include, e.g.:
- support for the use of methane from hard coal mines to produce electricity and heat,
- the development of economically viable methods for methane recovery and its use as a clean source of energy from the hard coal mining sector, waste landfills, wastewater management, agriculture and oil and gas systems. This work is carried out within the framework of the international programme "*Global Methane Initiative"*;
- within the framework of the Innovative Economy Operational Programme; *inter alia*, the project called *The environment-friendly technology for mine methane utilisation* aimed at developing a modern technology for the oxidation of methane obtained from the mine ventilation air.

The diversification of the electricity generation mix

The structure of the consumption of primary energy carriers changed slightly but gradually over the last years (Table 4.4). The share of hard coal fell, while the share of natural gas and renewable energy sources increased. Enhanced energy efficiency and an increased share of energy from renewable sources, including biofuels, contribute to the diversification of the electricity generation mix.

Table 4.4. The structure of the primary energy consumption in electricity generation.

Energy carrier	Structure of the consumption of primary energy carriers by years [%]			
	2008	2009	2010	2011
Hard coal	55.2	54.8	55.8	53.4
Lignite	34.3	33.1	30.9	32.1
Natural gas	3.0	3.2[1)]	3.0[1)]	3.6[1)]
Other fuels	2.9	2.8[2)]	3.0[2)]	2.6[2)]
From pumped water	4.6	5.7	6.9	8
RES				
including:		3.4	4	4.6
Biomass and biogas	2.3	2[3)]	2.2[3)]	1.7[3)]
Water	1.8[3)]	0.7	1.1	2
Wind	0.5	54.8	55.8	53.4

1) high-methane and nitrified natural gas, gas from mine methane removal, gas accompanying crude oil,
2) fuel oils and diesel oil, industrial gases, inorganic industrial and municipal waste,
3) including energy from pumped water.
Source: Statistical Data on the Polish Electricity Sector, Ministry of the Economy/ARE S.A.

Climate protection and the climate and energy package adopted by the EU make it necessary to shift energy production to technologies with low CO_2 emissions. Given the present trends in European energy policy, nuclear energy has become one of the most desirable sources (the first power plant of this type should be built in Poland by 2024), because, apart from the absence of CO_2 emissions, it also ensures stable energy supplies in a long term, at competitive prices, as well as the independence of variations in energy raw material prices on the world markets (given the fact that the purchase cost of uranium necessary to produce the nuclear fuel is only a slight percentage of the total electricity generation costs).

Enhanced use of renewable energy sources, including biofuels

The *Executive Action Programme for 2009-2012*, which is Annex 3 to the *Energy Policy of Poland until 2030* provides that the mechanisms of support for electricity producers using renewable sources will be maintained.

In order to **support the development of energy from renewable sources** in Poland, a system of instruments was adopted, including e.g.: the obligation to buy energy from renewable sources and the obligation to obtain certificates of origin for energy from renewable sources, the so-called "green certificates", and to submit them to the President of the Energy Regulatory Office (URE) for cancellation or to make a compensatory payment.

According to the Energy Regulatory Office, as of the end of 2012, as a total there were 1,744 installations using renewable energy sources, including:

- biogas power plants – 199,
- biomass power plants – 27,
- solar generation installations – 9,
- wind power plants – 696,
- hydro-power plants – 770,
- co-firing units – 43.

The capacity of these installations was as follows [MW]: wind power plants – 2,496.748; hydro-power plants – 966.103; biomass power plants – 820.7; biogas power plants – 131.247 and solar generation installations – 1.29.

The limitation of the environmental impact of the energy sector

In order to limit the environmental impact of the energy sector, a system for managing the national ceilings of the emissions of greenhouse gases and other substances was established (pursuant to the Act on the System to Manage the Emissions of Greenhouse Gases and Other Substances). It is also important to note the information and educational campaigns conducted in Poland to promote rational energy use.

The measures in industry

Improvements in the technical standards of installations and equipment – such measures improve the energy efficiency of industrial production (e.g. in the iron and steel sector, the improvement is a result of the modernisation of natural gas-fired tunnel furnaces).

Fluorinated greenhouse gases – Poland's main measures concerning fluorinated greenhouse gases (F-gases)[40] include e.g..:

- the monitoring and analyses of the national consumption of fluorinated greenhouse gases (F-gases) and the inspiration of measures to reduce their emissions;
- the establishment and management of a data bank on F-gases;
- the establishment and management of the register of the operators of fire protection equipment and systems containing F-gases;
- information activities on the limitation of the emissions of F-gases;
- the adoption of a charge for the placing of fluorinated greenhouse gases on the market in the Polish territory, including the gases contained in products and equipment.

The implementation of the best available techniques – integrated permits are granted to installations and plants which implement BAT/BEP.

Reductions in methane emissions from fuel production and distribution processes – for this purpose legal regulations concerning hermetic fuel distribution were issued[41].

The promotion of environmentally friendly and effective practices and technologies in industrial operations and support for the development of environmentally friendly and technically cost-effective methods for greenhouse gas emission reductions – in order to promote environmentally friendly technologies, brochures were published to popularise the best available techniques for the individual fields of production.

[40] F-gases, i.e. **HFCs –hydrofluorocarbons**, used in different sectors and applications, e.g. as refrigerants in refrigeration and air-conditioning systems and heat pumps, as foaming agents, as extinguishing agents, aerosol propellants and solvents, **PFC – perfluorocarbons**, commonly used in the electronic sector (e.g. for plasma clearing of silicon chips) and in the cosmetics and pharmaceutical industries (to obtain natural products, such as conditioners and aromas), **SF_6 – sulphur hexafluoride**, commonly used as an insulating gas and to extinguish arc short-circuits in high-voltage switchboards, as well as a shielding gas in the production of magnesium and aluminium.

[41] The Regulation of the Minister of the Economy of 21 November 2005 on the technical conditions to be met by liquid fuel bases and stations, long-distance transmission pipelines serving to transport crude oil and petroleum products and their situation (Official Journal of the Laws, No. 243, Item 2063, as amended).

Technological modernisation at industrial plants. These measures consisted e.g. in coal to gas conversion at boiler-houses involving the modernisation of heating ovens and those for thermal processing as well as in the construction of an installation for basic oxygen furnace gas recovery.

4.6.2.Transport, construction and housing management

Transport

The transport development in 2007-2011 focused mainly on the continued creation of an efficient system of transport connections and the conditions for sustainable development, enabling the utilisation of the existing economic, social and territorial potential, and contributing to the creation of the conditions for the building of a modern and competitive economy. The most important priorities included: connecting the major economic centres in Poland by a network of motorways, expressways and modern railway lines, ensuring transport connections with the rest of Europe (within the TEN-T network), improving the quality of the transport system, expanding it in accordance with the principles of sustainable development and enhancing the share of public transport in services for the population.

The strategic, programming and legal frameworks

In 2008-2012, the basic planning document in the area of transport was the *National Transport Policy for 2006-2025*. On 22 January 2013, the Council of Ministers adopted the *Transport Development Strategy until* 2*020 (with an Outlook until 2030 (SRT))*, a medium-term planning document prepared pursuant to the Act of 6 December 2006 *on the Principles of the Implementation of Development Policy*, indicating the objectives and directions of interventions enabling the implementation of the intentions defined in the *Medium-Term National Development Strategy (SRK 2020)* and - to be phased in until 2030 – the *Long-Term National Development Strategy (DSRK)*.

Apart from the objectives set out for in the Long-Term and Medium-Term National Development Strategies, the *Transport Development Strategy* (SRT) took into account the objectives and directions of measures identified in national and EU strategic documents, including e.g. A strategy for smart, sustainable and inclusive growth - Europe 2020, and the National Reform Programme for the Implementation of the Europe 2020 Strategy (KPR).

The main goal of the *Transport Development Strategy* is to enhance territorial accessibility and to improve the safety of traffic participants and the efficiency of the transport sector by creating a consistent, sustainable and user-friendly transport system at the local, national, European and global levels. One of the detailed objectives is to "limit the adverse impact of transport on the environment". In respect of the climate, reference is made to the EU climate policy, including greenhouse gas emission reductions in the context of adaptation of infrastructure and transport services to climate change.

The Act of 6 December 2006 *on the Principles of the Implementation of Development Policy* imposes on the authorities preparing development strategies and programmes the obligation to consider the issues of environmental protection in these documents and to apply the regulations on public participation in environmental protection and environmental impact assessments. Moreover, the process of implementing operational programmes involves the

requirement for an environmental impact assessment procedure for projects co-financed from national or regional operational programmes.

The most important legal acts adopted in 2007-2011 included the *Act of 16 December 2010 on Public Collective Transport*, which introduced the obligation to prepare transport plans that would also contribute to optimising passenger transport and to improving the energy efficiency of such transport. In addition, the obligation to consider emissions-related factors and energy consumption in the purchases of vehicles to provide public transport services was also introduced and the Regulation of the Council of Ministers of 2011 imposed this obligation on all road vehicles purchased in the public procurement procedure.

Construction and housing management

Construction and housing management are indicated as the sector where the potential opportunities for reducing energy intensity and – in a longer term – for the global limitation of non-renewable energy consumption, and, thereby, for the lowering of greenhouse gas emission levels, are some of the highest and most co-effective.

The strategic, programming and legal frameworks

Housing construction policy is decentralised and subject to decisions taken by local governments[42]. The legislators believe that the adopted amendments, along with higher requirements for thermal protection of buildings, stimulate the launch of measures to reduce the energy intensity of the construction sector and improve the characteristics of the entire sector of buildings from the point of view of a reduction in the consumption of non-renewable fuels, environmental protection safety and ensuring users' thermal comfort.

These measures are designed to implement the provisions of *Directive 2010/31/EC of 19 May 2010 on the energy performance of buildings,* according to which by 31 December 2020 all new buildings should be nearly zero-energy buildings, while after 31 December 2018 new buildings occupied and owned by public authorities should also be nearly zero-energy buildings. The definition of a nearly zero-energy building, i.e. a building that has a very high energy performance, characterised by the use of the most efficient design and installation solutions, using energy from renewable energy sources, will set the standard for all newly built buildings. The amended regulations take into account the development of the construction sector and gradually introduce the level of the optimum requirements in terms of costs, too.

On 1 January 2009, as a result of an amendment to the Act of 7 July 1994 on Construction Law, the system for the assessment of the energy performance of buildings was introduced, using energy performance certificates and records from inspections of heating and air-conditioning systems.

The Regulation of *the Minister of Internal Affairs and Administration of 16 August 1999 on the technical conditions for the use of residential buildings* in effect sets out the technical conditions for the use of residential buildings, along with the related installations and technical equipment. The provisions of the Regulation also regulate the issues related to the execution of periodical inspections of buildings, including the inspections of elements of buildings damage to which can pose danger for the environment.

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[42] To the extent of more than 90%, this is construction of private or commercial character. Construction investment projects are subject to the provisions of the Construction Law and control exercised by the construction supervision.

Amendments were made to the Regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions to be met by buildings and their situation. The issues related to energy saving buildings are covered in Part X – Energy saving and thermal insulation levels. The Regulation applies to new and existing buildings which are expanded, rebuilt, raised or changed in terms of its use. The aim of the provisions is such design and erection of buildings, along with their heating, ventilation and hot water installations and, in the case of public utility buildings, also lighting systems, that ensures the possibility of keeping at reasonably low levels the quantities of heat, cold and electricity needed for them to be used in accordance with their purposes. On 1 January 2014, the amended provisions of the Regulation, providing for a gradual strengthening of the regulations in this scope, will come into effect.

On 3 October 2013, the *Regulation of the Minister of Transport, Construction and Maritime Economy of 25 April 2012 amending the Regulation on the detailed scope and form of construction design* came into effect. For all newly designed buildings, it introduced the obligation to analyse, at the stage of preparing the construction design, different solutions for heat supply to buildings, including high-efficiency alternative systems using energy from renewable sources and heat pumps.

A description of the most important Polish documents regarding transport, construction and housing management in Poland presents Table 4.5.

Table. 4.5. Documents in effect for transport, construction and housing management in Poland.

Title of document	Description of document
The National Transport Policy for 2006-2025, adopted by the Council of Ministers on 29 June 2005.	The Transport Policy adopted as its basic goal a distinct improvement in the quality of the transport system and its expansion, in accordance with the principles of sustainable development, since the quality of the transport system is one of the key factors determining the living conditions of the population and the economic growth of the country and its regions. The problems considered in the Policy (after the changes that occurred in Poland's economic environment had been taken into account and following a relevant update) were integrated into the Transport Development Strategy until 2020 (with an Outlook until 2030) (SRT), adopted by the Council of Ministers on 22 January 2013.
The Master Plan for Rail Transport in Poland until 2030, adopted by the Council of Ministers on 19 December 2008.	The Master Plan covers all the aspects of rail transport until 2030. Its main goal is to make rail transport a competitive segment of the transport market, on the basis of cooperation among national and local authorities, rail companies and infrastructure managers. The major tasks of the Master Plan include e.g. the limitation of environmental damage caused by higher demand for transport.
The Long-Term Rail Investment Programme until 2013 with an Outlook until 2015, adopted by the Council of Ministers on 7 November 2011, complemented by the Council of Ministers on 18 July 2012.[43]	The Long-Term Investment Programme is a tool which will make it possible to achieve in rail transport the effects of infrastructural investment projects provided for in strategic documents setting out the directions of infrastructure development in Poland. The overriding goal is for the services rendered by the manager of the national, public rail infrastructure to reach a level which would fully meet the expectations and needs of carriers and their customers. This also includes e.g. the limitation of the effects of an adverse impact on the environment.

[43] A document in effect; work is underway to have it replaced by *The Long-Term Rail Investment Programme until 2015.*

Title of document	Description of document
The Programme for the Construction of National Roads for 2011-2015, the Resolution of the Council of Ministers No. 10/2011 of 25.01.2011.	Poland carries out successive road infrastructure development. The road programme is defined as a medium-term one, establishing a financial framework for the planned investment projects.
The National Road Traffic Safety Programme 2005-2007-2013 GAMBIT 2005, adopted by the Council of Ministers on 19 April 2005.	This is a programme of measures to be taken by the Government administration in order to implement the main goal and detailed objectives of Vision Zero adopted by Poland in the scope of road traffic safety. The Programme is a diagnosis and assessment of road traffic safety in Poland and takes into account the Polish and European conditions for programming road traffic safety.
The Assumptions of the Maritime Policy of the Republic of Poland until 2020, September 2009.	A huge potential for a transition of the economy towards a low-emission one is related to the development of sea shipping as a transport mode characterised by low energy intensity which translates into low emissions into the air.
The Programme for the Construction and Setting in Operation of High-Speed Railways in Poland, adopted by the Resolution No. 276/2008 of the Council of Ministers of 19 December 2008.	The aim of the Programme is to propose a means of transport which would be alternative to road and air transport and cause a lower unit environmental load per passenger-kilometre (measured by the CO_2 emission factor).
The Strategy for the Development of Seaports until 2015, the Resolution No. 292/2007 of the Council of Ministers of 13 November 2007.	Improvements in the infrastructure of seaports and access to them from both the land and the sea become a fundamental factor determining the possibility of making use of the advantage offered by the low energy intensity of sea shipping. The development of motorways of the sea and shortsea shipping, the acquisition of larger loads and an expansion of port infrastructure connections with the national and European transport networks play an important role. Under the assumption that LNG can be recognised as an alternative with lower emission intensity to traditional fuels, the development of infrastructure for gas supplies by the sea transport to the LNG port terminal and for the farther distribution of this energy may turn out to be important, too.
The Operational Programme Infrastructure and Environment. The National Strategic Reference Framework 2007-2013. The version approved by the European Commission on 5 December 2007.	Priority Axis VII: Environmentally friendly transport The implementation of the priority axis will enhance the share of transport modes which are alternative to road transport (rail transport, sea transport, public transport in metropolitan areas, intermodal transport and inland waterway transport) in the cargo and passenger transport, leading to a better balance in the transport system, the limitation of an adverse impact of transport on the environment and a reduction in traffic congestion.
The National Plan for the Implementation of the European Rail Traffic Management System in Poland, adopted by the Council of Ministers in March 2007.	The Plan provides for the implementation of a more effective and safer rail traffic management system – the European Rail Traffic Management System (ERTMS) – at the key sections of the railway network, which, bearing in mind the lower annoyance caused by railways for the surroundings (compared in particular with road transport), will diminish the impact of transport as a whole on the environment. Moreover, the implementation of the ERTMS system will enhance the energy efficiency of this mode of transport by improving rail traffic fluidity.
The Programme for the Development of a Network of Airfields and Aviation Ground Facilities, adopted by the Resolution No. 86/2007 of the Council of Ministers on 8 May 2007.	To a large extent, the factors affecting the development of air transport, including its infrastructure, include environmental considerations. The development of airfields requires an integrated approach to the issues related to environmental protection; primarily, the maximum limitation of aviation noise and the plan-based spatial development of the areas around airfields as the necessary conditions for limiting their noise annoyance and for integrating airfields into an intermodal

Title of document	Description of document
	transport network, thus significantly diminishing their impact range.
The Regulation of the Minister of Transport, Construction and Maritime Economy of 9 October 2012 on the plan for the sustainable development of public collective transport within the transport network in interregional and international passenger rail transport (Official Journal of the Laws, Item 1151).	The Plan formulates the basic principles of the functioning and development of interregional and international passenger rail transport, carried out as public utility transport within the framework of public collective transport on the market subject to the principles of regulated competition. The Plan is based on the provisions of strategic government documents programming the national development which indicate e.g. the need for rail transport to minimise its adverse impact on the environment.
The Act of 21 November 2008 on Support for Thermal Modernisation and Repairs (Official Journal of the Laws, No. 223, Item 1459, as amended).	The Act sets out the principles of financing of part of the costs of thermal modernisation projects and the related repair projects from the resources of the state budget-supported Thermal Modernisation and Repair Fund.
The Act of 7 July 1994 on Construction Law (Official Journal of the Laws of 2013, Item 1409, as amended).	The Act introduced a system for the energy assessment of buildings pursuant to the provisions of Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings. The aim of these regulations is to promote the raising of the energy standard of buildings by limiting their demand for energy related to heating, ventilation, hot water preparation and lighting, as well as to build public awareness as regards rationalisation of energy use. The effect of these measures will be a reduction in global energy consumption and, at the same time, lower greenhouse gas emission levels.
Regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions to be met by buildings and their situation (Official Journal of the Laws, No. 75, Item 690, as amended).	The Regulation sets out the technical conditions to be met by buildings, the related facilities, their situation on a construction parcel and the development of parcels designated for construction. These regulations apply to the design, construction, reconstruction and change in the use of buildings. Part X applies to energy saving and thermal insulation levels. The application of the regulations contributes to lower energy consumption in the construction sector and, thereby, to greenhouse gas emission reductions.
The Regulation of the Minister of Internal Affairs and Administration of 16 August 1999 on the technical conditions for the use of residential buildings (Official Journal of the Laws, No. 74, Item 836, as amended).	It sets out the technical conditions for the use of residential buildings, along with the related installations and technical equipment, *inter alia*, ensuring the correct technical condition of the elements of a building, taking into account their impact on the environment.
The Regulation of the Minister of Transport, Construction and Maritime Economy of 25 April 2012 on the detailed scope and form of the construction design (Official Journal of the Laws of 2012, Item 462, as amended).	The Regulation lays down a detailed scope and form of the construction design which provides the basis for the issue of a decision on the construction permit. Its amended content imposes the obligation to consider the implementation of high-efficiency alternative systems using energy from renewable sources and heat pumps, prior to the launch of the construction, provided that it is feasible in technical, environmental and economic terms.
The Act of 27 March 2003 on Spatial Planning and Development (Official Journal of the Laws of 2012, No. 80, poz. 647, as amended). (Since 2012, the Official Journal of the Laws of 2012, Item 647, as amended).	The Act sets out e.g. the principles of the shaping of spatial policy by territorial self-government units and Government administration authorities. Spatial planning and development take into account, *inter alia*, the requirements of environmental protection, including those related to water management and the protection of farmland and forest land.

Source: Ministry of the Environment.

Due to the adoption of new macroeconomic strategic documents (the Long-Term National Development Strategy (DSRK), the Medium-Term National Development Strategy (SRK) 2020 and the National Spatial Development Concept (KPZK)) and the Transport Development Strategy, as well as given the ongoing process of the programming of a new EU financial perspective 2014–2020, the abovementioned planning documents will be updated or replaced by new development programmes and operational programmes implementing the abovementioned superior documents.

Measures

Transport

In the individual transport modes, the major measures to reduce greenhouse gas emissions include:

Reduction of the environmental annoyance of road transport

More stringent emission standards were adopted for internal-combustion engines. In 2012, the requirements of the Euro 5 emission standards already covered all new passenger cars, while from the beginning of the year the requirements of the Euro 6 emission standards applied to the type approval of trucks. In addition, the replacement of the vehicle fleet with low energy consumption and CO_2 emissions is stimulated by the requirements of Regulations (EC) No 443/2009 and No 510/2011 setting CO_2 emission standards for passenger cars and light commercial vehicles. Moreover, the system of technical inspections of motor vehicles and their trailers contributes to the elimination of non-roadworthy or end-of-life vehicles which have an adverse impact on the state of the natural environment and energy efficiency.

Moreover, differentiated rates of charges were introduced for travels on national roads, depending on the levels of vehicle exhaust gas emissions, to promote the traffic of "cleaner" vehicles in national roads. An additional instrument are the charges for the use of the environment which are incurred basically for the use of motor fuels generated from non-renewable sources. The introduction of environmentally clean and energy-saving vehicles is supported through the information system for consumers concerning fuel consumption and CO_2 emissions in the context of the marketing of new passenger cars. Support is also given for the purchase of environment–friendly vehicles within the framework of *regional operational programmes* and the *Green Investment Scheme*.

The modern solutions placed on the market by road vehicle producers improved the efficiency of fuel consumption in new cars, trucks and buses commissioned in Poland. In particular, it is important to stress the development of the electric drive technology of the plug-in and hybrid types in buses, with the latter already launched in a series production, and the progress in the improvement in the efficiency of conventional internal-combustion motors and drives. The information and educational activities relating to the need to change drivers' behaviour consisted of public campaigns. The main goal of the campaigns was to make the road traffic participants aware of the linkage between the technical condition of the car and safety, as well as to raise the level of the public acceptance of the need to comply with speed limits. In addition to their impact on road traffic safety, both the operation of roadworthy vehicles and the limitation of the speed of motor vehicles directly contribute to reducing environmental pollution, including greenhouse gas emissions. Apart from the campaigns, the measures to raise drivers' environmental and energy-related awareness are elements of the process of

learning to drive vehicles (both for amateurs and professionals) and also of driving licence examinations.

Enhanced share of alternative fuels in transport

Many incentives were introduced to increase the consumption of alternative fuels, including preferential tax rate on LPG in comparison to traditional fuels, tax reliefs for bio-components for motor fuels (dehydrated alcohols, ethers and esters), special natural gas prices and the obligation to introduce bio-components into fuels, the mechanisms supporting the construction of installations to produce bio-components and biofuels, as well as new mechanisms promoting the use of these fuels (the production of biofuels for own use and the authorisation of fuels with any composition of bio-components).

Rail transport

Through many investment measures, such as the modernisation of rail infrastructure (including railway stations) or the purchase of modern rolling stock and the modernisation of the existing stock, a qualitative improvement came in this transport mode.

The modernisation of railway infrastructure made it possible to increase the train traffic speed and the travel frequency of trains. In goods transport, measures were also taken to ensure an efficient organisation of the railway system.

An efficient organisation of the railway system was ensured through adapting the number of train carriages to the transport needs and replacing traditional trains by lightweight railcars on lines with lesser passenger streams. The monitoring of seat occupancy in individual trains determined the need to increase the frequency of trains during rush hours, improving travellers' comfort and also increasing their ability to travel. The system of travel and tariff offers was developed, integrating several collective transport operators.

Due to the application of lightweight components to build them, the use of internal-combustion engines and the recovery of heat from the cooling of the engine and transmission gear to heat the vehicle, lightweight railcars set in operation, including railbuses designed to serve the local traffic, consume significantly less energy. Electric and internal-combustion railway engines were modernised and self-propelled network trains with internal-combustion engines meeting the most recent requirements for gaseous pollutant emission reductions were purchased.

Sea shipping

The measures to reduce CO2 emissions taken in the sea shipping sector include the drafting and adoption of international regulations concerning the Energy Efficiency Design Index (EEDI) for newly built ships. This index is an instrument which makes it possible to support and promote design solutions with higher energy efficiency and related lower CO2 emissions in the course of the operation of a ship. Already in the nearest years, due to the application of EEDI, newly built ships will be fitted with technical solutions meeting more stringent requirements concerning energy efficiency.

Air transport

Poland intensified its activities to establish the Single European Sky (SES), the main pillar of which is the new generation air traffic management system SESAR. Poland implements its tasks under the ATM Master Plan, which is the road map for the SESAR programme. This task serves to implement the general objectives of the Single European Sky, including a 10% reduction in the environmental impact (in practice, this means the avoided emissions of 50 million tonnes of carbon dioxide). Moreover, within the tasks imposed by the SES regulations, at the level of the Baltic Functional Airspace Block, together with Lithuania, Poland prepares the Efficiency Action Plan, which also provides for indicators and objectives for the area of environmental protection. These objectives consist in shortening the air flight routes — the real ones in relation to the last flight plan submitted. The SES initiative was adopted in response to a surge in the air traffic intensity in the late 1990s which was related to the liberalisation of the air transport market. At present, Poland and its partners are engaged e.g. in the work to establish the Baltic Functional Airspace Block (the *Baltic FAB*) in order to contribute to achieving the objectives set out the assumptions of the SES. Measures which contribute directly and indirectly to reducing greenhouse gas emissions into the air from air traffic are carried out continuously (e.g. the F. Chopin Airport in Warsaw takes part in a voluntary programme to reduce greenhouse gas emissions through the so-called Airport Carbon Accreditation (ACI)). Such measures also include modifications of the existing airspace structures designed to shorten the arrival routes and to increase the capacity of air traffic control sectors. In recent years, the system of air traffic routes was restructured by shutting down or modifying several dozen of them. Starting in 2012, civil aviation was also covered by the EU emission allowance trading scheme (EU ETS) as the only transport mode, pursuant to *Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community.* However, it should be pointed out that the main component of emission reductions is the emission reductions at source through the successive strengthening of emission standards and price competition among air carriers, forcing appropriate savings in the management of propellants.

City transport, including public transport

One of the measures to reduce the emissions related to the functioning of transport in cities is encouraging their residents to use public transport more frequently, thus contributing to the limitation of passenger car traffic. However, the key measure is the introduction of a modern fleet with higher emission parameters. New vehicles, including rail ones, are characterised by more efficient use of the energy supplied. One of the most effective measures is the development of electricity-powered rail units (the underground train, tramway and city rail), which take over the tasks of individual and bus transport. In the transport served by buses, the measures to reduce exhaust gas emissions include purchases of hybrid buses enabling savings of about 30% in the energy which propels them, the use of gas (CNG and LPG) to propel them, the use of biofuels and the purchase of a fleet with better emission parameters. On lines with low passenger streams, a fleet with lesser capacity than the units used so far is introduced. Integrating investment projects are carried out in the vicinity of transport nodes (e.g. railway stations, city transport terminuses), consisting in the construction of new parking lots and also the adaptation and modernisation of already existing parking places. Depending on their locations, parking lots operate as generally accessible parking places or on the PARK&RIDE basis. . By way of public and private initiatives, publicly accessible and gradually integrated (in terms of modes and areas) passenger information systems are created (e.g. remote-access travel planners, also using applications for mobile devices). Incentives encouraging the use of collective transport also include integrated tickets for a train, tramway and bus on specified routes and the promotion of collective transport instead of the individual

transport using passenger cars (limitations and restrictions for cars). The general principle is to encourage passenger car users to leave their cars in a designated parking lot and to continue their travel by means of public transport. Promotional measures involving opportunities for cheaper rail travels are used, such as the free of charge transport of a bicycle in spring and summer or the so-called "family travels" during the summer or winter holidays. Different types of public campaigns are conducted, e.g. "Change from the Car to the Bus", the European Week of Sustainable Mobility, the European Car Free Day and the Public Transport Days (DTP), with the aim of convincing drivers to more frequently leave their cars and change to the increasingly modern and efficient public transport, *inter alia*, due to the designation of bus lanes. There is a cyclic event promoting public rail transport.

The fluidity of road traffic and the optimisation of truck parking in cities are ensured by the construction of ring roads (both outside cities and the so-called internal city ring roads), the improvement of the condition of the road surface and the appropriate change in the traffic organisation (a ban on heavy vehicle traffic in certain trees or entire areas, also at specific hours, the designation of parking places dedicated to trucks etc.).

Intermodal transport

Work continued to ensure the further development of intermodal transport, which provides an alternative to the dominating road transport, using resources from different assistance programmes. The construction and modernisation of terminals and the purchase of a fleet for intermodal transport could be supported from the resources of the *Operational Programme Infrastructure and Environment 2007–2013*, Measure 7.4 Development of intermodal transport. It was recognised that it would be purposeful to co-finance further intermodal transport in the next EU financial perspective UE 2014–2020. In the system of charges for access to rail infrastructure, cut rates were available for intermodal transport.

Cycling transport

The measures focused on amendments to regulations (the Road Traffic Law) to ensure that they are friendly to cyclers, the promotion of the bicycle as a means of transport, the construction of cycle paths and the introduction of a system of public cycle hire facilities in cities. Within the framework of the measures to implement the National Road Traffic Safety Programme 2005-2007-2013 GAMBIT 2005, the Secretariat of the National Road Traffic Safety Council conducted information and promotional campaigns to change the behaviour of road users, including the use of the bicycle as an alternative means of transport. Nongovernmental organisations disseminated guides for designers, builders and users of the cycling infrastructure, thus supporting the regulations existing in this respect. In the scope of the promotion of safe cycling, many actions were carried out by the members of the National Road Traffic Safety Council. Within the framework of rail transport, it was generally possible to transport bicycles (in the summer season more and more often carriers offer free of charge bicycle transport).

Construction and housing management

The most important measures taken to reduce greenhouse gas emissions in construction and housing management included:

The requirements related to the energy standard in construction. The technical construction regulations concerning the thermal protection of buildings in terms of the quantities of heat, cold and electricity, the use of buildings in accordance with their purposes, as well as the coefficient of heat penetration through partitions, the efficiency of heating, ventilation and air-conditioning installations and the preparation of domestic hot water were expanded and modified. This aimed at improving the energy efficiency of new buildings and existing ones undergoing expansion, reconstruction, raising and change of their use.

The assessment of the energy performance of buildings. The obligation to prepare energy performance certificates for new and expanded buildings and inspections of heating and air-conditioning systems were introduced. Moreover, the scope of the energy performance certificate template includes comments regarding the demand for energy. This raises the awareness of owners and users about the possible feasible works which would improve the energy performance of a building.

The promotion of the use of renewable energy sources. The existing regulations require an analysis of the possibility of rationally using alternative high-efficiency systems for supply of electricity and heat using energy from renewable sources and heat pumps, apart from conventional solutions, which should be carried out at the stage of preparing the construction design for all buildings.

The methodology for calculating the energy performance of a building also promote the contribution from renewable energy sources (e.g. the use of solar energy or heating with biomass).
Moreover, financial resources are available to encourage the launch of investment projects in the construction sector, using energy from renewable energy sources, and to erect buildings with high energy performance, e.g. within the framework of the National Fund for Environmental Fund for Environmental Protection and Water Management.

Thermal modernisation of buildings. Support is given from the Thermal Modernisation and Repair Fund in the form of the repayment of part of the credit taken for the implementation of a thermal modernisation project. The same form of support is also given to repair projects related to thermal modernisation that are implemented in multi-family residential buildings the use of which began before 1961.

The raising of the awareness of managers, owners and users of buildings concerning energy savings. The popularisation of measures to save energy, such as an energy saving house or thermal modernisation of buildings.

4.6.3.Agriculture

Apart from their economic functions and the creation of good conditions for social development, the rural areas are attributed an important role in respect of the preservation and recovery of landscape values and natural resources, i.e. the preservation of good ecological status of waters and soils, the richness of habitats and biodiversity, as well as the cultural heritage of the countryside. The basic principles of the EU rural development policy for 2007-2013 and also the financial instruments which can be used by Member States and regions were laid down in Council Regulation (EC) No 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) (OJ L 277 of 21.10.2005, p. 1). The National Strategic Plan for Poland was prepared in accordance with this Regulation; it covers the support for rural development by the EAFRD

and provides the basis for the implementation of measures based on the concept of multi-functionality of agriculture and rural areas.

Table 4.6. The basic regulations and programming documents laying down the directions of environmental protection in Polish agriculture.

Title of document	Description of document
The Act of 7 March 2007 on Support for Rural Development Using the Resources of the European Agricultural Fund for Rural Development (Official Journal of the Laws of 2013, Item 173).	The Act sets out the tasks and competence of authorities and organisational units in the scope of support for rural development using the resources from the European Agricultural Fund for Rural Development laid down in Council Regulation (EC) No 1698/2005 of 20 September 2005.
The Rural Development Programme for 2007–2013	The Programme lays down the objectives, priorities and principles of support for sustainable rural development.
The Act of 25 June 2009 on Organic Farming (Official Journal of the Laws, No. 116, Item 975).	The Act sets out the tasks and competence of public administration authorities and organisational units in organic farming in the scope of the implementation of the provisions of Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products (OJ L 189 of 20.07.2007, p.1).
The Act of 3 February 1995 on the Protection of Farmland and Forest Land (Official Journal of the Laws of 2013, Item 1205).	The Act regulates the principles of the protection of farmland and forest land, the reclamation and improvement of the utility value of lands, and also lays down possible conversion of forest areas to non-forestry uses.
The Directions of the Development of Agricultural Biogas Plants in Poland in 2010–2020, adopted by the Council of Ministers on 13 July 2010.	The document provides that by 2020 on average in each Polish commune one biogas plant will be set up to use biomass of agricultural origin, provided that the commune has adequate conditions for launching such a project. The basic aim of the document is to optimise the legal and administrative system for the establishment of agricultural biogas plants in Poland and to indicate the opportunities for installations of this type to be co-financed from public resources, both national and EU, available within the framework of national and regional operational programmes. It is envisaged that biogas plants will be set up in rural communes and in those where there are large areas from which biomass can be acquired, which in a way harmonises the national government measures with the priorities of the Common Agricultural Policy of the European Union.
The National Strategic Plan	The document provides the basis for the implementation of the measures of the Rural Development Programme for 2007-2013, taking into account the Community strategic guidelines for rural development.
The Strategy for Sustainable Rural Development, Agriculture and Fisheries	The aim of the Strategy is to lay down a long-term vision for rural areas and the fisheries sector in Poland and to indicate the measures which would implement this vision by 2020. The Strategy also plays the role of a platform for coordinating support given for rural areas under different policies.

Source: Ministry of the Environment.

Measures

The rationalisation of the use of fertilisers, including nitrogen fertilisers. The Act regulating fertiliser management introduced a limitation of the natural fertiliser dose to 170 kg N/ha/year, a ban on the use of natural fertilisers from the end of November to the beginning of

March, mandatory training courses for farmers who use fertilizers, a ban on the use of fertilisers on water-saturated, snow-covered and frozen soils and in fields with a slope of more than 10%. The obligation to prepare a fertilisation plan was imposed on large commercial farms. The aim of these measures is to reduce the risk posed by the impact of agriculture on water resources and the risk of losses of fertiliser components. The fertiliser extension system is disseminated. On the Internet, free of charge software was made available for calculating the quantities of natural fertilisers and the composition of fertilisers produced in a farm and so was a calculator of the nutritional needs of crop plants in respect of nutrients, depending on the yields, soil richness and the cultivated pre-crop. The mineral nitrogen in the soils of arable land and grasslands is also monitored on a regular basis.

The consumption of fertilisers still continues to be much lower than that in Western European countries, but the rationalisation of fertiliser use becomes a priority issue in agriculture, given the forecasts of higher fertiliser consumption related to enhanced productivity.

The rationalisation of energy management in agriculture, including energy production from biomass from waste, liquid manure and solid manure. The process of building new biogas plants is underway. Within the framework of the Rural Development Programme for 2007–2013, support was given to investment projects, e.g. to build urine and liquid manure tanks and manure plates. Research and development work is underway to develop technologies to increase the yield rate and methane content in biogas from locally acquired substrates and feeds on the sites where agricultural biogas plants are built. The rationalisation of energy management in agriculture encompasses the continued process of adaptation of local boiler-houses to burn wood biomass and straw. In 2010, the share of renewable carriers (including biomass) in energy supply was about 10%. The Regulation of the Council of Ministers *on the National Overall Targets for 2008–2013* of 15 June 2007 defined the minimum required energy share of bio-components in transport fuels. As a result of the achievement of this target in Poland, the consumption of ethanol in fuels amounted to 5,291 TJ in 2008; 8,162 TJ in 2009; 7,909 TJ in 2010 and 7,479 TJ in 2011, while, respectively, the use of methyl esters (biodiesel) was 13,211 TJ in 2008, 19,600 TJ in 2009, 29,221 TJ in 2010 and 31,621 TJ in 2011. It should be emphasised that substantial quantities of imported bioethanol and esters were used as fuels. The share of domestically produced bioethanol was 46% in 2008, 47% and 57%, respectively, in 2009 and 2010, and 54% in 2011. In the case of domestically produced esters, their share was 32% in 2008, 71% in 2009, 50% in 2010 and barely 44% in 2011. In recent years, the utilisation of the national capacity to produce bioethanol varied about 23–27% and in the case of esters about 44–60%. Work is underway to use fuels from renewable sources of agricultural origin, including biogas, fuels from animal fats and used cooking oil, to propel tractors. The technical modernisation of farms is underway, consisting primarily in purchases of new more energy efficient machinery and equipment. In order to limit the consumption of motor fuels, work is conducted on changes in field work technologies, including mainly the simplification of tillage, the possibilities of combining machinery and changes in harvesting technologies, particularly for sugar beet.

The use of renewable energy in agriculture is promoted within the framework of the EU projects:

- RAMseS – a multi-functional, electricity-driven agricultural vehicle supplied from photocells;
- BioMotion – enhanced consumption and wide public acceptance of biofuels as a result of knowledge transfer, information, motivation and fuel conversion strategies, the establishment of clusters and support for regional implementation strategies;

- Biosire – the initiation of the use of electric and biofuel-powered vehicles in Poland's tourist regions.

Improvements in animal feeding techniques and feed management. The implementation of breeding programmes and appropriate animal feeding standards contributing to higher productivity can cause a reduction in CO_2 and CH_4 emissions. The overall greenhouse gas emission balance was also affected by the decrease in the livestock population raised on a grid floor, as a result of many factors related e.g. to the cost-effectiveness of production, the costs of inputs, environmental and veterinary requirements and changes unfolding in Polish rural areas. Surveys were carried out showing changes in livestock populations and their more effective enteric fermentation (as a result of genetic progress and improved feeding). This made it possible for GHG emissions to be reduced by almost 40% in terms of CO_2 eq. in 2007 relative to the base year 1988.

The afforestation of agricultural land and the afforestation of non-agricultural land. In 2007-2013, the measure *Afforestation of agricultural land and non-agricultural land* continued within the framework of the Rural Development Programme (PROW); in 2007–2012, the afforestation covered 27,352.21 ha, thus contributing to greater carbon dioxide sequestration and CO_2 emission reductions, while, at the same time, producing wood biomass.

Preferences for crops with high CO_2 capture. In 2007-2009, the cultivation of crop plants for energy purposes were co-financed with EU resources at a rate of 45 EUR/ha. Using national funds, the Agricultural Market Agency supported the establishment of permanent plantations for energy purposes in the form of one-off subsidies defined as a percentage of lump-rate costs of setting up 1 ha of plantation of: energy willow (*Salix* sp.) – 50%, poplar (*Populus* sp.*)* – 30% (20% in 2009), Miscanthus (*Miscanthus* sp.*)* – 40% (30% in 2009) and Pennsylvanian mallow (*Sida hermaphrodita)* – 40% (30% in 2009). The area of permanent plantations of plants cultivated for energy purposes grew in recent years. In 2009, apart from the harvest from 7,210 ha of permanent crops, the harvest from about 22,400 ha of perennial crops was used for energy purposes. In 2010, after the Health Check of the 2003 reform of the Common Agricultural Policy it was recognised that – given the developments in the bioenergy sector (the high prices of products used to produce biofuels, the large demand for these products) and also the legal regulation of the share of biofuels in the fuel market – there was no justification for the continued award of special support in respect of energy crops. This repealed EU subsidies to the cultivation of energy plants (Council Regulation (EC) No 73/2009 of 19 January 2009 establishing common rules for direct support schemes for farmers under the common agricultural policy and establishing certain support schemes for farmers, amending Regulations (EC) No 1290/2005, (EC) No 247/2006, (EC) No 378/2007 and repealing Regulation (EC) No 1782/2003 (OJ L 30 of 31 January 2009, p. 16). There are no signals to suggest a further dynamic growth of long-term plantations for energy purposes.

The technologies for growing and harvesting willow, Micanthus and Pennsylvanian mallow were improved and work began to develop technologies and to implement the cultivation of new species of energy plants: poplar, false acacia, big bluestem, prairie cordgrass and switchgrass. Research was carried out to develop a technology for setting up willow and poplar plantations on unused grasslands in the system of willow cuttings, which rules out the plough cultivation of this land. Moreover, research is carried out on the technology for the cultivation of agricultural plants (corn, sorghum, sugar beet) to be used as substrates for biogas production. Studies are carried out to assess the energy efficiency of the cultivation of agricultural plants using the Life Cycle Assessment (LCA) method. A project is underway to

develop the species-specific indices of the utility selected plants for energy purposes and to optimise their field production techniques.

The rational management of farmland. The obligation of all the beneficiaries of direct support and other area payments under the EU Common Agricultural Policy to comply with the practices of good agricultural culture, such as the minimum soil cover and crop rotation (the co-called cross-compliance principle) has been in place since 2005. This brings positive implications for both the CO_2 balance in soil and for the national management of nitrogen fertilisers (the enhanced efficiency of the fertilisers used and the limitation of water pollution by nutrients). Indeed, the large scale of the impact (a potentially absolute effect) related to the application of this instrument to most farmland in Poland in the country – more than 14 million ha – is of large importance. Conservation methods for soil cultivation without ploughing designed to reduce gas emissions from mineralisation are disseminated. The effectiveness of the use of mulching systems in differentiated conditions of habitats and field plant production is enhanced through:

- the limitation of the intensity of soil cultivation and, as a result, the limitation of the mineralisation of the organic matter in soil,
- an increase in the organic matter in soil, decaying into nutrients and, as a result, a reduction in mineral fertilisation,
- an increase in the organic matter in soil, improving its sorption properties and, as a result, e.g. the mineral fertiliser storage capacity.

The long-term research to determine the optimum groundwater level in peat and half-bog soils, in terms of halting organic matter losses in them, made it possible to draw up relevant recommendations. The reconstruction and modernisation of land amelioration systems to restore the appropriate moisture content in organic soils in order to limit their mineralisation would reduce CO_2 emissions from these soils by 22%.

Improvements in animal keeping systems and reductions in methane emissions from animal excreta. Research and development work was carried out to develop new technological systems of buildings and new livestock keeping methods. As a result of changing pig keeping techniques from traditional high-emission to low-emission ones (with the emission levels per pen of 0.8 kg CH_4/year and 0.65 N_2O/year), by partially covering the coop by a grid and increasing the angle of inclination of the floor (to speed up the excreta runoff), the emission intensity of animal production fell by 15% compared with 2004. Progress in the implementation of regulations concerning the storage and disposal of animal excreta significantly contributed to methane emission reductions. Research was carried out to determine the impact of new technological systems of buildings and livestock keeping methods on greenhouse gas emissions in order to select solutions defined as the best available techniques (BAT) in pig and poultry growing.

On the basis of research done on the emissions of noxious gases from milk cow houses, it was found that, as a result of the application of less emission intensive technologies, the CH_4 emissions could be reduced by 10%, while those of NH_3 by about 30%.

The elimination of gaseous pollutants emitted from poultry buildings by using phytomediation and solar ventilation. Research was carried out to estimate and select the plants which would be most suitable for applications of this type; moreover, it was envisaged

that modified henhouses with solar ventilation would be developed. The CO_2 emission reduction levels were determined as 30–40%.

4.6.4.Waste

The waste management principles, including the hierarchy of waste handling, are laid down by the Act of 14 December 2012 *on Waste* (Official Journal of the Laws of 2013, Items 21 and 888), which transposed into the Polish law *Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives* (OJ L 312 of 22.11.2008, p. 3).

The current state of waste management in the country is described by the *National Waste Management Plan 2014 (Kpgo 2014),* which corresponds to the strategic documents adopted at the European Union and national levels. The objectives and tasks contained in the Plan concern the period of 2011–2014 and, as an outlook, the period of 2015–2022.

Poland is obliged to reduce biodegradable municipal waste going to landfills pursuant to Article 5(2) of *Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste* (OJ L 182, of 16.07.1999, p. 1, as amended; OJ Special edition in Polish, Chapter 15, Volume 4, p. 228). In accordance with the provisions of the abovementioned Article, Member States should reduce the quantity of biodegradable municipal waste relative to the weight of this waste produced in 1995 to:

- 75% in 2006,
- 50% in 2009,
- 35% in 2016.

A 4-year derogation for the above deadlines was adopted for the Member States (including Poland) for which standard Eurostat data were available and which deposited more than 80% of their municipal waste at landfills in 1995 or the last year before 1995.

Poland transposed the above objectives of the Directive with the provisions of the Act of 13 September 1996 on the Keeping of Cleanness and Order in Communes (Official Journal of the Laws of 2012, Item 391, as amended) and, at the same time, using the derogation, postponed the deadlines for achieving the relevant targets by 4 years.

Moreover, Poland is obliged to achieve by 2020:

1. the levels of recycling and preparing for re-use of the following fractions of municipal waste: paper, metals, plastics and glass, of at least 50% by weight;
2. the levels of recycling, preparing for re-use and recovery by other methods of non-hazardous construction and demolition waste of at least 70% by weight.

This obligation ensues from Article 11 of *Directive 2008/98/EC on waste and repealing certain Directives* and was transposed into the Polish legislation by the Act of 13 September 1996 on the Keeping of Cleanness and Order in Communes.

A Thematic Strategy on the prevention and recycling of waste COM(2005)666 provided for the promotion of sustainable use of resources. One of the objectives of the Strategy is the

commitment to such a change in the behaviour of the public in respect of waste management which would make it possible to achieve high recycling levels.

Table 4.7 presents a description of the most important Polish documents concerning waste management.

Table 4.7. The main documents and legal regulations concerning waste in Poland.

Title of document	Description of document
The Act of 14 December 2012 on Waste (Official Journal of the Laws of 2013, Item 21, as amended).	The Act sets out the principles of waste handling in a manner ensuring the protection of human life and health and environmental protection in accordance with the principle of sustainable development.
The Act of 13 September 1996 on the Keeping of Cleanness and Order in Communes (Official Journal of the Laws of 2012, Item 391, as amended).	The Act sets out the tasks of communes and the obligations of real estate owners related to the keeping of cleanness and order, the conditions for the execution of operations in the scope of the collection of municipal waste from real estate owners and the management of this waste, as well as the conditions for the grant of permits to operators rendering services in the scope regulated by the Act.
The National Waste Management Plan 2014, adopted by the Resolution No. 217 of the Council of Ministers on 24 December 2010. (M. P. No. 101, Item 1183).	The Plan covers a full scope of tasks necessary to achieve integrated waste management in the country in a manner ensuring environmental protection, taking into account the present and futures capabilities and economic circumstances, and the technological level of the existing infrastructure. The objectives and tasks presented in the Plan concern the period of 2011–2014 and, as an outlook, the period of 2015–2022.
The Act of 11 May 2001 on Packaging and Packaging Waste (Official Journal of the Laws, No. 63, Item 638, as amended).	The Act sets out the requirements to be met by packaging in respect of the principles of environmental protection and the ways of handling packaging and packaging waste ensuring the protection of human life and health and environmental protection in accordance with the principle of sustainable development.
The Act of 20 January 2005 on the Recycling of End of Life Vehicles (Official Journal of the Laws of 2013, Item 1162).	The Act sets out the principles of handling end of life vehicles in a manner ensuring the protection of human life and health and environmental protection in accordance with the principle of sustainable development.
The Act of 29 July 2005 on Waste Electric and Electronic Equipment (Official Journal of the Laws of 2013, Item 1155).	The main goal of the Act is to establish a system for managing waste electric and electronic equipment through reducing the quantity and adverse impact of the waste, in the form of waste electric and electronic equipment, on the environment by introducing the obligation in the scope of selective collection and recovery of the waste, including its recycling.
Act of 24 April 2009 on Batteries and Accumulators (Official Journal of the Laws, No. 79, Item 666, as amended).	The Act sets out the requirements for products introduced in the form of batteries and accumulators, the waste arising from these products and the equipment which is wholly or partially powered by batteries and accumulators or is suitable to be powered with them.
The Act of 10 July 2008 on Extractive Waste (Official Journal of the Laws of 2013, Item 1136).	The Act sets out: 1) the principles of managing extractive waste and uncontaminated soil; 2) the principles of managing an extractive waste disposal site; 3) the procedures for obtaining permits and authorisations for extractive waste management; 4) the procedures for preventing major accidents at Category A extractive waste disposal sites.

Source: Ministry of the Environment.

The long-term goal of the establishment of the national waste management plan is to achieve a waste management system which would be consistent with the principle of sustainable development and which would fully implement the principles of correct waste management in terms of the protection of human health and protection. In particular, the hierarchy of waste handling should be followed, according to which the most desirable manner of waste handling is to prevent its generation and, subsequently, to prepare it for re-use, recycling, other recovery methods (e.g. energy recovery) and disposal. The achievement of this goal will make it possible to attain other objectives, such as the reduction of the landfill of waste, particularly in respect of biodegradable waste, the mitigation of climate change caused by waste management or an increase in the share of energy from renewable energy sources in the national energy balance through the replacement of fossil fuels by different types of methods for energy recovery from waste.

Measures

Enhanced recycling of municipal waste. The achievement of the levels of recycling and preparing for the re-use of paper, metals, plastics and glass of at least 50% by weight by the end of 2020 is planned.

Waste as a source of energy. Energy supply as a result of the application of waste incineration processes and the use of municipal waste landfills as a source of electricity and heat generation – through the processing of landfill gas.

The reduction of the quantity of waste, including biodegradable waste, going to landfills of non-hazardous and inert (municipal) waste. This measure is implemented by promoting no-waste/low-waste technologies, waste processing by more environment-friendly methods (e.g. recycling) and raising the rates of the charges for the landfill of waste containing a biodegradable fraction.

4.6.5.Forestry

Every year the communication on the state of forests and the implementation of the National Programme for the Augmentation of the Forest Cover (KPZL) in Poland is reviewed by the Government and Parliament. The National Forest Policy (KPZL), adopted by the Council of Ministers on 22 June 1997, is a document which guides the measures in the forestry sector and indicates the intersectoral and international linkages of forestry.

The aim of forest policy is to lay down a set of measures shaping man's attitude to forests, aiming to preserve the conditions for sustained multi-functionality of forests in a unlimited timeframe in a changing natural and socio-economic reality, and their comprehensive utility and role in shaping the natural environment in accordance with the present and future expectations of society. The National Forest Policy also places a large emphasis on the enhancement of the forest area.

The forest resources will be increased through:
- the augmentation of the national forest cover to 30% in 2020 and 33% in the mid-21st century, successively as the lands unsuitable for agriculture are transferred for afforestation and the spatially optimum forest structure is achieved in the landscape through the protection and full utilisation of the productive capacities of habitats,

- the restitution and rehabilitation of forest ecosystems, mainly through the reconstruction on appropriate sites of single-species tree-stands into mixed ones, and through biomelioration operations,
- the regeneration of devastated and neglected tree-stands in private forests and their subsequent ecological rehabilitation.

The implementation of these measures will contribute to the enhancement of the sequestration capacity of Polish forests. Forest policy covers forests under all forms of ownership and lays down the paths for the implementation of all the functions of forests – productive, ecological and social. The responsibility for the implementation of the policy rests mainly on the State Forests acting pursuant to the Act of 28 September 1991 *on Forests* (Official Journal of the Laws of 2011, No. 12, Item 59, as amended). Forest management is guided by the following principles:

- the general protection of forests;
- the sustained maintenance of forests;
- the continued and sustainable use of all the functions of forests;
- the enhancement of forest resources.

The pursuit of sustainable, multi-functional forest management directly involves the preservation and enhancement of forest resources and the rich biodiversity of forests. An expression of the protection and preservation of biodiversity in forests is the fact that large forest areas have been integrated into the European Ecological Network Natura 2000 (almost 40% of the forest area in Poland).

In March 2010, the European Commission published a Green Paper on forest protection and information in the EU: preparing forests for climate change. The Green Paper is a sort of a compendium of knowledge about the impact exerted by forests on climate phenomena. It presents the overall situation of forests, their importance in the world and their features and functions in the EU. A list of the most important documents related to forestry is given in Table 4.8.

Table 4.8. The main documents concerning forestry in effect in Poland.

Title of document	Description of document
The Act of 28 September 1991 on Forests (Official Journal of the Laws of 2011, No. 12, Item 59, as amended).	The Act sets out the principles of the preservation, protection and enhancement of forest resources and the principles of forest management linked to other elements of the environment and the national economy.
The National Forest Policy (PLP), adopted by the Council of Ministers on 22 April 1997.	It is a document which guides the measures in the forestry sector, indicating its intersectoral and international linkages.
Programme for the Augmentation of the Forest Cover (KPZL), adopted by the Council of Ministers in 1995 and updated in 2003.	The Programme sets out the tasks aimed at the augmentation of the forest cover rate to 30% by 2020 and 33% after 2050. It defines the quantitative transfer of lands from agriculture to forestry and presents a comprehensive plan of measures to rationalise the use structure of the national natural space. New afforestation projects are part of the implementation of the multi-functional and sustainable development of the country.

The Act of 16 April 2004 on Nature Conservation (Official Journal of the Laws of 2013, Item 627, as amended).	The last amendments to the Act expand the provisions setting out the scope of the conservation plan (necessary to effectively protect Natura 2000 sites) – meeting the obligation under Article 6 (1) of the Habitats Directive and under Article 4 of the Birds Directive and achieving to an appropriate extent the objective of both Directives – maintaining or restoring the favourable status of the conservation objects in the Natura 2000 Network.

Source: Ministry of the Environment.

Measures

Taking action against land use change. The conversion of forest land to non-forest uses is of marginal significance in relation to the continuously growing total surface area of forests.

The rationalisation of forest management, incentives and measures supporting afforestation and the protection of the ecological stability of forests. Forest management is conducted in accordance with the Act of 28 September 1991 on Forests and covers both the afforestation of non-forest lands, reforestation, the enhancement of standing timber and timber logging which varies at the level of about 50–60% of the current annual increment.

The afforestation in 2011 took place on a total of 5,277 ha, including 594 ha of the State Treasury lands. Altogether in 1995–2010, the (artificial) afforestation was carried out on 132,400 ha of the State Treasury lands, including 127,700 ha in the State Forests National Forest Holding.

4.6.6. Summary

Table 4.9 A summary description of the impact of national measures on greenhouse gas emissions.

Title of policy/measure	Objective and manner of implementation	GHG	Type of instrument	Status	Implementing institution	Quantitative assessment of the impact of policies/measures by years [Gg]			
						2010	2015	2020	2025
ENERGY SECTOR									
Stimulation of the development of cogeneration	A system of mechanisms of support for combined heat and power production	CO_2	legal, financial, organisational	W	Minister responsible for the economy	223.474[44]	199.890	30.005	30.005
Modernisation of local heating networks and the connection of heat users	A system of mechanisms of support for energy efficiency improvement	CO_2	legal, financial	W	Minister responsible for the economy	84.956[7]	143.063	127.140	171.565
Modernisation of heat sources	A system of mechanisms of support for energy efficiency improvement	CO_2	legal, financial	W	Minister responsible for the economy	60.885[7]	287.556	96.601	119.971
Modernisation of industrial installations	A system of mechanisms of support for energy efficiency improvement	CO_2	legal, financial	W	Minister responsible for the economy	4.352[7]	5.719	NA	NA
Modernisation of lighting systems	A system of mechanisms of support for energy efficiency improvement	CO_2	legal, financial	W	Minister responsible for the economy	0.221[7]	0.609	NA	NA
Support for the use of methane from hard coal mines to produce electricity and heat	Industrial use of methane from methane removal from hard coal mines	CH_4	legal, financial, organisational	W	Minister responsible for the economy	265.322[7]	NA	NA	NA
Support for the development of energy from renewable sources	Exemption of the sales of electricity from RES from the excise tax and the obligation for energy enterprises to have certificates of origin for electricity from RES	CO_2, CH_4	legal, financial, organisational	W	Minister responsible for the economy Minister responsible for finance	135.087[7]	187.048	163.846	169.853
INDUSTRY									
Improvements in technical standards of installations and equipment	Improvement in the energy efficiency of industrial production	CO_2	legal	W	Minister responsible for the economy	NA	NA	NA	NA
Fluorinated greenhouse gases	Introduction of mechanisms for monitoring and control of consumption	HFCs PFCs SF_6	legal, financial, organisational	P	Minister responsible for the environment Minister responsible for the economy	NA	NA	NA	NA
Implementation of the best available techniques	Prevention and minimisation of emissions	All GHGs	legal, financial organisational	W, P	Minister responsible for the environment	NA	NA	NA	NA
Reductions in methane emissions from fuel production and distribution processes	Introduction of hermetic systems at fuel stations to gain savings in trading in liquid fuels (on average 0.37%)	CH_4	legal	W	Minister responsible for the economy	NA	NA	NA	NA
Promotion of environmentally friendly and effective practices and technologies in industrial activities and support for the development of environment-friendly and technically cost-effective methods for greenhouse gas emission reductions	Popularisation of the best techniques in the individual fields of production	CO_2	educational	W	Minister responsible for the economy Minister responsible for the environment	NA	NA	NA	NA

[44] The effect of the projects supported with the resources of the Voivodeship Funds for Environmental Protection and Water Management.

Title of policy/measure	Objective and manner of implementation	GHG	Type of instrument	Status	Implementing institution	Quantitative assessment of the impact of policies/measures by years [Gg]			
						2010	2015	2020	2025
Technological modernisation at industrial plants	Improvement in energy efficiency and the replacement of fuels by low-emission ones	CO_2	legal, financial, organisational	W	Minister responsible for the economy	NA	NA	NA	NA
TRANSPORT									
Reduction in the environmental annoyance of goods road transport	A package of measures to reduce vehicle exhaust gas emissions	CO_2 N_2O	legal, financial, technical, educational	W	Minister responsible for transport/ Minister responsible for the environment/ Minister responsible for regional development / National Road Traffic Safety Council/ National Fund for Environmental Protection and Water Management (NFOŚiGW)	NA	2,241.39[45]	3,246.50	4,982.59
Enhanced share of alternative fuels in transport	Enhanced use of LPG and biofuels	CO_2	financial	W	Minister responsible for the economy/ Minister responsible for finance/ Minister responsible for transport/ Minister responsible for regional development / Minister responsible for the environment / NFOŚiGW	5.75%[46]	7.10%	10%	NA
Rail transport	A package of measures to improve energy efficiency	CO_2	legal, financial	W	Minister responsible for transport/ State Railways Track Manager (PKP PLK)/ territorial self-government units	NA	NA	NA	NA
Sea shipping	Improved energy efficiency on newly built ships	CO_2 N_2O	legal	W	Minister responsible for transport	NA	NA	NA	NA

[45] Own calculations based on "Expert forecasts of changes in the activity of the road transport sector (in the context of the Act on the System to Manage the Emissions of Greenhouse Gases and Other Substances)", Motor Transport Institute, Warsaw 2012; "Forecasts of transport demand in Poland until 2020 and 2030", Jan Burnewicz, Sopot 2012. The forecast emission reductions were determined in relation to 2010.

[46] The recorded or predicted share of bio-components and other renewable fuels in the total quantity of liquid fuels and liquid biofuels used in the course of a calendar year in transport. On the basis of the values of the National Overall Target pursuant to the Regulation of the Council of Ministers of *23 July 2013 on the National Overall Targets for 2013-2018* (Official Journal of the Laws of 13 August 2013, Item 918) and the information provided in the *Report to the European Commission on the support for the use of biofuels and other renewable fuels in transport in 2012.*

Title of policy/measure	Objective and manner of implementation	GHG	Type of instrument	Status	Implementing institution	Quantitative assessment of the impact of policies/measures by years [Gg]			
						2010	2015	2020	2025
Air transport	Activities to establish the Single European Sky (SES), carbon accreditations (ACI), restructuring of the system of air traffic routes, strengthening of emission standards, economical management of propellants	CO_2, N_2O	legal, technical	W	Minister responsible for transport	NA	NA	NA	NA
City transport, including public transport	A system of incentives encouraging the use of collective transport and measures to improve road traffic flow	CO_2, N_2O	legal, administrative, technical	W	territorial self-government units and other entities, mainly General Directorate of National Roads and Motorways (GDDKiA)	NA	NA	NA	NA
Intermodal transport	Development of intermodal transport as an alternative to the dominating road transport	CO_2, N_2O	legal, administrative, financial	W	Minister responsible for transport, carriers, terminal managers	NA	NA	NA	NA
Cycling transport	A system of mechanisms of support for cycling transport	CO_2, N_2O	legal, administrative	W	Minister responsible for transport/ Minister responsible for regional development / Minister responsible for sports/ territorial self-government units	NA	NA	NA	NA
CONSTRUCTION									
The requirements related to the energy standard in construction	Expansion and modification of technical construction regulations concerning the thermal protection of buildings	CO_2	legal	W	Minister responsible for infrastructure and development	NA	NA	NA	NA
The assessment of the energy performance of buildings	Energy performance certificates and inspections of heating and air-conditioning systems	CO_2	legal	W	Minister responsible for infrastructure and development	NA	NA	NA	NA

Title of policy/measure	Objective and manner of implementation	GHG	Type of instrument	Status	Implementing institution	Quantitative assessment of the impact of policies/measures by years [Gg]			
						2010	2015	2020	2025
The promotion of the use of renewable energy sources	Promotion of high-efficiency systems for supply of electricity and heat using energy from renewable sources	CO_2	legal, financial	W	Minister responsible for infrastructure and development Minister responsible for the economy, NFOŚiGW, Minister responsible for the environment	NA	NA	NA	NA
Thermal modernisation of buildings	Financial support for thermal modernisation projects	CO_2	legal, financial	W	Minister responsible for construction	15,673[47]	16,000	16,000	16,000
The raising of the awareness of managers and owners of buildings concerning energy savings	Popularisation of measures to save energy	CO_2	educational	W	Minister responsible for construction	NA	NA	NA	NA
AGRICULTURE									
The rationalisation of the use of fertilisers, including nitrogen fertilisers	A system of measures of support for efficient use fertilisers	N_2O	legal, organisational	W	institutes/ chemical and agricultural stations/ farmers	NA	NA	NA	NA
The rationalisation of energy management in agriculture, including the production of energy from biomass from waste, liquid manure and solid manure	A package of mechanisms of support for energy supply from RES and improvements in energy efficiency in agricultural production	CO_2, CH_4	legal, organisational, research, educational	W	self-government administration/ advisers/ entrepreneurs/ farmers/ institutes	16.390	16.390	NA	CO_2 – by 3.47424 CH_4 – by 0.01302
Improvements in animal feeding techniques and feed management	Implementation of breeding programmes and precise animal feeding standards combined with higher productivity and the resulting reduction in the livestock population	CO_2, CH_4	legal, organisational	W	farmers	NA	NA	NA	CO_2 – by 0.800 CH_4 – by 0.100
Afforestation of agricultural land and non-agricultural land	Afforestation of agricultural land and non-agricultural land within in the framework of the Rural Development Programme (PROW).	CO_2	legal, organisational, financial	W	Agency for Restructuring and Modernisation of Agriculture (ARiMR)/ farmers	NA	2008-60.253[48] 2009-200.409 2010-368.634 2011-432538	NA	NA
Preferences for crops with high CO_2 capture	A system of mechanisms of support for the cultivation of plants for energy purposes	CO_2	legal, financial, research, educational	W	Agricultural Property Agency (ANR)/ farmers/ institutes	NA	NA	NA	CO_2 – by 16,640
The rational management of farmland (arable land and permanent grassland)	Compliance with practices of good agricultural culture to halt the mineralisation of organic soils	CO_2	legal, organisational, financial, research, educational		institutes farmers/ advisers/ agricultural machinery industry	NA	NA	NA	NA

[47] The effect of thermal modernisation projects supported with the resources of the Voivodeship Funds for Environmental Protection and Water Management.

[48] The CO_2 sequestration level was determined on the basis of the methodology and data used in the national inventory to assess the carbon balance in afforestation under the KP-LULUCF.

Title of policy/measure	Objective and manner of implementation	GHG	Type of instrument	Status	Implementing institution	Quantitative assessment of the impact of policies/measures by years [Gg]			
						2010	2015	2020	2025
Improvements in livestock keeping systems, reductions in methane emissions from animal excreta	Research and development to develop new technological systems of buildings and new livestock keeping methods	CH_4, N_2O NH_3	research	W	institutes/ farmers	NA	NA	keeping of animals: CH_4 – by 3.285 NH_3- by 0.13	storage and disposal of excreta CH_4 – by 0.600 N_2O – by 1.000 keeping of animals: CH_4 – by 3.285 NH_3- by 0.13
The elimination of gaseous pollutants emitted from poultry buildings by using phytomediation and solar ventilation	Research to estimate and select the plants which would be most suitable for applications of this type and the development of modified henhouses with solar ventilation	CO_2, NH_3	research	W	institutes/ production enterprises	NA	NA	NA	NA
WASTE									
Enhanced recycling of municipal waste	Increasing the recycling of selected fractions of municipal waste. The achievement of the levels of recycling and preparing for the re-use of paper, metals, plastics and glass of at least 50% by weight by the end of 2020	CH_4 CO_2 N_2O	legal, organisational	S	self-government administration	[2] "avoided" emissions in Gg CO_2-eq: *200.*: 641.3 *2009:* 574.1 *2010:* 663.5 *2011:* 779.2	[1] "avoided" emissions in Gg CO_2 eq/Mg of waste: 3,000 – 3,500	[1] "avoided" emissions in Gg CO_2 eq/Mg of waste: 4,000 – 4,500	NA
Waste as a source of energy	Energy supply as a result of the application of waste incineration processes and the processing of landfill gas	CH_4 CO_2	legal, organisational	S	self-government administration/ inspection services (environmental inspectorate) / entrepreneurs	[3] "avoided" emissions in Gg CO_2 eq: *2008:* 159.2 *2009:* 210.8 *2010:* 271.0 *2011:* 373.9	NA	NA	NA
The reduction of the quantity of waste, including biodegradable waste, going to landfills of non-hazardous and inert (municipal) waste	The reduction of the quantity of waste (including biodegradable waste) going to municipal waste landfills	CH_4 CO_2	legal, organisational	S	government administration/ self-government administration (Marshals' Offices)/ inspection services (environmental inspectorate)	NA	[4] reduction by at least 5-10% relative to 2010 (by 383-766 Gg CO_2 eq)	[4] reduction by at least 5-10% relative to 2015 (by 345-728 Gg CO_2 eq)	NA
FORESTRY									

Title of policy/measure	Objective and manner of implementation	GHG	Type of instrument	Status	Implementing institution	Quantitative assessment of the impact of policies/measures by years [Gg]			
						2010	2015	2020	2025
Taking action against land use change	Maintenance of existing forest areas	CO_2	legal	W	State Forests National Forest Holding	NA	NA	NA	NA
The rationalisation of forest management, incentives and measures supporting afforestation and the protection of the ecological stability of forests	Afforestation of non-forest lands, reforestation, the enhancement of standing timber resources and timber logging which cannot exceed 50–60% of the annual increment	CO_2	legal	W	State Forests National Forest Holding	NA	NA	NA	NA

Note: W – implemented measures, S – continuous measures, P – planned measures

NA – Not Available

[1)] Expert assessment – estimates based on statistical data from GUS on the quantities of the individual fractions of municipal waste collected selectively in a given year (assuming its linear growth); the document "Waste and Climate Change: Global Trends and Strategy Framework", UNEP 2010

[2)] Calculations based on GUS Yearbooks and the document "Recycling for climate protection. Reducing greenhouse gas emissions – showing responsibility towards future generations" ALBA Group

[3)] Calculations based on:
- GUS data on the quantity of heat [GJ] and electricity [MWh] produced in a given year
- assumptions (sources: „Methane Tracking and Mitigation Options - EPA-CMOP", *www.epa.gov;* „Optimising anaerobic digestion", C. Banks, *www.forestry.gov.uk):*

[4)] Expert assessment – an estimate based on calculations of CO_2 eq. emissions in 2005-2011 from waste landfills. The following information was used: the CO_2 eq. emissions per kg of waste deposited at landfills – 0.39m^3 (source: http://marekpilawski.com, accessed on 24 May 2013), CO_2 density – 1.96 kg/m^3, GUS data on the quantity of waste deposited at landfills in a given year

The following indicators were used to assess the impact of recycling measures:

Type of recycled material	CO_2 eq (t) emissions "avoided" per 1t of recycled material	
	UNEP[1]	ALBA Group[2]
Electronic equipment		1.016
Plastics	0.500	0.958
Aluminium	10.000	
Steel	2.000	
Paper	1.550	0.402
Glass	0.500	0.295

[1]Waste and Climate Change: Global Trends and Strategy Framework", UNEP 2010.

[2] Recycling for climate protection. Reducing greenhouse gas emissions – showing responsibility towards future generations.

In turn, the following assumptions were adopted for emissions from the landfill gas:

Calorific value of CH_4= 37 MJ/m^3 = 0.037 GJ/m^3

1m^3 CH_4= 0.662 kg CH_4

1 kg CH_4 = 21 kg CO_2 eq

1m^3 CH_4= 10 kWh = 0.01 MWh

Sources: "Methane Tracking and Mitigation Options - EPA-CMOP", *www.epa.gov;* "Optimising anaerobic digestion", C. Banks, *www.forestry.gov.uk):*

4.7. Outdated policies and measures

Bearing in mind the fact that the abovementioned policies are of long-term character and their implementation began relatively recently, it is impossible yet to indicate which of them are least effective and should be ceased. Moreover, the abovementioned policies and measures play many functions and exert their impact not only on emission reductions or enhanced sequestration and, even with their slight effect on greenhouse gas emissions they must be continued.

4.8. The influence of policies and measures on long-term emission trends

In 2009, the potential for long-term greenhouse gas emission reductions until 2030 was assessed by McKinsey&Company and it was presented during the review of the Fifth National Communication in 2011. Another expert study carried out by the Institute for Structural Research (IBS) in 2013 covers the period until 2050. The analysis indicates that the greenhouse gas emissions in Poland can be reduced by 55% at negative costs without using expensive or poorly known technologies. The policies and measures identified as economically most beneficial and most effective that would enable the achievement of this goal are presented in Fig. 4.3.

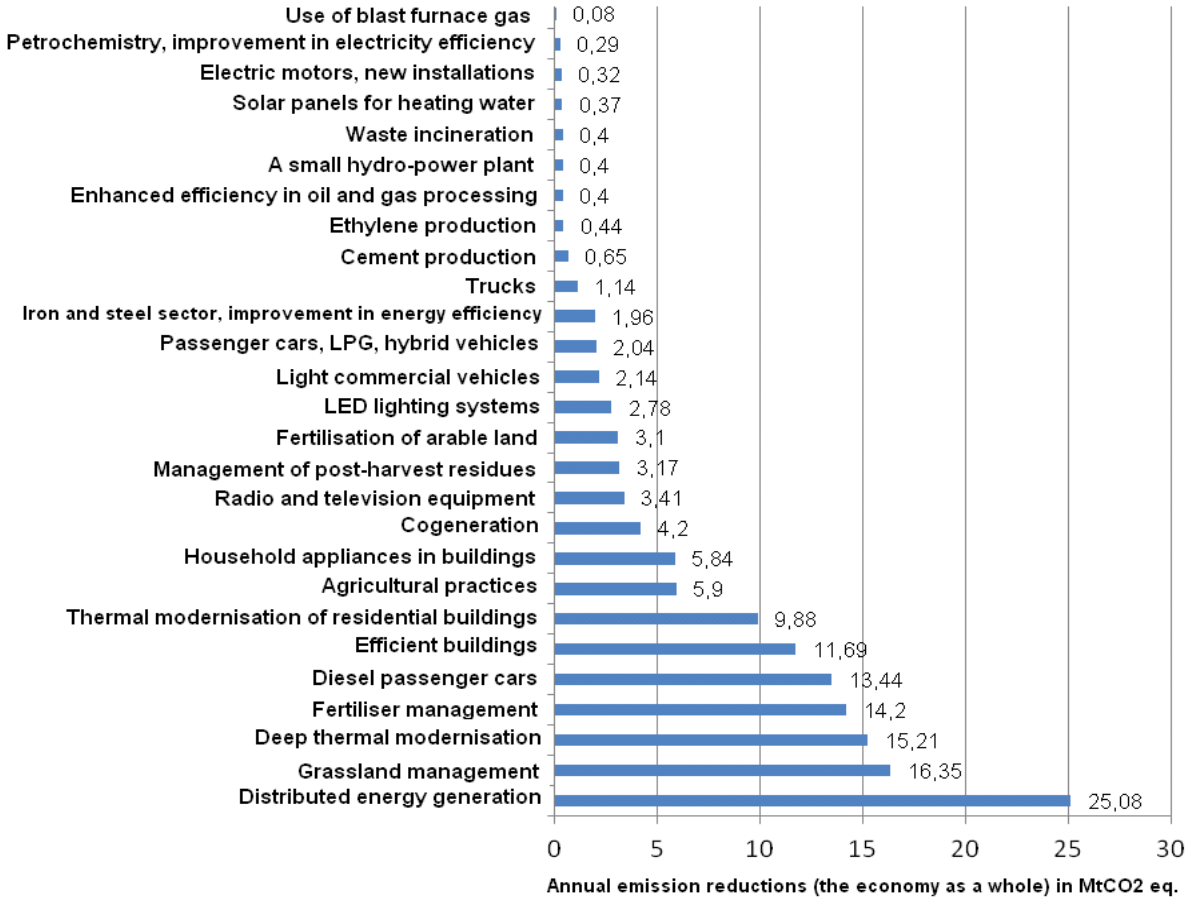


Fig. 4.3. The most effective measures enabling the achievement of a 55% greenhouse emission reduction until 2050. Source: IOŚ-PIB after IBS.

The greatest reduction potential is offered by distributed energy generation, including prosumer energy generation. Another four measures are related to agriculture, construction and road transport.

4.9. The implementation of the mechanisms of the Kyoto Protocol (the KP)

The Act of *17 July 2009 on the System to Manage the Emissions of Greenhouse Gases and Other Substances (*Official Journal of the Laws, No. 130, Item 1070, as amended*)* introduces three mechanisms under the Kyoto Protocol into Polish legal regime: Joint Implementation, the Clean Development Mechanism and emissions trading.

4.9.1. Joint Implementation (JI) – Article 6 of the KP

The procedure which is now applied in Poland to approve Joint Implementation projects is consistent with the international guidelines. It was laid down in the Act of *17 July 2009 on the System to Manage the Emissions of Greenhouse Gases and Other Substances.* These provisions regulate the issues concerning JI projects, providing a legal basis for their approval and implementation. Poland can carry out Joint Implementation projects under the Track I process in which projects can be approved within the framework of national procedures (set out in the abovementioned Act) without the need to involve the Joint Implementation Supervisory Committee (JISC). The execution of Joint Implementation projects requires the issue of a Letter of Endorsement and, subsequently, a Letter of Approval. Both of these types of letters are issued, by way of an administrative decision, by the Minister of the Environment.

4.9.2. The Clean Development Mechanism – Article 12 of the KP

The principles and procedures of Poland's implementation of projects within the framework of the Clean Development Mechanism (CDM) were laid down in the Act of *17July 2009 on the System to Manage the Emissions of Greenhouse Gases and Other Substances.* The participation in the implementation of a CDM project requires consent of the Minister of the Environment which is issued in the form of an administrative decision. The consent is given on request of the party interested in taking part in the project.

4.9.3. International Emissions Trading – Article 17 of the KP

In accordance with the provisions of Decision 11/CMP.1 laying down the rules and guidelines for emissions trading under the Kyoto Protocol (FCCC/KP/CMP/2005/8/Add.3), each country must meet specific conditions to participate in emissions trading (Article 17 of the Kyoto Protocol). On 29 April 2008, Poland became a country which met these requirements without reservations on the part of the Compliance Committee Enforcement Branch (http://unfccc.int/kyoto_protocol/compliance/ items/2875.php).

4.10. Emission allowance trading in the European Union

In accordance with the requirements of Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003, which was subsequently repeatedly amended, an emission

allowance trading scheme was set up in Poland. The last change was introduced pursuant to the provisions of Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009. The changes introduced by the provisions of Directive 2009/29/EC significantly modified the operating principles of the emission allowance trading scheme, hereinafter referred to as "the EU ETS scheme". New operating principles of the EU ETS scheme have been in effect since 1 January 2013. The main change lies in the adoption of new ambitious reduction targets by the EU. Starting in 2013, the sale of allowances at auctions was adopted as the main rule of their allocation in the EU ETS scheme. In the previous trading periods, the EU ETS scheme was principally based on free allowances determined on the basis of historical emissions, while allowances were sold only in the case of non-issued allowances.

The EU ETS scheme has been in operation within the EU since 1 January 2005, while Directive 2003/87/EC was transposed into the national legal regime with the provisions of the Act of 22 December 2004 *on the Air Emission Allowance Trading Scheme for Greenhouse Gases and Other Substances* (Official Journal of the Laws, No. 281, Item 2784, as amended), and then by the Act of 28 April 2011 *on the Greenhouse Gas Emission Allowance Trading Scheme* (Official Journal of the Laws, No. 122, Item 695), which came into effect on 21 June 2011 (see Table 4.1).

The emission allowance trading scheme covers installations meeting specific criteria under Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 *amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community*, referring to the types of activities and production capacity. Directive 2009/29/EC extended the EU ETS scheme with new types of activities and gases.

Before 21 June 2011, the Regulation of the Minister of the Environment of 27 July 2009 *on the types of installations covered by the Community emission allowance scheme* (Official Journal of the Laws, No. 136, Item 1120) had been in effect. In accordance with this Regulation, the largest installations in the country producing electricity, heat, coke, steel, cement, lime, glass and paper had been included in the greenhouse gas emission allowance trading scheme. Table 4.10 shows the number of installations covered by the EU ETS and the total CO_2 emissions in the EU ETS in 2005–2011.

Table 4.10. The number of installations participating in the EU ETS, the CO_2 emission levels in the EU ETS in 2005–2011 and their comparison with the GDP.

Year	Number of installations	CO_2 emissions [Mg CO_2]	Change in CO_2 emissions relative to the previous year [%]	GDP[49]	Change in GDP growth rate relative to the previous year [%]
2008	832	204,107,419	-2.63	5.1	-1.7
2009	828	191,174,249	-6.34	1.6	-3.5
2010	810	199,726,907	4.47	3.9	2.3
2011	813	203,026,525	1.65	NA	-

Source: KOBiZE, IOŚ-NRI.

In successive years, the number of installations covered by the EU ETS slightly varied due to changes in the National Allocation Plan (NAP)[50] caused by the inclusion of new installations

[49] http://www.stat.gov.pl/cps/rde/xbcr/gus/rn_komunikat_skor_szac_war_nom_i_pkb_za_lata_2009-2010.pdf.

[50] The Regulation of the Council of Ministers of 1 July 2008 on the adoption of the National Allocation Plan for carbon dioxide emissions for 2008–2012 for the Community emissions trading scheme (Official Journal of the Laws, No. 202, Item 1248). The Regulation of the

meeting the criteria for the participation in the EU ETS and the exclusion of installations ceasing to operate or significantly reducing their production capacity. In most cases, these are installations with low emissions and a slight impact on the total emissions from the EU ETS.

In the third trading period covering 2013-2020, the principles of the allocation of allowances are designed to ensure equal conditions for all the sectors and installations. Table 4.11 shows the main differences in the approach to the allocation of free allowances between the trading periods.

Table 4.11. Comparison of the principles of the allowance allocation between the first two trading periods and the third one.

First and second trading periods	Third trading period
National caps	A cap for the whole EU
A fixed cap	A cap reduced from year to year
3- and 5-year trading periods	8-year trading period
Limited auctioning (< 4 %)	A large share of allowances sold at auctions
Free allocation of allowances to industry and electricity production	Temporary free allocation to industry and heat production (no allocation to electricity production)
Free allocation based on emissions at the installation level	Free allocation based on emission intensity at the product level
Free allocation based on historical emissions	Free allocation calculated using emission intensity benchmarks for products
Legal basis: • Directive 2003/87/EC • National Allocation Plan • EC Decisions on the NAP • Decisions to upload the NAP table into the Community-wide registry	Legal basis: • Amended Directive 2003/87/EC • Principles of a harmonised allowance allocation in the EU as a whole (CIMs) • National Implementation Measures (NIMs)

Source: KOBiZE, IOŚ-NRI.

4.11. The National Green Investment Scheme (GIS)

The National Green Investment Scheme (GIS) derives from the emissions allowance trading mechanism. The idea and objective of the GIS are basically to generate and strengthen the environment-friendly effect of the sales of Assigned Amount Units (AAUs)**.**

The GIS is a mechanism of the sales of AAUs to countries or entities (authorised by these countries) which need the units to achieve their reduction target under the Kyoto Protocol. The GIS guarantees that the proceeds from the abovementioned sales will be allocated to objectives related to environmental protection and, in particular, to measures designed to reduce the adverse impacts of climate change and leading to further greenhouse gas emission reductions. In Poland, the legal framework for the National Green Investment Scheme was adopted by the Act of 17 July 2009 *on the System to Manage the Emissions of Greenhouse Gas Emissions and Other Substances* (Official Journal of the Laws, No. 130, Item 1070, as amended). This Act regulates the principles of the functioning of the GIS, including its organisation and the selection of projects. In turn, the Regulation of the Council of Ministers of 20 October 2009 *on the types of programmes and projects designated for implementation within the framework of the National Green Investment Scheme* (Official Journal of the Laws, No. 187, Item 1445) defines the types of programmes and projects designated for

Council of Ministers of 25 October 2012 amending the Regulation on the adoption of the National Allocation Plan for carbon dioxide emissions for 2008–2012 for the Community emissions trading scheme.

implementation within the framework of the GIS. They are projects designed to avoid or reduce greenhouse gas emissions and those involving CO_2 removals and sequestration, the measures to adapt to climate change and other measures to protect the air. Each time the choice of specific areas is defined in the negotiations with the buyer.

The priority programmes implemented within the framework of the GIS:

- energy management in public utility buildings;
- energy management in the buildings of selected entities of the public finance sector;
- biomass-fired heat and power plants and heating plants;
- agricultural biogas plants;
- the construction, expansion and reconstruction of electricity networks to connect wind energy generation sources (RES);
- low-emission city transport;
- energy-saving street lighting systems.

To the end of 2011 the Minister of the Environment has signed seven agreements on the sales of Assigned Amount Units (AAUs) for the total price of about 130 million EUR. Negotiations are underway with other partners interested in the purchase of the Polish surplus of AAU units from Poland.

Given the need to ensure that the proceeds from the sales of Assigned Amount Units are spent to implement strictly defined objectives related to environmental protection, the performance of the tasks of the National Operator of the Green Investment Scheme was entrusted to the National Fund for Environmental Protection and Water Management. The Minister responsible for the environment supervises the performance of the tasks by the National Operator.

The proceeds from the transactions to sell AAUs are collected at the Climate Account, which is a separate bank account of the National Fund (NFOŚiGW). These proceeds are allocated to co-financing of tasks supporting the activities carried out within the framework of the programmes and projects covered by the National Green Investment Scheme.

Table 4.12 presents the expected effects of co-financing agreements signed by 31.12.2012.

Table 4.12. The expected effects of co-financing agreements signed by 31.12.2012.

Tasks	Number of projects	Electricity		Heat		Energy savings		CO_2 emission reductions [Mg/yr]	Total cost [PLN]
		Installed capacity [MWe]	Production [MWh/yr]	Installed capacity [MWth]	Production [GJ/yr]	Number of buildings	Energy savings [GJ/yr]		
Biogas	11	13.46	105,748.77	7.54	108,081.60	0.00	0.00	98,342.50	195,641,345
Biomass	2	2.81	22,488.00	13.94	321,178.00	0.00	0.00	38,392.20	45,785,000
Thermal modernisation	276	NA	NA	NA	NA	1,406.00	2,108,893.63	324,631.58	1,437,434,675
Total	289	16.27	128,236.77	21.48	429,259.60	1,406.00	2,108,893.63	461,366.28	1,678,861,020

Source: NFOŚiGW.

4.12. The national commitments under the climate and energy package

The climate and energy package reflects the possibilities and previous reduction efforts of the Member States, an expression of which is, in particular, the manner of the distribution of the greenhouse gas emission allowances meant for sales at auctions by the individual Member States and the effort sharing in the non-ETS sectors. In accordance with the relevant decisions, Poland is obliged to reduce, within the EU ETS scheme, in 2013-2020 its greenhouse gas emissions by 21% relative to 2005 and may increase its emissions from the non-ETS sectors by 14%. Moreover, Poland has undertaken to increase the share of the final electricity production from renewable energy sources by 15%, to achieve a 10% share of biofuels in the transport fuel market and to improve the energy efficiency of the economy by 2016 to the level of 9% of the average annual national final energy consumption.

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

5.1. Assumptions for the projections

The national projections covered the anticipated greenhouse gas emission levels until 2030 (broken down into those in 2015, 2020, 2025 and 2030), taking into account the effects of the policies and measures adopted and implemented to reduce greenhouse gas emissions. These projections are the so-called scenario "with measures". The main assumptions for the projections were laid down by the Energy Policy of Poland until 2030, which was drawn up in 2009 by the Ministry of the Economy. At present, the new Energy Policy of Poland until 2050 is being prepared.

The emission projections were 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 sectors, according to the IPCC classification of sources: *IPCC: Energy (including Transport)*, *Industrial Processes*, *Solvent and Other Product Use*, *Agriculture* and *Waste*. In the case of the Sector of *Land Use, Land Use Change and Forestry,* different methodological assumptions were applied, in accordance with the requirements of the UNFCCC Convention and the Kyoto Protocol, including those relating to the anthropogenic activities set out in Article 3.3 (afforestation, reforestation and deforestation) and the measures activities Article 3.4 (forest management).

The data on the projected fuel consumption (responsible for 92.2% of the national CO_2 emissions in 2011) determined the national CO_2 emissions. They were drawn up on the basis of the *Projection of the demand for fuels and energy until 2030* (Market Energy Agency, 2009) underlying the *Energy Policy of Poland until 2030* (the Annex to Resolution No. 202/2009 of the Council of Ministers of 10 November 2009).

The abovementioned projection provided for the implementation of the basic directions of Poland's energy policy, taking into account the requirements of the European Union:
- improvements in energy efficiency;
- enhanced security of fuel and energy supply;
- 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;
- limitation of the impact of the energy sector on the environment.

In the scope of energy efficiency, the following objectives of energy policy, of relevance for the projection, were taken into account:
- the commitment to maintain zero-energy economic growth, i.e. the development of an economy which will not entail higher demand for primary energy;
- a consistent reduction in the energy intensity of the Polish economy to the level of EU-15.

In accordance with the anticipated requirements of the European Union, it was assumed that the share of renewable energy in the final energy mix would grow to 15% in 2020 and that a 10% share of biofuels in the market of transport fuels would be achieved in the same year. In addition, it was assumed that forests would be protected against excessive biomass production

and that farmland would be used in a sustainable manner to generate renewable energy, including biofuels so as to prevent competition between renewable energy generation and agriculture.

The main assumptions of the macroeconomic forecast included the projection of the economic growth until 2030, taking into account an adjustment for the financial crisis in 2008 and the anticipated slowdown of the economy in successive years (Table 5.1).

Table 5.1. A synthetic forecast of the growth rate of the Gross Domestic Product and the value added

Years	**2016-2020**	**2021-2025**	**2026-2030**	**2007-2030**
GDP	105.2	105.7	104.6	105.1
Value added	105.0	105.4	104.4	104.9

Source: "Projection of the demand for fuels and energy until 2030"(ARE, 2009).

It was assumed that services would be the fastest growing sector of the economy in Poland in the period covered by the forecast, as its share in the value added will grow from 58% in 2008 to 65.8% in 2030. The share of industry in the value added will fall from 24.3% in 2008 to 19.3% in 2030. The shares of transport and construction will decrease slightly, while the share of agriculture will fall from 3.7% to about 2.2%.

The end-use model called MAED was applied to forecast the demand for useful energy. This model generated projections of the demand for useful energy for each direction of energy use within the framework of each sector of the economy.

The forecast growth of the final energy consumption in the timeframe covered by the forecast (Table 5.2) will be about 29%, with the highest growth of 90% anticipated in the service sector. In the industry sector, this growth will be about 15%. In the timeframe covered by the forecast, it is expected that the final electricity consumption will grow by 55% and that of gas by 29%, district heat by 50%, oil products by 27% and directly used renewable energy by 60% (Table 5.3). Such a large increase in the renewable energy consumption results from the need to meet the requirements of the Package Climate and Energy Package.

Table 5.2. Final energy demand by sectors

Sector	**Final energy demand by years [Mtoe]**			
	2015	**2020**	**2025**	**2030**
Industry	19.0	20.9	23.0	24.0
Transport	16.5	18.7	21.2	23.3
Agriculture	4.9	5.0	4.5	4.2
Services	7.7	8.8	10.7	12.8
Households	19.1	19.4	19.9	20.1
TOTAL	**67.3**	**72.7**	**79.3**	**84.4**

Source: "Projection of the demand for fuels and energy until 2030"(ARE, 2009).

Table 5.3. Final energy demand by carriers

Specification	**Final energy demand by years [Mtoe]**			
	2015	**2020**	**2025**	**2030**
Coal	10.1	10.3	10.4	10.5
Oil products	23.1	24.3	26.3	27.9
Natural gas	10.3	11.1	12.2	12.9
Renewable energy	5.0	5.9	6.2	6.7
Electricity	9.9	11.2	13.1	14.8
District heat	8.2	9.1	10.0	10.5
Other fuels	0.6	0.8	1.0	1.2
TOTAL	**67.3**	**72.7**	**79.3**	**84.4**

Source: "Projection of the demand for fuels and energy until 2030"(ARE, 2009).

Moreover, it is forecast that all the energy carriers from renewable sources will grow in the period considered (electricity almost tenfold, heat almost twofold and liquid fuels twentyfold).

Due to the environmental requirements, nuclear power plants will appear in the cost-effective mix of electricity sources, although their development pace will limited by organisational and technical issues. It was assumed that the first nuclear power unit will appear in 2020. By 2030 three nuclear units power should operate with a net total capacity of 4,500 MW (4,800 MW gross).

The objectives of the EU targets for renewable energy will require the gross electricity production from RES at the level of about 31 TWh in 2020, representing about 18.4% of the total production and at the level of 39.5 TWh in 2030, representing about 18.2% of the total production. The energy from wind power plants will have the largest share –about 18 TWh in 2030, representing about 8.2% of the forecast gross total production.

It is forecast that the net electricity production will gradually grow from the level of about 140 TWh in 2008 to more than 201 TWh in 2030. Table 5.4 shows the changes in the forecast net electricity production by fuels.

Table 5.4. Net electricity production by fuels

Specification	**Net electricity production by years [TWh]**			
	2015	**2020**	**2025**	**2030**
Hard coal	62.9	62.7	58.4	71.8
Lignite	51.1	40.0	48.4	42.3
Natural gas	5.0	8.4	11.4	13.4
Oil products	2.5	2.8	2.9	3.0
Nuclear fuel	0.00	10.5	21.1	31.6
Renewable energy	17.0	30.1	36.5	38.0
Pumped-storage hydro-power plants	1.00	1.00	1.00	1.00
Waste	0.6	0.6	0.7	0.7
TOTAL	**140.1**	**156.1**	**180.3**	**201.8**
Share of energy from RES [%]	12.2	19.3	20.2	18.8

Source: "Projection of the demand for fuels and energy until 2030"(ARE, 2009).

The sources of information used as data inputs to the emission projections primarily included official activity forecasts, including the *Projection of the demand for fuels and energy until 2030* in the energy sector, and also information on the production of industrial goods, agricultural production, the quantities of waste generated etc. arranged by years and by the types of sources, which were provided to the Ministry of the Environment by the competent Ministries. If there were no input data on activities, for some activities use was made of the averaged historical data for 2009-2011 which were used in the national inventory of greenhouse gas emissions submitted in 2013.

Table 5.5 gives detailed data for Sector 1.A. *Fuel Combustion* on the consumption of fuels at stationary sources, determined on the basis of the *Projection of the demand fuels and energy until 2030*, which were used to assess the future changes in greenhouse gas emissions. The values in italics in the Table were complemented on the basis of the average consumption of a given fuel in a given category in 2009-2011.

Table 5.5. Input data for Sector 1.A *Fuel Combustion*

Fuels	Fuel consumption by years [PJ]			
	2015	**2020**	**2025**	**2030**
1.A. *Fuel Combustion*				
1.A.1.a *Public Electricity and Heat Production*				
Hard coal	907.95	849.55	798.40	891.52
Lignite	504.97	388.98	465.56	403.61
Natural gas	62.27	84.16	105.43	120.65
Fuel wood and wood waste	87.68	150.39	160.74	169.36
Biogas	19.89	41.30	62.80	66.99
Industrial waste	4.68	6.16	7.84	9.74
Municipal waste – non-biogenic fraction	*0.38*	*0.38*	*0.38*	*0.38*
Other petroleum products	*0.05*	*0.05*	*0.05*	*0.05*
Coke and semi-coke (including gas coke)	1.00	1.16	1.33	1.50
Liquid petroleum gas	0.05	0.06	0.07	0.07
Diesel oil	1.38	1.21	1.18	1.13
Fuel oil	33.27	35.92	36.74	38.17
Coke-oven gas	15.26	15.44	16.72	16.38
Blast furnace gas	6.45	6.45	6.55	6.57
1.A.1.b *Petroleum Refining* **1.A.1.c *Manufacture of Solid Fuels and Other Energy Industries***				
Hard coal	14.76	14.40	13.90	14.00
Lignite	0.15	0.16	0.15	0.13
Natural gas	23.70	25.05	26.26	27.47
Industrial waste	0.28	0.29	0.31	0.32
Other petroleum products	*1.22*	*1.22*	*1.22*	*1.22*
Coke and semi-coke (including gas coke)	0.00	0.00	0.00	0.00
Liquid petroleum gas	1.84	1.86	1.88	1.90
Diesel oil	0.56	0.59	0.62	0.65
Fuel oil	27.79	28.49	29.21	29.95
Refinery gas	17.46	19.57	19.57	19.57
Coke-oven gas	36.80	36.99	37.17	37.36
Blast furnace gas	1.33	1.37	1.38	1.38
1.A.2 *Manufacturing Industries and Construction*				
Hard coal	93.42	100.68	106.33	106.63
Lignite	0.10	0.12	0.13	0.13
Hard coal briquettes	*0.01*	*0.01*	*0.01*	*0.01*
Lignite briquettes	*0.13*	*0.13*	*0.13*	*0.13*
Natural gas	102.64	112.26	119.62	119.90
Fuel wood and wood waste	35.99	40.19	43.26	45.48
Industrial waste	18.85	21.26	23.54	25.19
Municipal waste – non-biogenic fraction	*4.65*	*4.65*	*4.65*	*4.65*
Municipal waste – biogenic fraction	*0.50*	*0.50*	*0.50*	*0.50*
Other petroleum products	*0.09*	*0.09*	*0.09*	*0.09*
Petroleum coke	*1.54*	*1.54*	*1.54*	*1.54*
Coke and semi-coke (including gas coke)	20.45	22.22	27.54	31.94
Liquid petroleum gas	5.13	4.95	4.79	4.33
Jet kerosene	*0.04*	*0.04*	*0.04*	*0.04*
Diesel oil	20.01	20.91	14.31	21.16
Fuel oil	12.41	13.10	13.27	12.64
Refinery gas	26.47	29.66	29.66	29.66

Fuels	Fuel consumption by years [PJ]			
	2015	2020	2025	2030
Coke-oven gas	21.56	22.88	25.56	29.18
Blast furnace gas	14.71	14.44	16.33	17.60
1.A.4 *Other Sectors* (*including institutional, commercial, services, residential, agriculture)*				
Hard coal	267.78	243.34	243.34	203.25
Lignite	3.84	3.73	3.73	3.13
Hard coal briquettes	0.04	0.04	0.04	0.04
Natural gas	240.77	261.84	289.53	310.55
Fuel wood and wood waste	133.94	141.94	150.29	161.01
Biogas	0.00	0.00	0.00	0.00
Industrial waste	0.00	0.00	0.00	0.00
Municipal waste – non-biogenic fraction	0.01	0.01	0.01	0.01
Coke and semi-coke (including gas coke)	7.60	7.76	7.70	7.73
Liquid petroleum gas	23.69	21.18	19.02	17.05
Diesel oil	133.44	134.12	50.35	123.64
Fuel oil	2.88	2.73	2.20	1.87

Source: "Projection of the demand for fuels and energy until 2030"(ARE, 2009); the values in italics were complemented on the basis of the average consumption of a given fuel in a given category in 2009-2011.

The data from the study of the Motor Transport Institute (ITS) "Expert forecasts of the activity of road transport" (Table 5.6) were used to assess the future greenhouse gas emissions from fuel combustion in mobile sources, primarily in road transport which was responsible for 98% of the emissions in the transport sector (1.A.3). The study was carried out on commission from the Ministry of Transport, Construction and Maritime Economy in October 2012. For the other sub-categories of Sector 1.A.3. (Civil Aviation, Railways, Navigation, Other Transportation, International Bunker Fuels) the average levels of fuel consumption in 2009-2011 were used.

Table 5.6. Input data for Sector 1.A3.b *Road Transport*

Fuel	Fuel consumption by years [PJ]			
	2015	2020	2025	2030
1.A.3.b. *Road Transport*				
Motor gasoline	164.18	157.16	149.65	134.55
Diesel oil	398.84	444.53	461.65	462.71
LPG	89.50	93.17	94.79	175.94
Biofuels	39.24	57.74	75.01	89.89

Source: "Expert forecasts of the activity of road transport"(ITS, 2012).

The input data for Sector 2. *Industrial Processes* are shown in Table 5.7. Primarily, they came from the Ministry of the Economy (the production of soda ash, ammonia, nitric acid, carbide, methanol, carbon black, styrene, ethylene, caprolactam, iron ore sinter, steel and iron casts, pig iron, basic oxygen furnace steel and electric furnace steel, and ferroalloys production) and from forecasts prepared by sectoral associations (lime and cement production). In the case of the sources for which no production level forecasts were obtained for 2015−2030, the average values for the activities covered in the national inventory of greenhouse gas emissions for 2009-2011 were used. In the table, these data are distinguished by italics.

Table 5.7. Input data for Sector 2. *Industrial Processes* [Gg]

2. *Industrial Processes*	**Industrial production by years [Gg]**			
	2015	**2020**	**2025**	**2030**
A. *Mineral Products*				
1. Clinker Cement Production	15,000	16,500	18,500	20,500
2. Lime Production	2,350	2,350	2,350	2,350
3. Limestone and Dolomite Use	*4,079*	*4,079*	*4,079*	*4,079*
4. Soda Ash- Use	1,275	1,400	1,400	1,415
B. *Chemical Industry*				
1. Ammonia Production	2,700	3,000	3,000	3,100
2. Nitric Acid Production	2,250	2,300	2,350	2,600
4. Carbide Production	0	0	0	0
5.Other				
5.a Methanol Production	0	0	0	0
5.b Carbon Black Production	60	60	60	60
5.c Styrene Production	130	130	300	300
5.e Ethylene Production	640	680	1200	1200
5.j Caprolactam	160	160	160	160
C. *Metal Production*				
1. Iron and Steel Production				
1.a Iron Ore Sinter Production	12,000	12,000	12,000	12,000
1.c Steel Cast Production	112	132	136	143
1.d Iron Cast Production	1,244	1,276	1,341	1,422
1.e Pig Iron Production in Blast Furnaces	6,200	6,200	6,200	6,200
1.f Basic Oxygen Furnace Steel Production	7,000	7,000	7,000	7,000
1.g Electric Furnace Steel Production	4,208	5,810	6,100	6,200
2. Ferroalloys Production	78	78	78	78
3. Aluminium Production (electrolytic method)	0	0	0	0
5. Other				
5.b Refined Lead Production	*85*	*85*	*85*	*85*
5.c Technically Pure Zinc Production	*106*	*106*	*106*	*106*

Source: Data from the Ministry of the Economy (2013); the values in italics were complemented on the basis of the average consumption of a given fuel in a given category in 2009-2011.

Given the absence of forecast data for Sector 3. *Solvent and Other Product Use*, in order to calculate the emissions, the average value for the activities covered in the national inventory of greenhouse gases for 2009-2011 was used for the whole projection period (Table 5.8).

Table 5.8 Input data for Sector 3. *Solvent and Other Product Use*

3. *Solvent and Other Product Use*	**Emissions of non-methane volatile organic compounds [Gg]**			
	2015	**2020**	**2025**	**2030**
A. Paint Application	107.40	107.40	107.40	107.40
B. Degreasing and Dry Cleaning	23.68	23.68	23.68	23.68
C. Chemical Products. Manufacture and Processing	23.95	23.95	23.95	23.95
D. Other Solvent Uses	53.25	53.25	53.25	53.25

Source: KOBIZE IOS-PIB

Table 5.9 shows detailed data on the anticipated rate of changes in the activities in Sector 4. *Agriculture*. As indicated by the information provided by the Ministry of Agriculture and Rural Development, it is difficult to forecast the developments in agriculture until 2030,

because of the length of this period of time, the dynamically changing conditions on the market and also the continuous changes in agricultural policy, including the Common Agricultural Policy. The forecasts of the livestock population can be significantly different from the realities, because of the unpredictability of feed prices and the supply and demand over such a long timeframe. It is also difficult to predict the development of the conditions on the milk market after milk quota have been abolished. At present, there is a crisis on the swine market and in 2013 the population fell to about 10.7 million heads. This was caused by high prices of cereals in the previous period. At present, the horse population is estimated at 250,000 heads and systematically falls. Structural changes in rural areas (the concentration of production at larger farms) causes a fall in the population of cold-blooded (draught) horses. The growing population of hot-blooded horses (breeding, race and other types) will not offset the fall of the population at small farms. The data on mean annual milk yields per cow were used to modify the methane emission factor for milk cows in the years covered by the forecast.

Table 5.9. Input data for Sector 4. *Agriculture*

4. *Agriculture*	**Unit**	**Years**			
		2015	**2020**	**2025**	**2030**
Area of farmland*	thousand ha	15,000	14,600	14,500	14,350
Total sown area*	thousand ha	10,450	10,400	10,350	10,300
Area of utilised soils*	thousand ha	14,500	14,150	14,050	14,000
Consumption of nitrogen fertilisers*	thousand ton	1,110	1,175	1,210	1,250
Mean annual milk yield per cow**	kg	5,200	5,650	6,200	6,850
Cattle population**	thousand heads	5,600	5,800	6,000	6,200
Including milk cows**	thousand heads	2,500	2,300	2,100	1,900
Sheep population**	thousand heads	250	250	300	300
Horse population**	thousand heads	250	230	210	200
Swine population**	thousand heads	11,000	11,500	12,500	13,000
Poultry population**	thousand heads	150,000	160,000	165,000	171,000
Cultivation area of papilionaceous plants (total)*	thousand ha	390	380	400	420
Cultivation area of other than papilionaceous plants*	thousand ha	10,060	10,020	9,950	9,880
Area of organic soils under cultivation*	thousand ha	680	675	670	665

Sources: Data from the Institute of Soil Science and Plant Cultivation (IUNG)*
*** Data from the Institute of Agricultural and Food Economics (IERiGŻ)*

Table 5.10 shows the activity data which provided the basis for estimating the greenhouse gas emissions in Sector 6. *Waste.* Here, the data from the 2014 National Waste Management Plan were used (KPGO 2014). The Plan gave the municipal waste quantities forecast for 2013, 2014, 2020 and 2022 and the quantities of generated municipal sewage sludge for 2014, 2015, 2016, 2018, 2019 and 2022. By interpolation and extrapolation, these quantities were estimated for 2015, 2020, 2025 and 2030. On the basis of them and averaged historical data from 2009-2011, the quantities of collected municipal waste and those of solid municipal waste deposited at landfills were estimated. In a similar way, the forecast quantities of solid municipal waste deposited at landfills complying with Directive 1999/31/EC (the so-called "well-managed solid waste disposal sites", according to the 2006 IPCC methodology), the quantities of deposited industrial wastes and those of methane recovered at landfills were estimated.

The population size forecast was taken from the Information Release in the series "CSO Survey Results" issued by the Central Statistical Office, entitled "The Population Projection for Poland for 2008-2035". Given the absence of relevant forecasts, the quantities of wastewater discharged, the populations served by wastewater treatment plants and the quantities of treated wastewater were adopted at the levels of the averaged values from 2009-2011 used in the emissions inventory. The annual quantities of incinerated municipal, medical and industrial waste and sewage sludge were estimated analogously. The annual protein consumption per capita was adopted as that in 2009 because of the lack of more recent data in the FAOSTAT database and forecast data.

Table 5.10. Input data for Sector 6. *Waste*

6. Waste	**Unit**	**Years**			
		2015	**2020**	**2025**	**2030**
Quantity of solid municipal waste generated in the country*	Gg	13,246	14,254	15,399	16,544
Quantity of solid municipal waste deposited at landfills	Gg	7,398	7,398	7,398	7,398
Quantity of solid municipal waste deposited at landfills complying with Directive 1999/31/EC	Gg	6,640	6,640	6,640	6,640
Quantity of landfilled industrial waste	Gg	83	83	83	83
Quantity of landfilled sewage sludge*	Gg	695	773	799	825
Quantity of discharged industrial wastewater	million m3	131.25	131.25	131.25	131.25
Quantity of discharged municipal wastewater	million m3	1,260.4	1,260.4	1,260.4	1,260.4
Urban population served by wastewater treatment plants	thousand	20,597.3	20,597.3	20,597.3	20,597.3
Rural population served by wastewater treatment plants	thousand	4,316.1	4,316.1	4,316.1	4,316.1
Quantity of treated wastewater	million m3	1,208.8	1,208.8	1,208.8	1,208.8
Animal protein consumption**	g/person/day	52.2	52.2	52.2	52.2
Vegetable protein consumption**	g/person/day	48.9	48.9	48.9	48.9
Country population***	million	38.02	37.83	37.44	36.80
Quantity of incinerated municipal waste	Gg	40.20	40.20	40.20	40.20
Quantity of incinerated industrial waste	Gg	116.31	116.31	116.31	116.31
Quantity of incinerated medical waste	Gg	29.39	29.39	29.39	29.39
Quantity of incinerated sewage sludge	Gg	34.94	34.94	34.94	34.94

*Source: * The National Waste Management Plan*
*** FAO Food and Agriculture Organization*
**** Central Statistical Office, the Information Release in the series "CSO Survey Results" entitled "The Population Projection for Poland for 2008-2035".*
The other data come from statistical yearbooks on Environmental Protection or were calculated by the Institute of Environmental Protection, KOBIZE..

The data on the anticipated rate of changes in the activities in Sector *5.Land Use, Land Use Change and Forestry* are given in Table 5.11. Land use in Poland is dominated by agriculture and forestry, but in recent years there were substantial changes in this scope. Therefore, for the purposes of forecasts, an attempt was made to present land use change taking into account the differentiation of unfolding processes. To this end, based on available statistical data, a dynamic analysis of the directions of land use change was carried out for 1988–2011. In the period examined, there was a sustained tendency for the area of farmland to diminish in favour of other land uses, such as e.g. forests, infrastructure etc. The changes observed in the area of permanent crops indicate that after the accession to the EU the structural changes in agriculture to an increasingly large extent were affected by the Common Agricultural Policy (CAP) and the financial mechanisms related to its implementation. The analysis also indicated that the dynamics and direction of land use change were significantly affected by the intensity of agricultural production.

Table 5.11. Changes in the area occupied by individual land uses

5. *Land Use, Land Use Change and Forestry* (LULUCF)	**Change in area by years [kha]**			
	2015	**2020**	**2025**	**2030**
5.A. Forest Land	9,427	9,549	9,671	9,793
5.B. Cropland	14,049	13,882	13,712	13,549
5.C. Grassland	4,149	4,200	4,090	4,060
5.D. Wetlands	1,373	1,379	1,384	1,390
5.E. Settlements	2,183	2,263	2,343	2,423
5 F. Other Lands	85	74	64	53

Source: Own estimates by the KOBIZE IOS-PIB

In the case of the development of timber resources, which depends on the overriding principles of the implementation of multi-functional forest management adopted in the national forestry policy, in practice one can see dependencies between the current age structure of forests, the state of resources and the related harvesting intensity, Tabel 2.12.

Table 5.12. The forests structure of the thickness of standing timber resources by age classes.*

Standing timber resources by age classes:	**Unit**	**Years**			
		2015	**2020**	**2025**	**2030**
- Total	million m^3	2237.15	2352.30	2436.00	2519.70
- I (1-20 years)	million m^3	13.72	12.60	16.28	19.96
- II (21-40 years)	million m^3	206.72	199.39	198.60	197.80
- III (41-60 years)	million m^3	581.36	544.58	486.75	428.92
- IV (61-80 years)	million m^3	587.33	664.28	733.20	802.12
- V (81-100 years)	million m^3	423.41	456.99	477.51	498.03
- VI+VII (100-120 - + years)	million m^3	169.07	173.74	191.88	210.01
- VII and higher (121 years and more)	million m^3	x	x	x	x
- Other tree-stands:					
1) in the renewal class, the regeneration class and with a throughfell construction	million m^3	152.69	191.29	202.20	213.11
2) in the regeneration class	million m^3	x	x	x	x
3) with a throughfell construction	million m^3	x	x	x	x

Source: Data from the Department of Forestry and Nature Conservation, Ministry of the Environment.*

The methodology applied to estimate the projections of greenhouse emissions and removals for all the IPCC sectors presented above is the same as the methodology applied in the preparation of the greenhouse gas inventory described in the 2013 National Inventory Report (NIR 2013). Where there were no forecast data necessary to update the emission factors, the average data from 2009−2011 were used and so they were in the case of activities.

5.2. The results of emission projections

The projected greenhouse gas emissions, primarily those of CO_2, decrease until 2020, to subsequently grow in 2025 and 2030 (Table 5.13). This is consistent with the trend of the forecast demand for fuels and energy, underlying the Energy Policy of Poland until 2030. Carbon dioxide will have the greatest share of the emissions, i.e. more than 81%, with the shares of methane and nitrous oxide being, respectively, about 9.2% and 7.5%, while those of industrial gases will represent about 2.1% of total emissions.

Table 5.13. Summary results of GHG emission projections for 2011, 2015, 2020, 2025 and 2030.

Greenhouse gases*	Gas emissions projections by years [Gg CO_2 eq.]				
	2011	**2015**	**2020**	**2025**	**2030**
CO_2	330,309.43	317,413.47	306,518.06	316,826.60	323,722.53
CH_4	35,537.91	34,757.92	35,516.85	36,217.26	36,692.06
N_2O	27,240.63	26,631.77	27,526.86	29,127.42	29,708.27
HFCs	6,210.80	7,828.26	8,002.73	8,177.20	8,351.67
PFCs	49.88	49.88	49.88	49.88	49.88
SF_6	40.90	40.90	40.90	40.90	40.90
Total	**399,389.55**	**386,722.20**	**377,655.28**	**390,439.27**	**398 565.31**

* The values given above do not include the emissions and removals of Sector *5. Land Use, Land Use Change and Forestry.*

The level of the **projected summary greenhouse gas emissions** is affected to the greatest extent by Sector 1. *Energy* (Table 5.14). Moreover, it is projected that by 2020 the emissions in this sector will gradually fall, to subsequently grow gradually until 2030. According to the results of the initial greenhouse gas emission inventory for 2012, prepared on the basis of quarterly fuel balances (*The energy situation in the 4th quarter of 2012,* Energy Market Agency - ARE), the emissions in Sector 1. *Energy* fell by 6% relative to 2011, amounting to about 305 million tonnes of CO_2 eq., which correlates with the projected emissions for 2015. In turn, the emissions from Sectors: *Agriculture, Industrial Processes* and *Waste* will systematically grow in the years covered by the projection.

Table 5.14. Greenhouse gas emission projections compared with the base years 1988, 1990 and 2011.

Source categories	Emissions [Gg CO_2 eq.]			Emission projections [Gg CO_2 eq]			
	1988	**1990**	**2011**	**2015**	**2020**	**2025**	**2030**
1. Energy	470,309.06	374,069.28	325,205.95	305,699.14	293,319.50	302,664.86	308,189.19
2. Industrial Processes	32,832.19	22,024.98	28,719.88	36,571.03	38,311.64	39,630.49	41,178.61
3. Solvent and Other Product Use	1,006.46	629.23	788.67	773.16	773.16	773.16	773.16
4. Agriculture	50,893.90	49,655.35	34,929.80	34,031.63	35,138.64	37,041.55	37,804.60
5. Land Use. Land Use Change and Forestry	-32,926.48	-16,329.24	-21,912.35	-21,166.23	-15,196.91	-11,457.42	-7,921.09
6. Waste	8,401.16	10,635.81	9,745.25	9,647.24	10,112.33	10,329.21	10,619.75
Total*	**563,442.77**	**457,014.65**	**399,389.55**	**386,722.20**	**377,655.28**	**390,439.27**	**398,565.31**
Total International Bunker Fuels	***2,781.58***	***2,669.52***	***1,916.66***	***2,104.98***	***2,104.98***	***2,104.98***	***2,104.98***
Aviation	*1,117.17*	*1,121.31*	*1,358.44*	*1,424.55*	*1,424.55*	*1,424.55*	*1,424.55*
Marine	*1,664.41*	*1,548.21*	*558.22*	*680.44*	*680.44*	*680.44*	*680.44*

*Total emissions do not include the emissions and removals of Sector *5. Land Use, Land Use Change and Forestry;*
the emissions for 1988 were approved for the purposes of accounting for the national reduction target under the Kyoto Protocol;
the values in italics were estimated on the basis of the average consumption of a given fuel in 2009-2011.

The comparison of the emissions in 2015-2030 covered by the projections with the base year 1988 showed a drop of about 30% in the total emissions from all the sectors, with the highest emission reductions occurring in Sectors *Energy* and *Agriculture*. *Industrial Processes* and *Waste* are characterised by higher emissions in 2015−2030 than in the base year (Table 5.13). It should be noted that the projected emissions until 2030 are much lower than the national reduction target under Kyoto Protocol (a 6% emission reduction in 2008─2012 compared with the base year 1988) (Fig. 5.1).

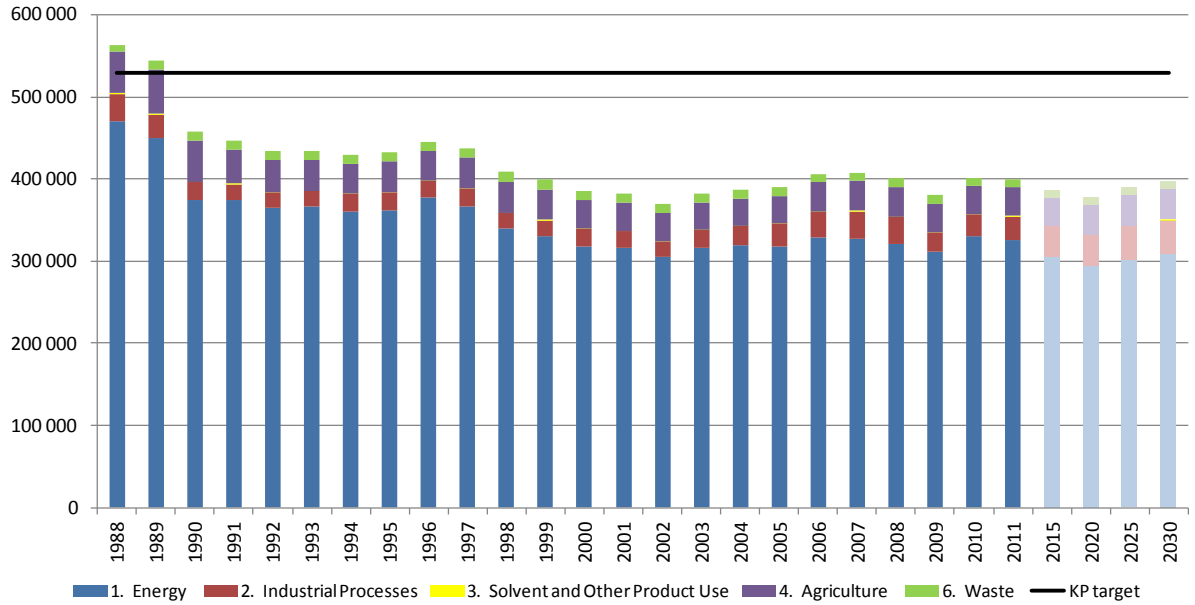


Fig. 5.1. The present greenhouse emissions (1988–2011) and the projected greenhouse emissions (2015, 2020, 2025 and 2030), expressed in CO_2 equivalent, in Poland relative to the national reduction target under the Kyoto Protocol (for 2008−2012). Source: KOBiZE, IOS-PIB

The changes in the structure of greenhouse gas emissions in 1988 and 2030 for the IPCC source categories (Table 5.15) indicate a decrease in the share of the Sector of *Energy* from more than 83% to about 77% in favour of an increase in the shares of *Industrial Processes* and *Waste*.

Table 5.15. The structure of GHG emissions in 1988 and 2030

Source categories	**Structure of GHG emissions [%]**	
	1988	**2030**
1. Energy	83.47	77.32
2. Industrial Processes	5.83	10.33
3. Solvent and Other Product Use	0.18	0.19
4. Agriculture	9.03	9.49
6. Waste	1.49	2.66

Source: KOBiZE. IOS-PIB

Table 5.16 shows the detailed results of **carbon dioxide emission projections** by the IPCC source categories. Specifically, the CO_2 emissions reach the level of about 317 million tonnes in 2015, to subsequently fall by about 3.4% to the level of about 306 million tonnes in 2020. By 2030 the emissions will grow again by about 5.6%. Compared with the base year 1988 there is a substantial fall in the emissions: by 32% for 2015, by 33% for 2020, by 32% for 2025 and by 31% for 2030. Sector 1. *Energy* and the related projected changes in the structure and level of the fuel consumption have the greatest impact on fluctuations in emissions.

Table 5.16. CO_2 emissions by specific IPCC source categories for 1988 and 2011 and for 2015, 2020, 2025 and 2030 covered by projections.

Source categories	CO_2 emissions by years [Gg]					
	1988	2011	2015	2020	2025	2030
1. Energy	**440,437.35**	**308,389.70**	**289,309.92**	**276,904.36**	**286,114.82**	**291,748.50**
A. Fuel Combustion	440,389.27	304,568.18	286,311.78	273,906.22	283,116.69	288,750.37
1. Energy Industries	268,294.61	173,821.99	158,616.89	142,381.12	147,517.67	151,008.66
2. Manufacturing Industries and Construction	42,536.34	31,062.53	28,673.95	30,656.78	33,042.75	34,117.87
3. Transport	21,846.92	47,987.70	47,398.08	50,479.04	51,304.87	55,440.83
4. Other Sectors	107,711.40	51,695.95	51,622.86	50,389.28	51,251.40	48,183.00
B. Fugitive Emissions from Fuels	48.08	3,821.52	2,998.13	2,998.13	2,998.13	2,998.13
1. Solid Fuels	2.17	2,097.42	1,573.90	1,573.90	1,573.90	1,573.90
2. Oil and Natural Gas	45.91	1,724.10	1,424.23	1,424.23	1 424.23	1 424.23
2. Industrial Processes	**27,244.74**	**21,029.08**	**27,161.08**	**28,671.23**	**29,769.30**	**31,031.56**
A. Mineral Products	10,802.63	10,711.41	12,669.41	13,526.40	14,599.89	15,679.60
B. Chemical Industry	4,801.70	3,968.60	4,685.01	5,205.56	5,205.72	5,379.23
C. Metal Production	11,640.41	6,006.06	9,446.95	9,579.56	9,603.98	9,613.01
D. Other Production	0.00	8.20	8.47	8.47	8.47	8.47
E. Production of HFCs, PFCs and SF_6	0.00	0.00	0.00	0.00	0.00	0.00
F. Use of HFCs, PFCs and SF_6	0.00	0.00	0.00	0.00	0.00	0.00
G. Other Processes	0.00	334.81	351.23	351.23	351.23	351.23
3. Solvent and Other Product Use	**882.46**	**664.67**	**649.16**	**649.16**	**649.16**	**649.16**
4. Agriculture	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
5. Land Use. Land Use Change and Forestry	-32,934.72	-24,170.50	-23,426.04	-17,484.66	-13,760.67	-10,246.07
6. Waste	**579.27**	**225.98**	**293.31**	**293.31**	**293.31**	**293.31**
A. Solid Waste Disposal on Land	0.00	0.00	0.00	0.00	0.00	0.00
B. Waste Water Handling	0.00	0.00	0.00	0.00	0.00	0.00
C. Waste Incineration	579.27	225.98	293.31	293.31	293.31	293.31
Total CO_2 emissions excluding Sector 5	469,143.82	330,309.43	317,413.47	306,518.06	316,826.60	323,722.53
CO_2 emissions from biomass	3,866.95	32,390.86	32,183.04	42,877.45	47,658.24	51,305.28

Source: KOBiZE IOS-POIB

The changes in the structure of carbon dioxide emissions in 1988, 2011 and 2030 by the IPCC source categories are shown in Table 5.17. The share of the Sector of *Energy* in the total emissions can be seen to fall, with the simultaneous growth of the shares of the Sectors of *Industrial Processes* and *Waste*.

Table 5.17. The structure of CO_2 emissions in 1988, 2011 and 2030.

Source categories	Structure of CO_2 emissions by years [%]		
	1988	2011	2030
1. Energy	93,88	93,36	90,12
2. Industrial Processes	5,81	6,37	9,59
3. Solvent and Other Product Use	0,19	0,20	0,20
6. Waste	0,12	0,07	0,09

Source: KOBiZE IOS-PIB

The **projected methane emissions** gradually grow from about 34.8 million tonnes of CO_2 eq. in 2015 to about 36.7 million tonnes of CO_2 eq. in 2030 (Table 5.18). The changes in emissions are slight, as they are projected to grow by 2.2% in 2015−2020, by 2% in 2020−2025 and by 1.3% in 2025−2030. Compared with 1988 the CH_4 emissions fall by about 35% in 2015, by 34% in 2020, by 33% in 2025 and by 32% in 2030. Sector 6. *Waste* is responsible for the largest increase in the methane emissions in the period covered by the projections.

Table 5.18. CH_4 emissions by the IPCC source categories for 1988 and 2011 and for 2015, 2020, 2025 and 2030 covered by the projections.

	CH_4 w emissions by years [Gg CO_2 eq.]					
Source categories	**1988**	**2011**	**2015**	**2020**	**2025**	**2030**
1. Energy	**27,555.85**	**14,718.00**	**14,468.28**	**14,430.97**	**14,501.82**	**14,369.30**
A. Fuel Combustion	4,840.91	3,037.86	2,751.36	2,714.05	2,784.90	2,652.37
1. Energy Industries	75.09	94.55	96.54	134.52	143.68	151.54
2. Manufacturing Industries and Construction	46.58	77.73	75.79	82.97	89.50	92.95
3. Transport	134.02	105.90	106.04	110.22	111.71	130.29
4. Other Sectors	4,585.20	2,759.67	2,473.00	2,386.34	2,440.00	2,277.59
B. Fugitive Emissions from Fuels	22,714.95	11,680.13	11,716.92	11,716.92	11,716.92	11,716.92
1. Solid Fuels	18,583.63	7,182.86	7,317.08	7,317.08	7,317.08	7,317.08
2. Oil and Natural Gas	4,131.32	4,497.28	4,399.84	4,399.84	4,399.84	4,399.84
2. Industrial Processes	**293.62**	**305.79**	**351.16**	**387.04**	**413.24**	**424.12**
A. Mineral Products	0.00	0.00	0.00	0.00	0.00	0.00
B. Chemical Industry	255.46	270.88	316.05	347.76	372.96	383.25
C. Metal Production	38.16	34.91	35.11	39.28	40.28	40.87
3. Solvent and Other Product Use	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
4. Agriculture	**19,157.04**	**12,113.40**	**11,687.45**	**11,977.36**	**12,352.58**	**12,640.01**
A. Enteric Fermentation	15,706.86	9,286.65	9,137.46	9,356.02	9,605.38	9,827.73
B. Manure Management	3,419.72	2,809.12	2,531.29	2,602.63	2,728.49	2,793.57
C. Rice Production	0.00	0.00	0.00	0.00	0.00	0.00
D. Agricultural Soils	0.00	0.00	0.00	0.00	0.00	0.00
E. Savanna Burning	0.00	0.00	0.00	0.00	0.00	0.00
F. Field Burning of Agricultural Residues	30.46	17.62	18.70	18.70	18.70	18.70
G. Other Processes	0.00	0.00	0.00	0.00	0.00	0.00
5. Land Use, Land Use Change and Forestry	7.48	2 249.16	2 259.81	2 287.74	2 303.26	2 324.98
6. Waste	**6,658.51**	**8,400.72**	**8,251.03**	**8,721.48**	**8,949.62**	**9,258.63**
A. Solid Waste Disposal on Land	4,934.38	7,290.34	7,147.53	7,617.98	7,846.12	8,155.13
B. Waste-water Handling	1,724.13	1,110.38	1,103.50	1,103.50	1,103.50	1,103.50
C. Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00
Total CH_4 emissions excluding Sector 5	**53,665.03**	**35,537.91**	**34,757.92**	**35,516.85**	**36,217.26**	**36,692.06**

Source: KOBiZE. IOS-PIB

The structure of the methane emissions in 1988, 2011 and 2030 by the IPCC source categories is shown in Table 5.19. The share of Sector 6. *Waste* in the national methane emissions can be seen to grow significantly, with a simultaneous distinct fall in the share of Sector 1. *Energy*.

Table 5.19. The structure of CH_4 w emissions in 1988, 2011 and 2030

Source categories	**Structure of CH_4 emissions by years [%]**		
	1988	**2011**	**2030**
1. Energy	51.35	41.41	39.16
2. Industrial Processes	0.55	0.86	1.16
3. Solvent and Other Product Use	0.00	0.00	0.00
4. Agriculture	35.70	34.09	34.45
6. Waste	12.41	23.64	25.23

Source: KOBIZE IOS-PIB

Table 5.20 shows the results of **nitrous oxide emission projections**. The N_2O emissions in 2015 exceed the level of 26.6 million tonnes of CO_2 eq., to subsequently grow by about 3.4% in 2020, by 5.8% in 2025 and by about 2.0% in 2030, reaching the level of about 30 million tonnes of CO_2 eq. The emission projections provide for them to fall, respectively, by about 34%, 32%, 27% and 26% in 2015, 2020, 2025 and 2030 compared with 1988. The greatest

fall in N_2O emissions relative to the base year can be found in Sector 4. *Agriculture*, as the livestock population, fertiliser use and sown area diminish.

Table 5.20. N_2O emissions by the IPCC source categories compared with the data for 1988 and 2011 and for 2015, 2020, 2025 and 2030 covered by the projections.

Source categories	N_2O emissions by years [Gg CO_2 eq.]					
	1988	2011	2015	2020	2025	2030
1. Energy	**2,315.86**	**2,098.26**	**1,920.94**	**1,984.17**	**2,048.22**	**2,071.40**
A. Fuel Combustion	2,315.86	2,098.07	1,920.75	1,983.98	2,048.02	2,071.20
1. Energy Industries	1,192.18	854.35	797.44	797.94	826.23	854.93
2. Manufacturing Industries and Construction	226.41	160.44	138.13	151.04	163.11	169.95
3. Transport	278.17	593.62	575.25	623.25	638.68	632.15
4. Other Sectors	619.11	489.65	409.93	411.76	420.01	414.18
B. Fugitive Emissions from Fuels	0.00	0.19	0.20	0.20	0.20	0.20
1. Solid Fuels	0.00	0.00	0.00	0.00	0.00	0.00
2. Oil and Natural Gas	0.00	0.19	0.20	0.20	0.20	0.20
2. Industrial Processes	**4,993.43**	**1,083.42**	**1,139.75**	**1,159.86**	**1,179.96**	**1,280.47**
A. Mineral Products	0.00	0.00	0.00	0.00	0.00	0.00
B. Chemical Industry	4,993.43	1,064.65	1,139.75	1,159.86	1,179.96	1,280.47
C. Metal Production	0.00	0.00	0.00	0.00	0.00	0.00
3. Solvent and Other Product Use	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**
4. Agriculture	**31,736.85**	**22,816.40**	**22,344.18**	**23,161.29**	**24,688.98**	**25,164.60**
A. Enteric Fermentation	0.00	0.00	0.00	0.00	0.00	0.00
B. Manure Management	9,335.10	5,108.51	4,768.90	4,901.85	5,600.49	5,669.33
C. Rice Production	0.00	0.00	0.00	0.00	0.00	0.00
D. Agricultural Soils	22,378.37	17,697.57	17,564.60	18,248.76	19,077.80	19,484.59
E. Savanna Burning	0.00	0.00	0.00	0.00	0.00	0.00
F. Field Burning of Agricultural Residues	23.38	10.31	10.68	10.68	10.68	10.68
G. Other Processes	0.00	0.00	0.00	0.00	0.00	0.00
5. Land Use, Land Use Change and Forestry	0.76	8.99	0.00	0.00	0.00	0.00
6. Waste	**1,163.38**	**1,118.55**	**1,102.90**	**1,097.54**	**1,086.27**	**1,067.80**
A. Solid Waste Disposal on Land	0.00	0.00	0.00	0.00	0.00	0.00
B. Waste-water Handling	1,142.28	1,108.44	1,093.42	1,088.07	1,076.80	1,058.33
C. Waste Incineration	21.10	10.11	9.47	9.47	9.47	9.47
Total N_2O emissions excluding Sector 5	40,333.53	27,240.63	26, 631.77	27,526.86	29,127.42	29,708.27

Source: KOBiZE. IOS-PIB

The changes in the structure of nitrous oxide emissions in 1988, 2011 and 2030 by the IPCC sectors are shown in Table 5.21. Here, the share of industrial processes can be seen to fall in favour of the other IPPC source categories.

Table 5.21. The structure of the N_2O emissions in 1988, 2011 and 2030.

Source categories	Structure of N2O w emissions by years [%]		
	1988	2011	2030
1. Energy	5.74	7.70	6.97
2. Industrial Processes	12.38	3.98	4.31
3. Solvent and Other Product Use	0.31	0.46	0.42
4. Agriculture	78.69	83.76	84.71
6. Waste	2.88	4.11	3.59

Source: KOBiZE. IOS-PIB

The balance of greenhouse gas emissions and removals for 2011-2030 by the activities related to land use, land use change and forestry (LULUCF) under Articles 3.3 and 3.4 of the Kyoto

Protocol is shown in Table 5.22. In case of the forestation of lands other than forest land and forestry, this balance is negative, meaning net CO_2 absorption.

Table 5.22. The balance of greenhouse gas emissions and removals for LULUCF activities under the Kyoto Protocol

Scope of activities	Activity	Balance of gas emissions and removals [Gg CO_2 eq.]				
		2011	2015	2020	2025	2030
Article 3.3 of KP	Afforestation/ reforestation	-6,192.1	-7,126.3	-8,040.8	-9,123.9	-10,230.7
	Deforestation	235.6	244.9	244.9	244.9	244.9
Article 3.4 of KP	Forest management	-25,232.7	-21,285.2	-14,537.2	-9784.96	-5270.8
	Management of cropland	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*
	Management of grassland	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*
	Renewal of vegetation	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*	*Not applicable*

Source: KOBIZE IOS-PIB

5.3. Comparison of the projection results with the emission projections presented in the Fifth National Communication

Table 5.23 and Table 5.24 show a comparison of the abovementioned greenhouse gas emission projections with the data presented in the Fifth National Communication for 2015, 2020 and 2030. Both of these scenarios are those "with measures".

The total greenhouse gas emissions for all the years covered by the projections in the present Communication are higher than those in the Fifth National Communication. Specifically, this difference is 9.1 million tonnes of CO_2, eq. in 2015, 11.6 million tonnes of CO_2 eq. in 2020 and 10.6 million tonnes of CO_2 eq. in 2030. Thus, compared with the Fifth National Communication the now projected emissions grow, respectively, by 2.4%, 3.2% and 2.7% in 2015, 2020 and 2030. In general, the projected emissions presented in the Fifth National Communication were lower for CO_2 and industrial gases, but higher for CH_4 and N_2O.

Table 5.23. Comparison of the present greenhouse gas emission projections with the scenario "with measures" in the Fifth National Communication by greenhouse gases.

Greenhouse gases	Sixth National Communication			Fifth National Communication		
	2015	2020	2030	2015	2020	2030
	Gg CO_2 eq.			Gg CO_2 eq.		
CO_2	317,413.47	306,518.06	323,722.53	307,273.58	294,833.04	314,690.16
CH_4	34,757.92	35,516.85	36,692.06	35,512.22	36,204.12	37,621.78
N_2O	26,631.77	27,526.86	29,708.27	31,263.42	31,435.00	32,073.56
HFCs	7,828.26	8,002.73	8,351.67	3,254.27	3,265.85	3,265.85
PFCs	49.88	49.88	49.88	265.82	260.92	260.92
SF_6	40.90	40.90	40.90	30.94	35.72	35.72
Total excluding Sector 5	**386,722.20**	**377,655.28**	**398,565.31**	**377,600.26**	**366,034.66**	**387,948.00**

Source: KOBiZE IOS-PIB

Table 5.24. Comparison of the present greenhouse gas emission projections with the scenario "with measures" in the Fifth National Communication by key source categories.

Source categories	Sixth National Communication			Fifth National Communication		
	2015	2020	2030	2015	2020	2030
	Gg CO_2 eq.			Gg CO_2 eq.		
1. Energy	305,699.14	293,319.50	308,189.19	296,830.12	284,392.39	304,900.95
2. Industrial Processes	36,571.03	38,311.64	41,178.61	35,604.20	35,716.69	35,716.69
3. Solvent and Other Product Use	773.16	773.16	773.16	835.53	835.53	835.53
4. Agriculture	34,031.63	35,138.64	37,804.60	35,269.29	35,650.66	36,560.52
5. Land Use. Land Use Change and Forestry	-21,166.23	-15,196.91	-7,921.09	-4,006.67	-4,006.67	-4,006.67
6. Waste	9,647.24	10,112.33	10,619.75	9,061.13	9,439.39	9,934.32
Total excluding Sector 5	**386,722.20**	**377,655.28**	**398,565.31**	**377,600.26**	**366,034.66**	**387,948.00**

Source: KOBiZE. IOS-PIB

The main assumptions for the energy sector concerning fuel consumption in stationary sources remained the same in both of the Communications; they were prepared on the basis of the *Projection of the demand for fuels and energy until 2030* (Market Energy Agency, 2009) underlying the *Energy Policy of Poland until 2030*. The Ministry of the Economy is developing new assumptions for Poland's energy until 2050, including an update of the forecast demand for fuels and energy. In turn, tor the purposes of the present Communication, the fuel consumption levels in the road transport sector were updated on the basis of a new study from 2012, increasing the forecast greenhouse gas emissions in Sector 1. *Energy*. The higher levels of anticipated industrial production (including cement clinker, soda ash, ammonia, nitric acid, iron and steel) caused enhanced emissions in Sector 2. *Industrial Processes*, just as larger quantities of generated municipal waste raised the emissions in Sector 6. *Waste* compared with the Fifth National Communication. An update of the livestock population in accordance with the present trends led to a reduction in greenhouse gas emissions in Sector 4. *Agriculture* w 2015−2020. The present Communication also complemented projections for international bunker fuels and for Sector 5. *Land Use, Land Use Change and Forestry* (LULUCF). The projections for the LULUCF activities under Articles 3.3 and 3.4 of the Kyoto Protocol were also updated.

5.4. The sensitivity analysis of the data for 2030

Referring to the definition proposed by Morgan and Henrion (1990),[51] the sensitivity analysis can be defined as the modelling of the impact of changes in the input parameters or assumptions on the final results of calculations. In Poland's case, the sensitivity analysis for the annual inventories of greenhouse gas emissions into the air was carried out for the first time in 2007. The present analysis is based on modified assumptions, ensuing primarily from the update of available information and also from a change in the system of inputs to the computational model for calculating the projections. After the computational model has been created it undergoes numerical analysis designed to identify the impact exerted by changes in

[51] 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.

selected input parameters and certain initial assumptions on the overall results of the greenhouse gas emission inventory.

The changes in the parameters were grouped in four basic scenarios, enabling the examination of the "strength" of the impacts of the individual input data and a clear presentation of the results of such impacts. The preparation of the sensitivity analysis scenarios was preceded by an in-depth analysis of the trends in inventory data, with particular consideration given to Sectors 1. Energy and 2. Industrial Processes. A simplified method of deterministic analysis, where changes were made to more than one initial parameters at the same time, was chosen for the numerical analysis.

Four options of the analysis, subsequently called scenarios, are discussed below.
Scenario A – "The Shift from Coal Fuels to Gas" – was based on the assumption that part of the hard coal and lignite burned would be replaced by natural gas. Such a change in the fuel mix was considered in view of the much lower CO_2 emission factors for gaseous fuels compared with solid fuels. For the purposes of the scenario, it was assumed that in Sector 1.A.1.a Energy Industries the hard coal consumption would fall by 300 PJ and that of lignite by 200 PJ. The emerging gap in the energy demand would be filled by natural gas the consumption of which would grow by 500 PJ. Such a change in fuel use would cause reductions in CO_2 and N_2O emissions.
The result: the total emissions have fallen by 5.8%.

Scenario B – "CO_2 Reductions" – was based on the assumption that higher CO_2 emission allowance prices would force the highest emitters to introduce new technologies and systems designed to control air pollutant emissions into the air (e.g. Carbon Capture and Storage - CCS) and, in particular, to reduce CO_2 emissions. It was assumed that, as a result, the CO_2 emission intensity would be reduced by 5% in Sectors 1.A Fuel Combustion and 2. Industrial Processes (Sub-Categories 2.A Mineral Products, 2.B Chemical Industry and 2.C Metal Production).
The result: the total emissions have fallen by 4.1%.

Scenario C – "GHG Reductions" – was based on the assumptions that new energy production technologies would be introduced, such as nuclear power plants, and also that CO_2 capture technology would be implemented in the CCS system. The activities for the emission sources in Categories 1.A.1 Energy Industries were reduced by 10%.
The result: the total emissions have fallen by 3.9%

Scenario D – "Transport Development" – was based on the assumption of a 20% increase of mineral fuels in transport in Category 1.A.3 Transport.
The result: the total emissions have risen by 2.9%

It should be emphasised that these scenarios were designed specifically for the purposes of the sensitivity analysis to demonstrate the specific properties of the computational model applied in the emission inventories. These scenarios should not be treated as real and official assumptions for the environmental policies implemented by Poland. Table 5.25 presents a general description of the sensitivity analysis scenarios, along with the relevant assumptions. In turn, Table 5.26 and Fig. 5.2 show the summary results of the sensitivity analysis.

Table 5.25. A general description of the scenarios, along with their initial conditions and main assumptions.

Scenario	Name	Description	Assumptions	Main results
A	The Shift from Coal Fuels to Gas	The scenario provides for a partial shift from solid fuels to gaseous ones in the energy sector (1.A.1.a)	A decrease in hard coal consumption by 300 PJ and that of lignite by 200 PJ, an increase in the use of natural gas by 500 PJ in the IPPC Sector 1.A.1.a	A fall in total emissions by about 5.8%
B	CO_2 Reductions	The scenario provides for the use of better systems for controlling industrial processes and flue gas clearing in the sectors of energy and industrial processes (e.g. CCS)	A 5% decrease in the emission factors in IPCC 1.A, 2.A, 2.B and 2.C	A fall in total emissions by about 4.1%
C	GHG Reductions	An enhanced share of energy sources other than coal-fired power plants (e.g. nuclear power plants)	A 10% fall in the activity in IPCC Sector 1.A.1 Energy Industries	A fall in total emissions by about 3.9%
D	Transport Development	The scenario provides for a rapid growth of transport and a substantial increase in fuel consumption	It was provided that the fuel consumption would grow by 20% in IPCC Sector 1.A.3 Transport	An increase on total emissions by about 2.9%

Source: KOBiZE. IOS-PIB

Table 5.26. The summary results of the sensitivity analysis and the impact of changes in the input parameters on emissions

Scenarios	Total emissions [%]	Total emissions [Gg CO2 eq.]
The results of the emission inventory (projection) for 2030	**100.0%**	**390,653.54**
Scenario A – a change in emissions compared with the inventory	94.2%	368,144.50
Scenario B - a change in emissions compared with the inventory	95.9%	374,682.43
Scenario C - a change in emissions compared with the inventory	96.1%	375,452.02
Scenario D - a change in emissions compared with the inventory	102.9%	401,894.19

Source: KOBiZE. IOS-PIB

The sensitivity analysis demonstrated that for the scenarios related to the dominating energy sectors it is particularly important to appropriately select data on the activities of sources and to assign correct emission factors to them. Changes in the input parameters for Sectors 3. Solvent and Other Product Use, 4. Agriculture, 5. Land Use, Land Use Change and Forestry and 6. Waste do not have such large impact on the final results.

The uncertainty analysis for the energy sector demonstrated the low uncertainty of output data; still, because of its dominating contribution to total emissions, it should be subjected to further numerical research, e.g. using the probability distributions and modelling by the Monte Carlo method.

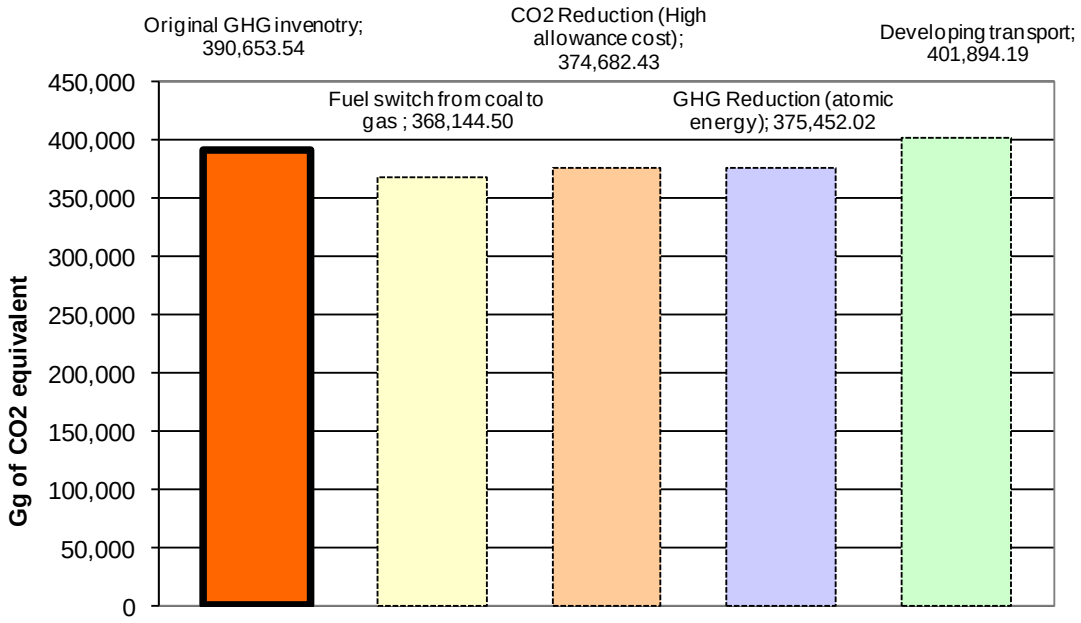


Fig. 5.2. Total emissions taking into account the assumptions for the individual scenarios.
Source: KOBiZE, IOS-PIB

5.5. The use of the Kyoto Protocol mechanisms

5.5.1. The Joint Implementation (JI) mechanism – Article 6 of the KP

By the end of 2011, 19 Joint Implementation projects had been approved in Poland. The expected total greenhouse gas emission reductions from the implementation of these projects in 2008-2011, determined on the basis of project design documents (PDDs), was 15,647,682 t CO2 eq. Table 5.27 presents summary information on the reduction levels and the transfers of units for the approved JI projects.

Table 5.27. The levels of greenhouse gas emission reductions and ERU transfers in the 19 approved Joint Implementation (JI) projects in 2008–2011

Period	**Greenhouse gas emission reduction levels [Gg CO_2 eq.] in 2008-2011**		**ERU transfers for emission reductions in 2008-2011**
	Expected (acc. to project design documents [PDDs])	**Verified** (by accredited independent entities [AIEs])	**Total number of ERUs** transferred to buyers
2008-2011	15,647.682	13,737.072	13,120,323.

Source: KOBiZE, IOS-PIB

The JI projects implemented in Poland are related to the following types of activities:

a) use of renewable energy sources (12 projects),
b) methane removal from mines (3 projects),
c) industrial processes (4 projects).

The implemented JI projects concerned the nitrous oxide (N_2O) emissions to the extent of 78%, methane (CH_4) emissions to the extent of 16% and carbon dioxide (CO_2) to the extent of 6% – relative to the total anticipated emission reduction level. The projects are implemented in the following sectors: the energy sector, mining, the chemical industry, waste management, district heating and agriculture. The most important foreign partners involved in the JI projects in Poland are such countries of the European Union as Denmark, Netherlands and, from outside the EU, Japan. One of the partners is also the World Bank.

Six of the JI projects approved and implemented in Poland were included in the reserve in NAP II as the approved JI projects contributing to greenhouse gas reductions in the EU ETS. The other 13 projects have no effect on the emissions under the EU ETS.

5.5.2. The Clean Development Mechanism – Article 12 of the KP

Until now Poland has not participated in the implementation of CDM projects.

5.5.3. The emission allowance trading in the European Union

The CO_2 emission levels covered by the EU ETS are calculated in accordance with the *Commission Decision of 18 July 2007,* which was transposed into the Polish law by the Regulation of the Minister of the Environment of 12 September 2008 *on the manner of monitoring the emission levels of substances covered by the Community emission allowance trading scheme* (Official Journal of the Laws No. 183, Item 1142). The calculations of CO_2 emissions by the operators of installations covered by the EU ETS are verified by external, independent and accredited auditors. A reliable determination of CO_2 emissions from installations is of key importance for trading in a surplus of allowances and balancing the emission allowance trading scheme. The verified CO_2 emission levels are transferred to the Union Registry of allowances where they decrease the pool of allowances allocated to a given installation.

Combustion installations, including main activity power plants, main activity heat and power plants, autoproducer heat and power plants and main activity heating plants, were responsible for the greatest part of CO_2 emissions in the EU ETS (Table 5.28). In successive years, the use of biomass grew, the emission factor of which in the EU ETS is 0 Mg CO_2/TJ. In the key sectors, i.e. the main activity energy sector, iron and steel plants and the cement, refinery, lime and paper industries, the emissions grew in recent years, in connection with an intensive national development programme, among other, owing to the European Union funds (including e.g. the construction of roads and motorways, the development of transport etc.).

Table 5.28. The levels of emissions from the individual sectors covered by the EU ETS.

Sector	CO_2 emissions [Mg]						
	2005	2006	2007	2008	2009	2010	2011
Main activity power plants	118,470,414	123,053,990	121,955,867	118,302,161	113,789,798	117,327,018	120,622,780
Main activity heat and power plants	28,859,995	27,991,099	27601,665	26,179,298	25,270,775	25,871,876	24,199,285
Main activity heating plants	10,011,752	9,679,235	9,172,572	8,598,964	8,550,105	9,441,325	7,802,577
Autoproducer heat and power plants	6,263,744	6,045,494	6,374,067	5,801,152	5,290,086	6,054,284	5,852,178

Sector	CO_2 emissions [Mg]						
	2005	2006	2007	2008	2009	2010	2011
Iron and steel plants	7,535,683	8,812,301	9,169,996	10,280,827	6,807,220	7,565,141	8,131,369
Cement industry	8,085,961	9,637,971	11,423,789	10,465,611	8,795,565	9,448,720	11,425,789
Sugar industry	1,547,461	1,334,122	1,451,129	1,206,587	1,153,003	1,251,199	1,223,907
Chemical industry	4,829,201	4,762,923	4,469,550	4,113,194	4,109,148	4,214,402	4,093,360
Wood products industry	621,354	607,492	611,735	701,579	587,531	614,623	554,437
Coking industry	2,471,325	2,912,315	3,251,754	2,924,693	2,091,712	2,744,642	2,714,007
Other industries	2,168,276	2,111,445	2,129,943	2,787,371	2,501,492	2,446,039	2,382,381
Refinery industry	6,757,279	6,983,691	6,552,459	7,520,287	7,406,534	7,550,881	8,264992
Glassmaking industry	1,454,544	1,447,301	1,480,676	1,704,867	1,399,538	1,521,811	1,725,331
Lime industry	1,434,526	1,642,481	1,856,818	1,651,930	1,560,764	1,599,642	1,808,687
Ceramic industry	1,134,430	1,141,011	700,079	659,035	519,322	518,521	500,837
Paper industry	1,503,631	1,453,419	1,416,258	1,209,863	1,341,656	1,556,783	1,724,608

Source: KOBiZE, IOS-POB

The larger use of biomass was directly related to the implementation of the policy of enhancing the utilisation of RES and the mechanisms of support for energy producers using renewable sources through the system of certificates of origin and to the possibility of reducing CO_2 emission levels, thus saving emission allowances with a tangible economic value. The growing use of biomass was reflected in the stabilisation or reduction of the hard coal consumption by main activity power plants, main activity heat and power plants and main activity heating plants.

A change in the fuel mix was one of the measures taken by the installations covered by the EU ETS which directly affected the CO_2 emission levels. Indirect measures included e..g the use of cogeneration, the replacement of the heating network and the connection of new heat users. Cogeneration was an important way of improving the efficiency of using fossil fuels.

Apart from its direct effect on CO_2 emission levels, the functioning of the emission allowance trading scheme also improved the awareness of the installation operators and the public as a whole about climate change and the possibility of counteracting it. An additional value from the functioning of the EU ETS were the environmental data on fuel consumption and emissions reported to the system because of their external and independent verification by accredited auditors. These data made it possible to partly check the environmental data acquired in relation to other reporting obligations which were not subject to such strong control and provided numerous possibilities for using them in modelling and assessments of the effects of environmental impacts.

5.5.4. An assessment of the effects of the functioning of the ETS scheme

A correct indicator to assess the functioning of the EU ETS is the emission intensity index of a product since it reflects the real emissions from the production of a unit product and is not sensitive to a change in the number of installations covered by the scheme or a change in GDP. Changes in the level of this emission intensity index reflect the actual measures taken by the operators of installations covered by the EU ETS to reduce CO_2 emissions. The emission intensity indices of selected sectors in 2008–2011 are shown in Table 5.29. In the case of power plants, heat and power plants and heating plants, the emission intensity index of equivalent production was used, given the need to take into account the production of both electricity and heat in some installations.

Table 5.29. Emission intensity indices for selected sectors.

Sector	Emission intensity index [$MgCO_2/GJ$] EQUIVALENT PRODUCTION				Emission intensity index [$MgCO_2/Mg$] MAIN PRODUCT			
	2008	2009	2010	2011	2008	2009	2010	2011
Main activity heating plants	0.113	0.110	0.108	0.107	-	-	-	-
Autoproducer heat and power plants	0.134	0.133	0.137	0.125	-	-	-	-
Main activity heat and power plants	0.115	0.112	0.108	0.108	-	-	-	-
Main activity power plants	0.252	0.251	0.249	0.252	-	-	-	-
Coking industry	-	-	-	-	0.314	0.287	0.282	0.278
Cement industry	-	-	-	-	0.845	0.840	0.842	0.847
Ceramic industry	-	-	-	-	0.165	0.158	0.153	0.145
Paper industry	-	-	-	-	0.449	0.468	0.481	0.527
Line industry	-	-	-	-	1.062	1.077	1.070	1.067

Source: KOBiZE, IOS-PIB

The emission intensity index fell for the production in the energy sector, i.e. main activity power plants, main activity and autoproducer heat and power plants and main activity heating plants (Fig. 5.3). The changes in the emission intensity indices of the other industrial sectors were differentiated (Fig. 5.4). The cement, coking and ceramic industries were characterised by a fall in their emission intensity indices, whereas the lime and paper industries demonstrated large variability with a growing trend. The nature of the manufacture of goods in some industries (e.g. the glassmaking industry), which was very diverse and different in the individual years, made it practically impossible to determine an objective emission intensity index for the whole industry, without in-depth consideration of the division into specific types of products, such as e.g. packaging glass, flat glass, household glass, special glass or mineral wool. Moreover, it should be emphasised that in practice there were limited possibilities for improving the emission intensity indices of industrial installations which emitted CO_2 mostly from their technological processes rather than from fuel combustion, given the requirements of the technological process and the needed raw materials.

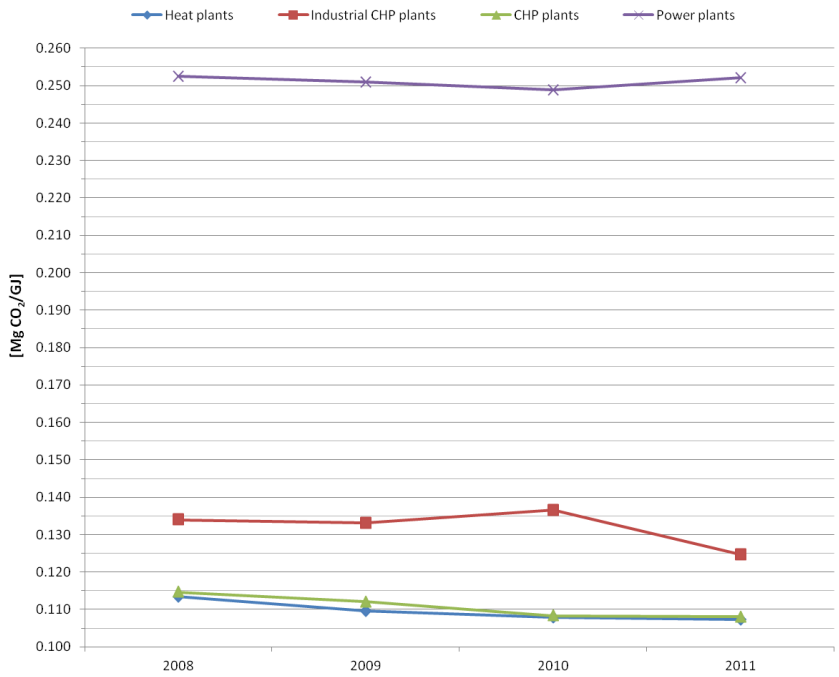


Fig. 5.3. The emission intensity indices for power plants, heat and power plants and heating plants for equivalent production. Source: KOBiZE, IOS-PIB.

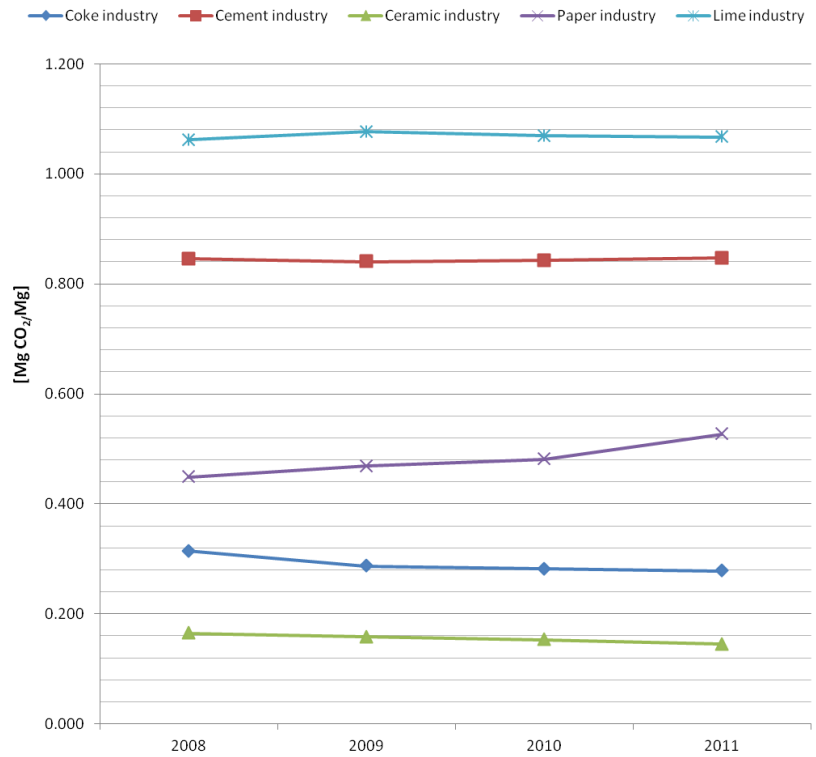


Fig. 5.4. The emission intensity indices for selected industries. Source: KOBiZE, IOS-PIB

The emission intensity indices of installations which emitted CO_2 from fuel combustion significantly changed as a result of enhanced use of biomass, which is regarded as causing no CO_2 emissions in the EU ETS. Table 5.30 shows the quantity of biomass used in the installations covered by the ETS scheme for, respectively, biogas, black liquor and solid biomass.

Table 5.30. The use of biomass in the ETS

Year	Fuels				
	Biogas [m^3]	Black liquor [m^3]	Biomass		
			[Mg]	[m^3]	[TJ]
2008	6,038,038.50	523,130.70	3,990,159.50	3,653.23	8,735.09
2009	8,050,817.03	532,565.25	4,908,096.39	5,708.03	12,097.06
2010	11,123,453.03	561,301.53	5,475,183.69	13,268.87	35,013.77
2011	13,009,995.15	540,770.65	6,166,673.58	1,931.70	23,124.59

Source: KOBiZE, IOS-PIB

It is also interesting to note the use of gas from mine methane removal (Table 5.31).

Table 5.31. The use of gas from mine methane removal in the ETS

Gas from mine methane removal by years	Quantity of fuel [m^3]	Emissions [Mg CO_2]
2008	270,579,070	287,660
2009	277,795,569	278,481
2010	265,518,039	265,322
2011	268,971,793	267,397

Source: KOBiZE, IOS-PIB

5.5.5. The results of the Second National Allowance Allocation Plan

The CO_2 emission levels in the ETS (cf. Table 5.28) were affected e.g. by:

- a change in the number of the installations covered by the ETS,
- a change in the GDP,
- a change in the structure of fuels and raw materials used by installations,
- technological changes improving the emission intensity index.

This was reflected in the significant emission reduction to 191.2 million Mg CO_2 in 2009 during the crisis.

The number of installations covered by the EU ETS fell from 832 in 2008 to 813 in 2011 as a result of the inclusion of newly established installations and the exclusion of installations which had ceased to produce. The reason why some installations were excluded from the EU ETS was not because they had ceased to produce, but because they had modernised and, in consequence of this, their production capacity had dropped below the thresholds obliging them to participate in the EU ETS. In 2012, the allowance trading scheme was expanded with aircraft operators. The emissions from aircraft operators attributed to Poland amounted to 641,424 Mg CO_2.

CHAPTER 6. VULNERABILITY ASSESSMENT, CLIMATE CHANGE EFFECTS AND ADAPTATION MEASURES

6.1. Introduction

Since the Fifth National Communication there has been significant progress in the adaptation of the Polish economy and society to the current and expected impacts of climate change. In 2009, the preparations for the development of the first strategy for adaptation to climate change (the Strategic Adaptation Plan) began. These measures were based on the Government's Position adopted on 3 July of 2009 by the European Committee of the Council of Ministers to implement the provisions of a strategic document of the European Commission (COM 2009 147) – A White Paper on adapting to climate change, which lays down the framework for and guides Europe's preparations for more effective response to the impacts of climate change at the levels of the EU and the Member States.

In its Position, the Government states that:
"In connection with climate change, Poland can expect an intensification of floods on both lowland and mountain rivers and sustained droughts related to water shortage. The rising level of the Baltic Sea also poses danger e.g. for the technical infrastructure of ports and depression areas and will cause enhanced coastal erosion and significant changes in marine ecosystems and the coastal zone. The extreme weather events, which can already be observed now, such as heat waves, tornados and storms, will also intensify.

For this reason, a strategy for sectoral adaptation measures must be developed in Poland at the government level, taking into account the assessment of the vulnerability of sectors to climate change and considering the cost and benefit analysis for the possible adaptation measures. On this basis, the existing socio-economic strategies need to be complemented at the national level and those of the individual economic sectors……"

The Government's Position laid down the basis for the launch in 2011–2013 of the Project called "The Development and Implementation of a Strategic Adaptation Plan for Sectors and Areas Vulnerable to Climate Change" with the acronym KLIMADA. The results of this Project provided the basis of for the preparation of the Strategic Adaptation Plan 2020 (SPA 2020) with an Outlook until 2030.

The Strategy should enable the preparations to adapt in the sectors which are most vulnerable to climate change, including agriculture and rural areas; waters, coastal and marine areas; the health of humans, fauna and flora, and infrastructure (transport, construction, the energy sector etc.). SPA 2020 is the first step towards defining a long-term vision of adaptation to climate change until 2070.

In the case of Poland, the major risks comprise e.g. the loss of biodiversity, changes in the water balance, including in particular the variability of precipitation and evaporation, lower yields of cereals and potatoes, the higher incidence of the extreme weather events, including floods, droughts and hurricanes, a higher fire risk in forests, faster soil erosion, and also greater losses in tree-stands as a result of more frequent extreme wind events. The health-care system will also face additional challenges, as the population will be exposed to a greater extent to the impacts of the extreme weather events and diseases which have not been present so far in our climatic zone.

6.2. Observed and predicted climate change

6.2.1. Contemporary climate change in Poland

The last two decades of the 20th century and the first decade of the 21st century have been the warmest periods in the history of instrumental observations in the Polish lands, with the annual average temperatures in Warsaw reaching, respectively: +8.7°C, +8.9°C and +9.2°C. In all the seasons of the year, the air temperature growth can be seen, which is the strongest in winter and the weakest in summer. The same change trends have been observed for the maximum and minimum temperatures. A distinct increase in the extreme temperatures has occurred since 1981. In turn, the warmest years over a period of 230 years were the following 4 years: 2008, 2000, 2007 and 1989.

The growing temperature trend since the mid-19th century has been accompanied by large annual variability. Until 2000 the growing temperature trend was 0.058°C/10 years, while over the last 12 years the temperature has grown by 0.12°C.

In most of Poland's territory, the numbers of frosty and very frosty days (days with the minimum temperature ≤-10°C and days with the maximum temperature ≤-10°C) have tended to fall.

The precipitation structure in the prevailing part of Poland has changed. The change consisted in a distinct increase in the number of days with very intensive precipitation, e.g. the daily precipitation rate ≥30 mm – by more than 3 days/decade and ≥50 mm by 2 days/decade. Heavy rains with their intensity exceeding 5 mm/min and their seasonal probability of ≥10% (May-September) occur most frequently in Southern Poland.

6.2.2. Emergencies

Emergencies mean extreme phenomena with a low probability of occurrence and of local nature, such as showers, strong winds and heat waves, as well as landslides, avalanches or forest fires. A common feature of these events is their unpredictability and relatively short duration, while because of their small-scale nature they are insufficiently explored in prediction models. Large-scale emergencies in terms of time and space include floods and droughts. They are classified as emergencies in view of the character and magnitude of the damage which they cause.

Floods

Floods and inundations are the most frequent and most dangerous phenomena related to the climate conditions and they pose danger almost throughout Poland (Fig. 6.1.).

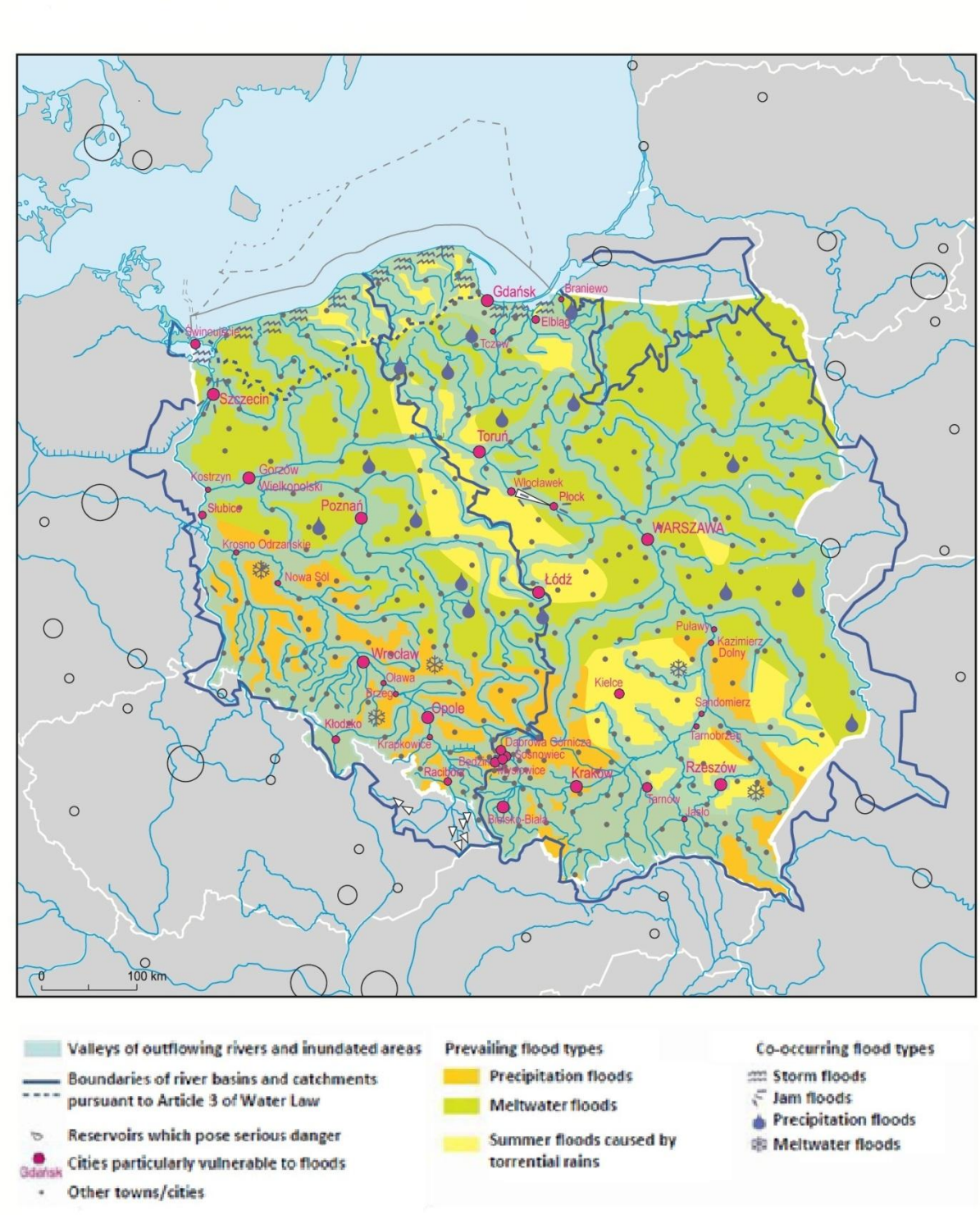


Fig. 6.1. Flood hazards in Poland, Source: KPZK 2030 (M.P. of 2012, Item 252)

Torrential precipitation floods (flash floods) are very dangerous and cause substantial damage, but they are of local character. Since the frequency of very intensive rainfalls increases along with climate change, the frequency of such floods also grows (Fig. 6.2.). Floods of this type are particularly dangerous in mountain and submontane areas, where they cause substantial damage through slope erosion, damage to tree-stands and landslides, and in urbanised areas, where they cause inundations and floodings.

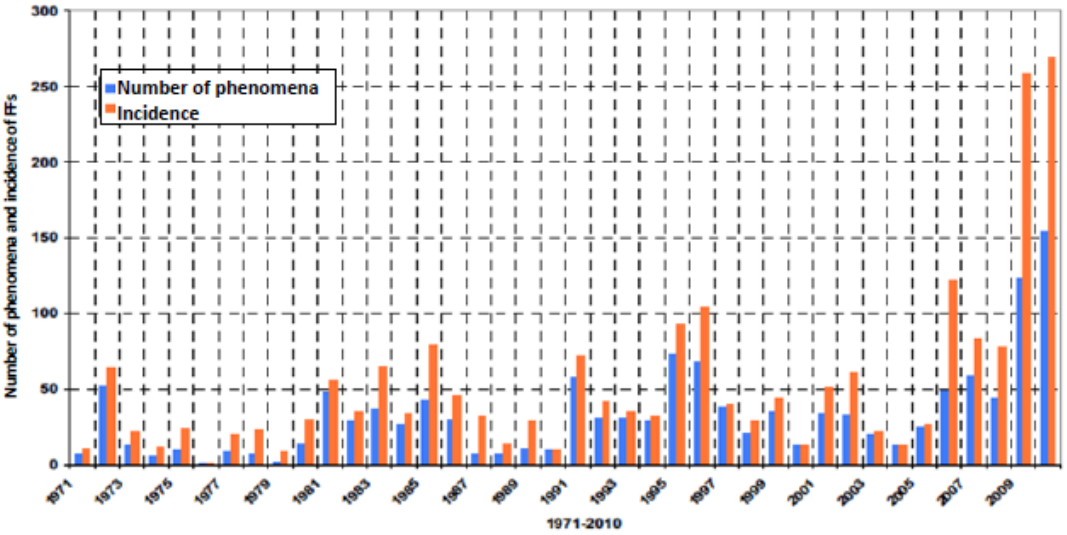


Fig. 6.2. The number of phenomena which cause flash floods (FFs) and their incidence in 1971-2010. Source: Ostrowski et al.2012[52].

The floods on the Odra River, the Vistula Rivera and their major tributaries ensue from a large number of interconnected natural factors and processes. However, they are mainly driven by rainfalls, their rates, spatial distribution and intensity. The soil and riverbed retention, the structure of the river network, the morphology, the forest cover rate and the status of the flood protection system are also of large importance. It follows from the analyses carried out for the Odra River that it is impossible to identify a distinct trend of change in the probability of the occurrence of the maximum flows (Fig. 6.3.), although on the Upper Odra the frequency of the occurrence of the maximum flows increases.

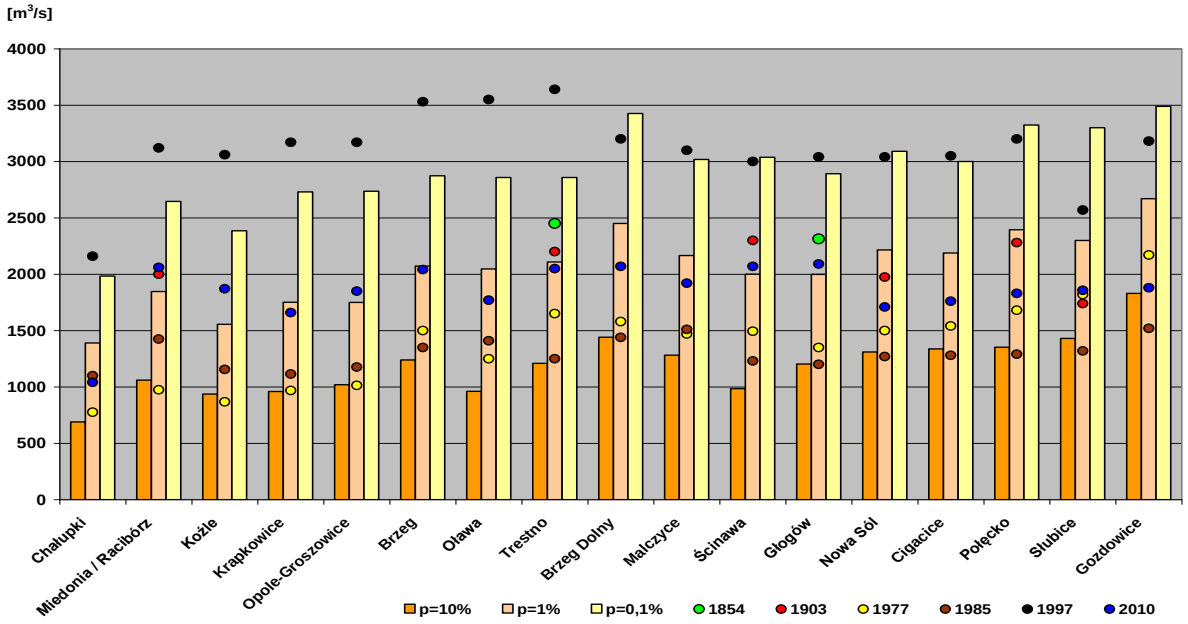


Fig. 6.3. The maximum flows of catastrophic flood waves on the Odra River for $p_{\%}$=10, 1 and 0.1. Source: Dubicki A.

[52] Ostrowski J. et al. 2012 Nagłe powodzie lokalne (flush flood) w Polsce i skala ich zagrożeń [Local flash floods and the magnitude of their hazards (in Polish) [in:]: KLIMAT Project, vol. 3, IMGW-NRI

In case of minimum flows, a further decrease can be expected in all the Voivodeships (from 10 to 30%).

Lower flows in rivers and streams will cause water shortages in submontane localities and aggravate economic problems, while higher water temperatures will generate eutrophication in lakes and flood protection reservoirs. Combined with a higher frequency of heavy rains, which will cause violent flash floods and slope erosion, this will bring about enhanced transport of dragged and floating loads, while the silting of substantial river sections and reservoirs will ensue. As a result of this, riverbeds will become more shallow and the flood risk will grow.

As the air temperatures grow and the thickness and resilience of snow cover diminish, the meltwater and winter floods, which depend on the climate conditions, demonstrate and will continue to demonstrate a decreasing frequency of their occurrence.

Landslides

Landslides, which increase above all in the mountain and submontane areas (Fig. 6.4), are a particularly dangerous phenomenon. They are caused by full saturation of the surface soil or rock layer as a result of heavy rains of long duration. Already at present, the rainfalls generate phenomena of this type on an unprecedented scale to date and this tendency still persists. The particularly vulnerable areas include Southern Poland, the slopes in the Carpathians and, to a lesser extent, steep river escarpments and upland areas.

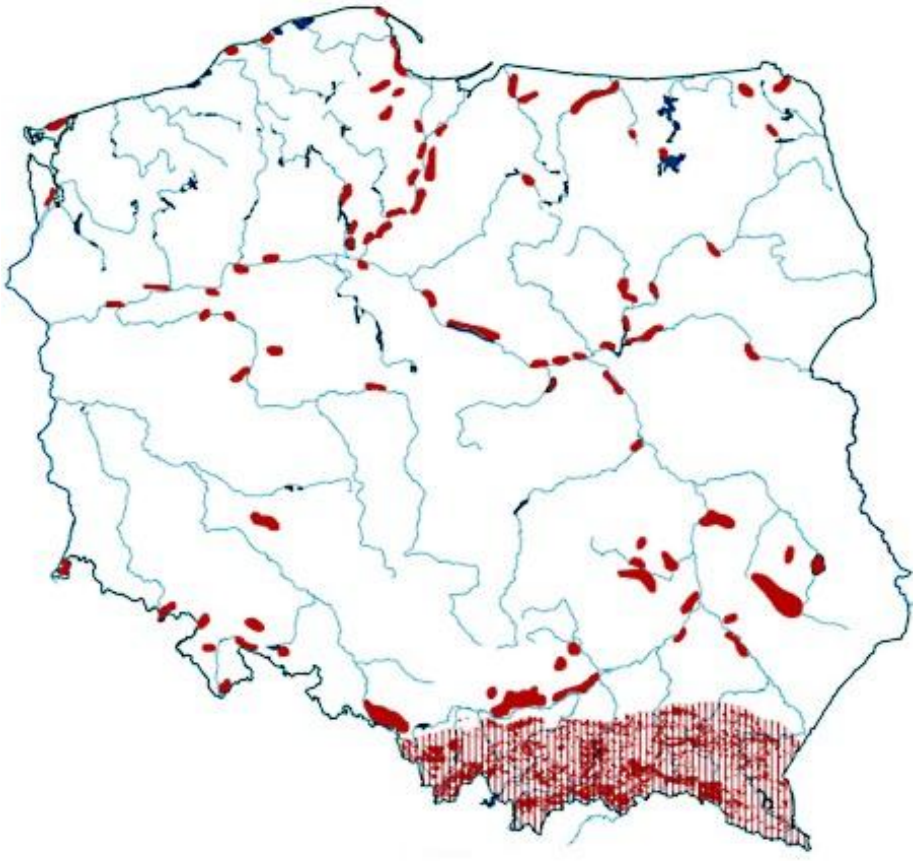


Fig. 6.4. A map of landslides in Poland. Source: PIG-PIB

Droughts and water deficit

The periodical occurrence of droughts is a characteristic feature of Poland's climate. Over the last 60 years, the frequency of this phenomena has been observed to grow; e.g. in Poland's territory droughts occurred 6 times in 1951-1981 and 18 times in 1982-2011. In that period, droughts occurred almost incessantly in the different regions of the country. Since the beginning of the 21st century, i.e. in 2001–2011, droughts occurred 9 times in the different periods of the year.

Over the last 12 years, throughout Eastern Poland (east of the Vistula River), a rainless period became longer, even by 5 days/decade. This is a region of the country which suffered most often from drought disasters in the period from 1991 to 2002. In 1982–2011, there were 18 dry years. In consequence, this leads to soil drought, causing losses in agriculture and a lower groundwater table, and, as a result, to hydrological drought, which is manifested by decreased flows in rivers, leading, in consequence, to water shortages.

In agriculture, a progressive, though non-uniform increase in the risk of agricultural drought can be seen in Poland's territory. The results of analyses indicate that losses in the yields of certain plants grow as a result of a greater risk of agricultural drought in 2021–2050 and 2071–2100. In relation to crops, the greatest losses of potential yields are expected in Central and South-Western Poland, while the lowest losses would come in North-Eastern Poland.

Water shortages are differentiated in space and time. In relation to most crops, the greatest water deficits occur in the central belt of Poland extending from the East to the Northwest (Fig. 6.5.).

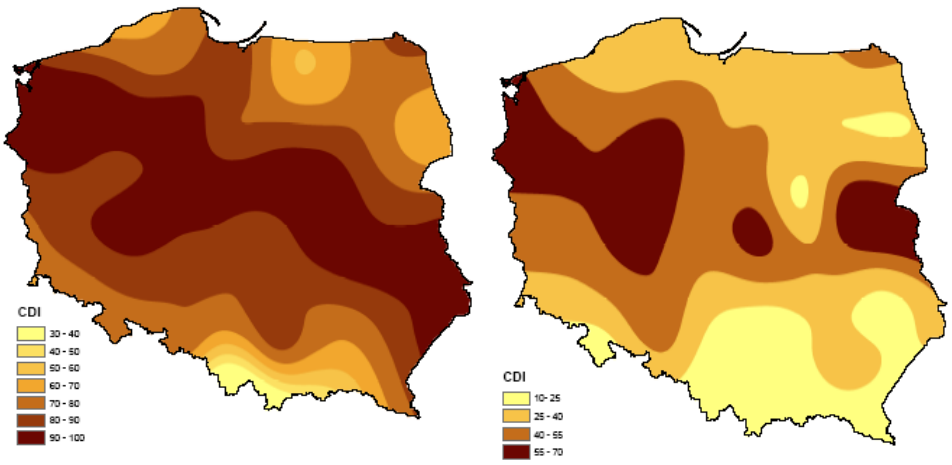


Fig. 6.5. The frequency rate (%) of agricultural droughts (CDI) for the cultivation of late potatoes (the left diagram) and winter wheat (the right diagram).Source: Łabędzki and Bąk, own research, maps by K. Smarzyńska, ITP Bydgoszcz.

The spatial differentiation of both water deficits and agricultural droughts quantified by the CDI index indicates the need for irrigation in order to gain high yields. In order to implement such irrigation, adequate water resources will have to be ensured in the form of current flows in watercourses and retention in lakes or artificial water reservoirs.

Strong winds

Since 2005 there have been 11 hurricanes in Poland, primarily in 2009, 2011 and 2012, with the wind speed periodically exceeding 30–35 m/s in Poland's territory. The areas which are most vulnerable to such phenomena include the central and eastern parts of the Słowińskie Coast, from Koszalin to Rozewie and Hel, and a wide, parallel belt in Northern Poland, extending up to the Suwałki Region, the areas of the Silesian and Żywiec Beskid Mountains, the Silesian Foreland, Podhale and the Dynowskie Foreland, the central part of Poland, including Mazovia and the eastern part of Greater Poland (Wielkopolska) (Fig. 6.6).

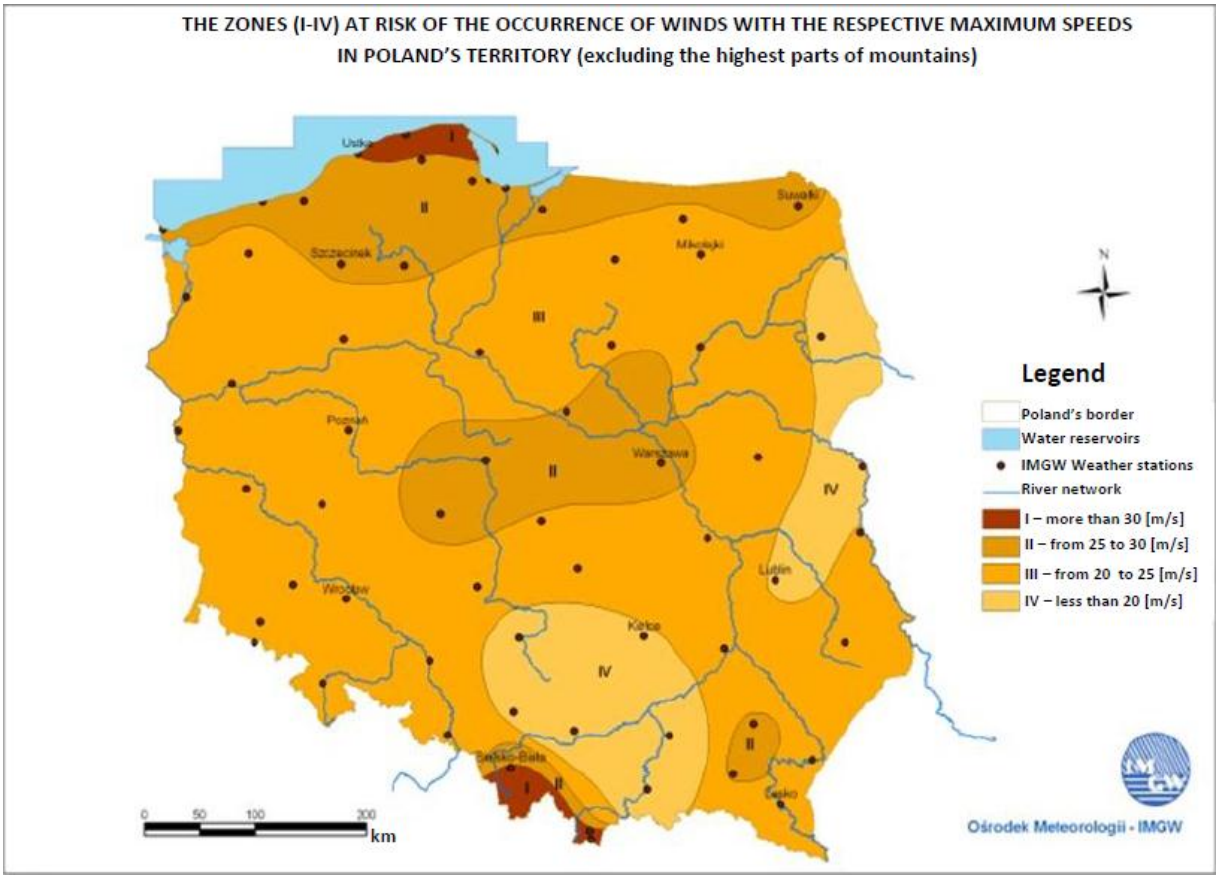


Fig. 6.6. The zones at risk of the occurrence of winds with the maximum speeds. Source: IMGW-PIB.

In the cold season of the year (October-April), the share of wind speeds with gusts ≥ 17 m/s grows, posing substantial danger, while in summer (June-July) hurricane wind speeds occur. In the structure of the duration of the maximum speeds, more and more often very high wind speeds can be seen to occur, to last for many hours or even several days.

From June to August, in the different regions of the country there are **tornados**. On average, they occur 6 times in a year, but in the last 3 years their frequency has grown to 7–20. Changes in the frequency of the occurrence of this phenomenon are shown in Fig. 6.7. In tornados, the wind speeds reach 30–120 m/s causing substantial damage at the local level.

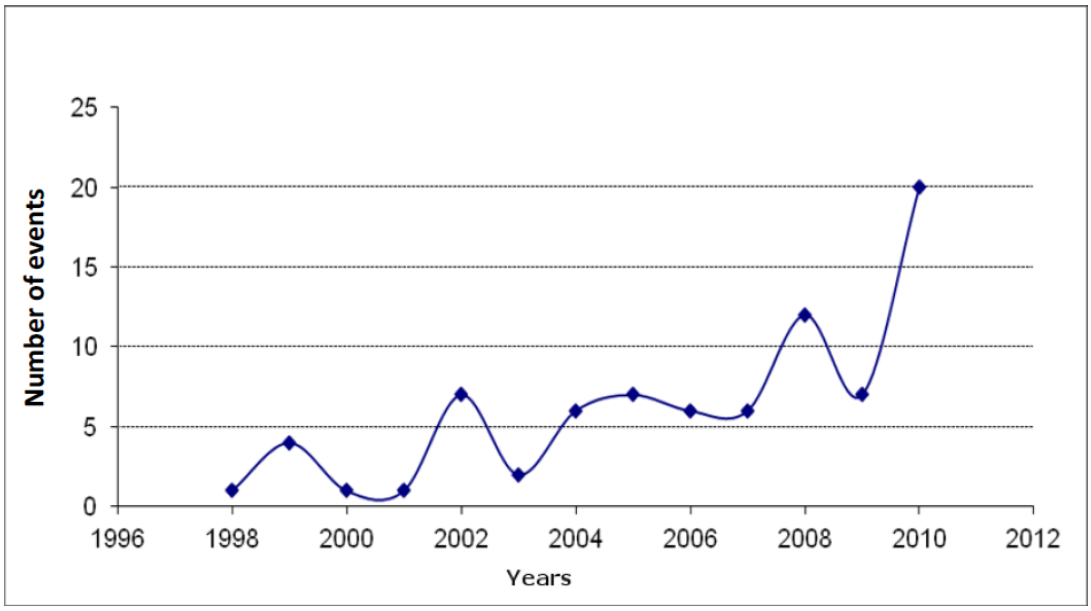


Fig. 6.7. The frequency of the occurrence of tornados in Poland. Source: IMGW-PIB.

Heat waves

Thermal phenomena which are unfavourable and uncomfortable for the environment and the public include heat waves and series of hot days ($t_{max} \geq 30^{o}C$). The longest heat wave, lasting for 15-20 days all over Poland, came at the turn of July and August 1994 (Fig. 6.8.).

Heat waves are most frequent in South-Western Poland and rarest on the coast and in the mountains, while longest series of hot days last for ≥17 days in Southern Poland.

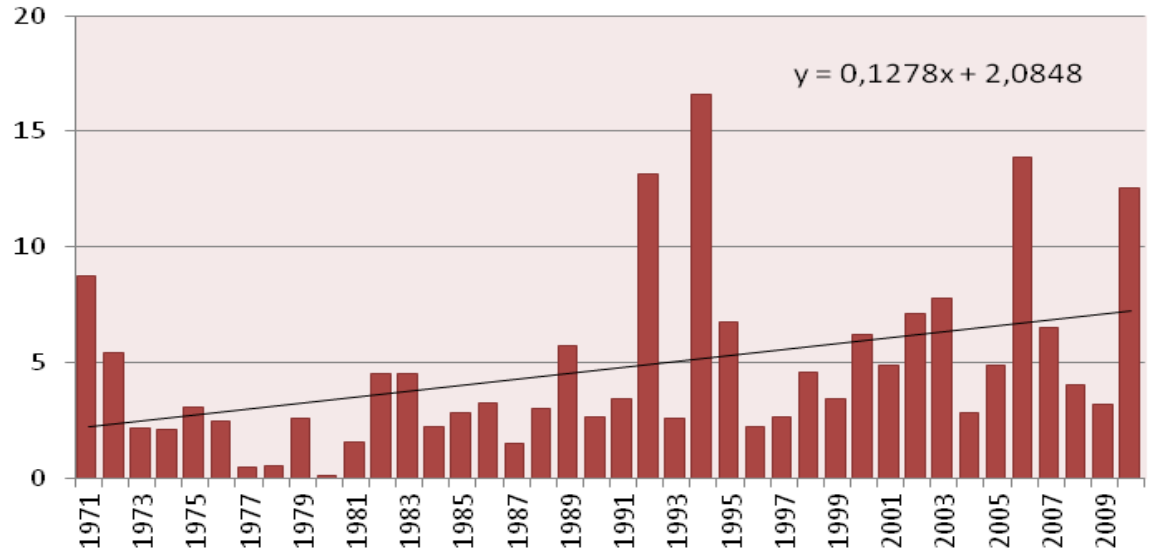


Fig. 6.8. The variability of the number of hot days ($t_{max} \geq 30^{o}C$) in Poland in 1971–2010. Source: IMGW-PIB.

Hail occurs most often in May and June. In 2000–2010, the number of days with hail fell compared with the period from 1971 to 1980. The annual average number of days with hail throughout Poland (in the period from 1960 to 1978) was 0.14 per 100 km². Values exceeding that average can be found primarily in the following Voivodeships: Małopolskie – 196% of the national average, Śląskie – 180%, Świętokrzyskie – 141% and Opolskie – 137%. Hail occurs in connection with to storms and heavy rains. Given the expected growth of the frequency and intensity of these phenomena, the frequency of hail precipitation events can also be expected to increase.

Other phenomena (icing, fires) are incidental in character.

6.2.3. Climate scenarios for Poland in the 21st century

The climate change scenarios for Poland were prepared in the Interdisciplinary Center for Mathematical and Computational Modelling (ICM) on the basis of simulations carried out in the EU ENSEMBLES Project. For the purposes of the assessment of climate change in Poland, the results of 8 regional models were applied using the boundary conditions from 4 global models (ARPEGE, ECHAM5, BCM and HadCM3Q0). A broad spectrum of available regional and global models generating the boundary conditions for scenario simulations was taken into account. An ensemble contains two different regional simulations for each global model.

Climate change projections for Poland were carried out under the assumptions of the greenhouse gas emission scenario SRES A1B (Nakicenovic, Swart, 2000).

Expected climate change in Poland

The method of the 10^{th}, 50^{th} and 90^{th} percentiles was used to analyse air temperature changes. The 10^{th} percentile indicates the temperature values below which 10% of all the temperature values fall in a given thirty-year period, the 50^{th} percentile is the median, dividing all the possible values into halves, while the 90^{th} percentile cuts off 10% of the highest temperature values in the period examined.

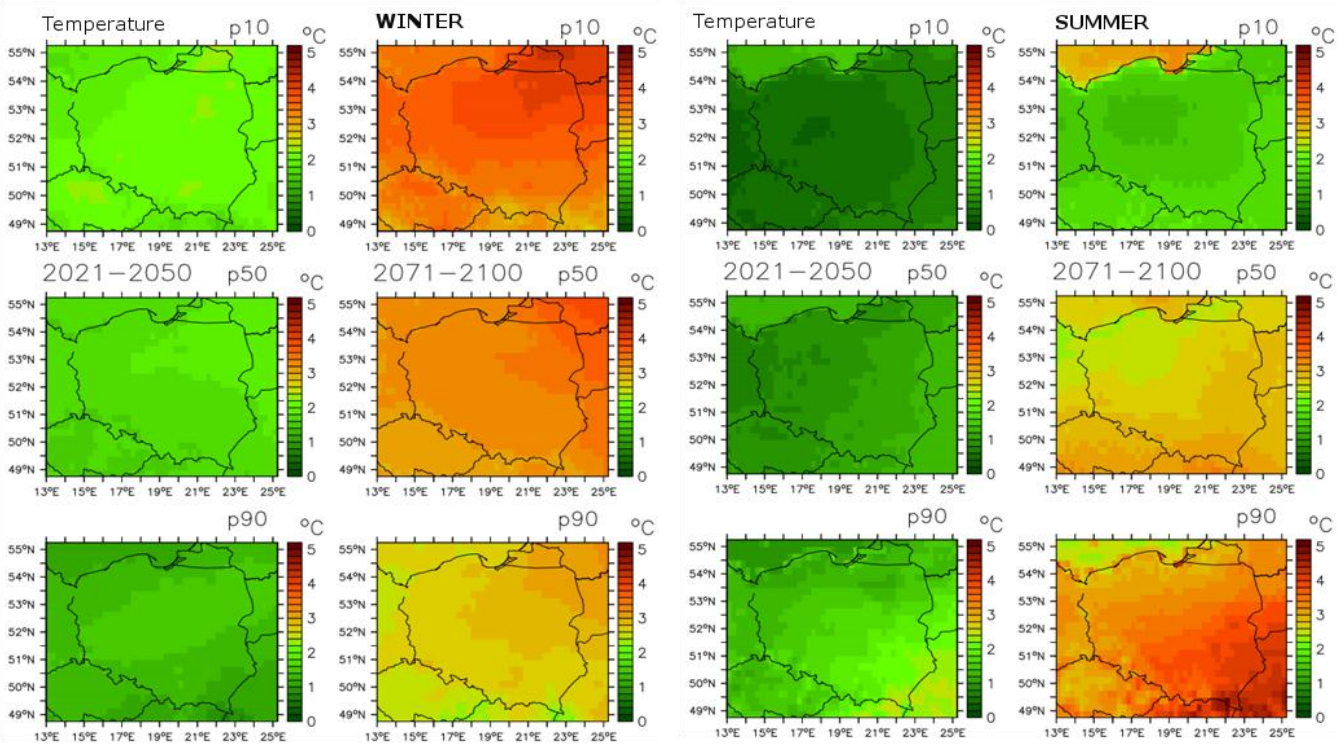


Fig. 6.9. The differences between the 10th, 50th and 90th air temperature percentiles [°C], between the periods from 2021 to 2050 and from 2071 to 2100 versus the reference period from 1971 to 2000, for winter (the left diagrams) and summer (the right diagrams). Source: ICM

It follows from Fig. 6.9 that the expected warming in the two periods and the two seasons is distinctly greater in the last thirty-year period. In the case of winter, distinctly higher increases should be expected in the low temperature range (the 10th percentile); they would be highest in North-Eastern Poland – up to 2.5°C in the middle period and above 4.5°C in the last thirty years. The increases in the median and high temperature values in the winter season are more uniform in the whole territory of the country, varying between about 1.5°C in 2021-2050 and about 3.5°C in 2071–2100 in the case of the 90th percentile. In summer, the increases in the low temperature values, represented by the 10th percentile, reach about 1°C in 2021–2050 and more than 2°C in 2071–2100. The high temperature values grow to a greater extent, particularly in North-Eastern Poland, from 2.5°C in the first period considered to more than 4.5°C at the end of the century.

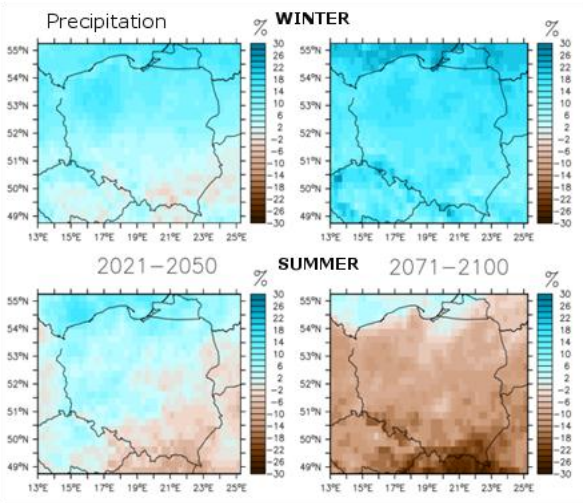


Fig. 6.10. Relative precipitation changes [%] for winter and summer, between the periods from 2021 to 2050 and from 2071 to 2100 versus the reference period from 1971 to 2000. Source: ICM

The spatial distribution of relative precipitation changes (Fig. 6.10.) indicates a higher precipitation rate in winter, reaching about 15% in the northern part of the country in 2021–2050 and more than 20% in the eastern part in 2071–2100. The precipitation rate in summer is expected to fall at the end of the century; to the greatest extent in the Southeast.

Fig. 6.11 shows the time behaviour of averaged air temperature values and precipitation rates in Poland in summer and winter for the whole period from 1971 to 2100. The grey areas illustrate the variability ranges of the two variables for the eight simulations considered and indicate the uncertainty levels of the scenarios calculated. The temperature clearly tends to grow. In the case of precipitation, the trend is not so clear; still, it can be seen that precipitation falls in winter and slightly grows in winter.

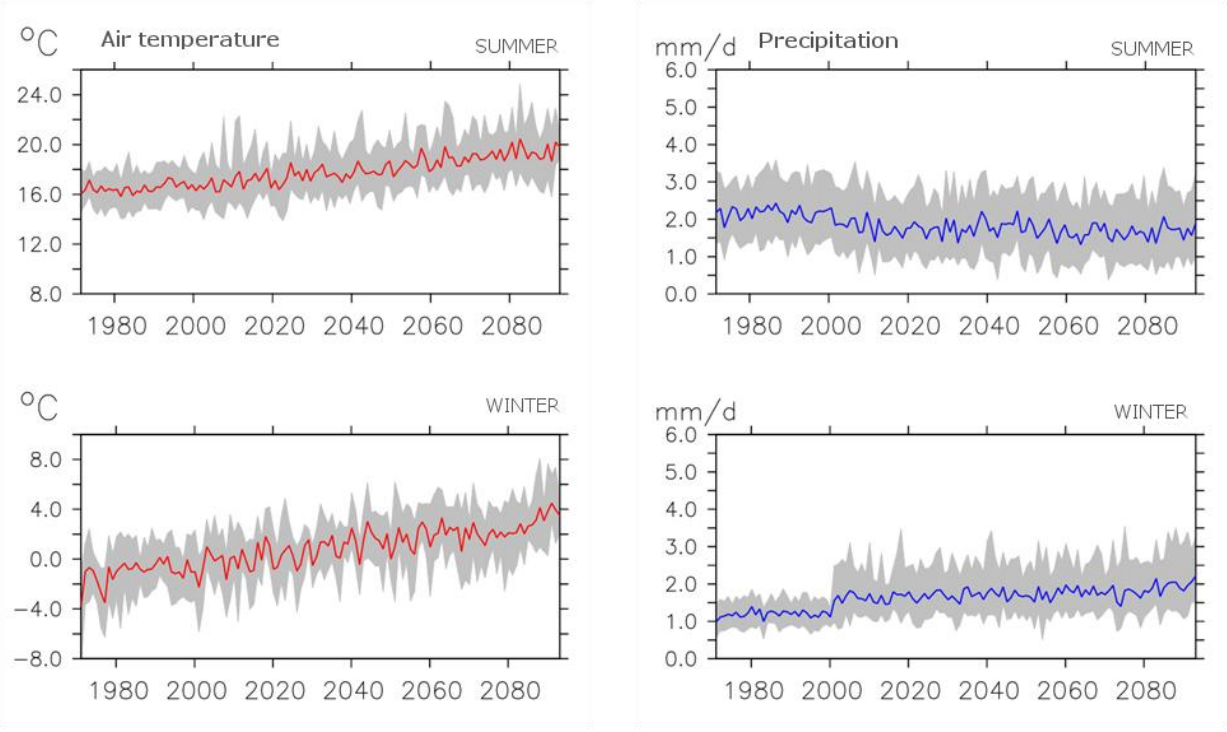


Fig. 6.11. The air temperature (the left diagrams) and the precipitation rate (the right diagrams) averaged for Poland in summer and winter. Source: ICM

The simulations indicate (Fig. 6.12.) that summer periods become longer (with the maximum temperatures >25°C), while the frosty periods become shorter (with the minimum (temperatures <0°C). In the reference period from 1971 to 2000, the number of frosty days exceeded the number of warm days more than twice, while at the end of the century this trend reversed.

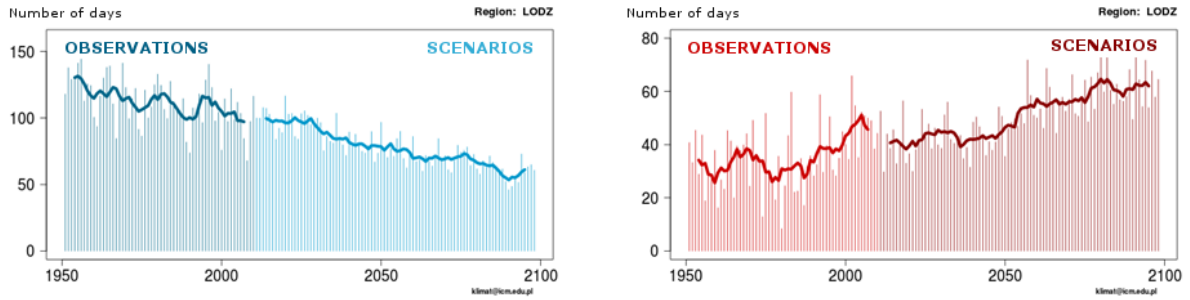


Fig. 6.12. The number of days with the minimum temperature below 0°C (the left diagram) and the maximum temperature above 25°C (the right diagram) for Central Poland. The diagrams for 1951-2010 are observation data, while the data for the later years come from scenarios. Source: ICM

The number of very hot days (with the maximum temperature exceeding 25°C), and, hence, the number of heat waves, greatly grows. This growth can be found throughout the country, although it varies from region to region.

The thermal vegetation period (T > 5°C) gradually becomes longer in the course of the 21st century, primarily because it begins earlier (Fig. 6.13.).

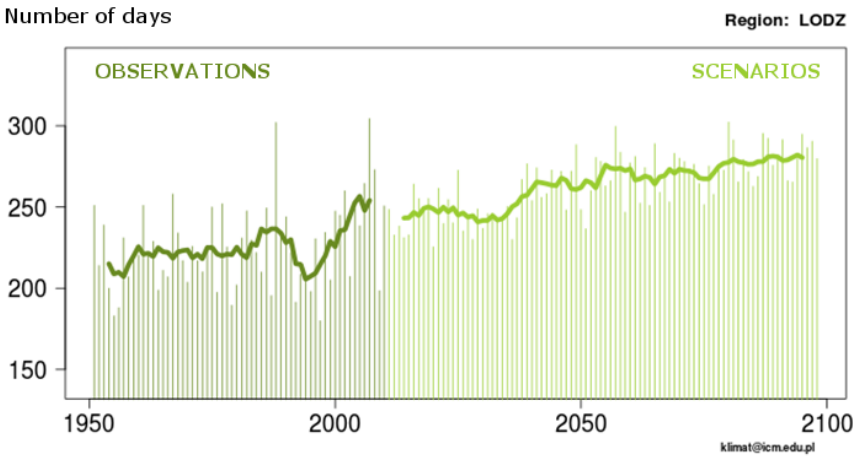


Fig. 6.13. The duration of the vegetation period under the criterion of T>5°C, for Central Poland. The diagrams for the period from 1951 to 2010 are based on observed data (EOBS), while the data for the later years come from scenarios. Source: ICM

The duration of the heating season (expressed by the number of degree-days) becomes shorter (Fig. 6.14). The fall in the demand for space heating varies from region to region, while the number of degree-days decreases, particularly in Northern and Eastern Poland.

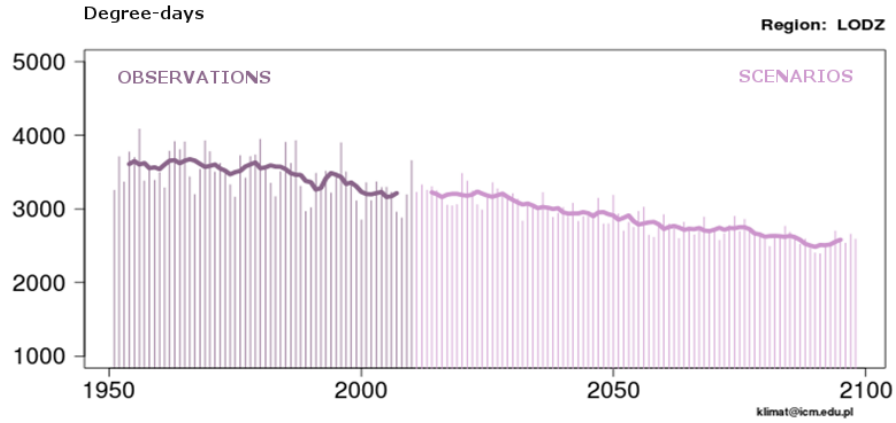


Fig. 6.14. The degree-days under the criterion of T<17°C for Central Poland. The series for 1951-2010 are observed data (EOBS), while the data for the later years come from scenarios. Source: ICM

The spatial distribution of annual precipitation totals does not change in relation to the present one (Fig. 6.15). In the case of wet periods (the longest periods with precipitation rates >1 mm/day), there is no clear trend within the country. In contrast, it can be seen that periods without precipitation (the longest periods with precipitation rates <1 mm/day) become longer.

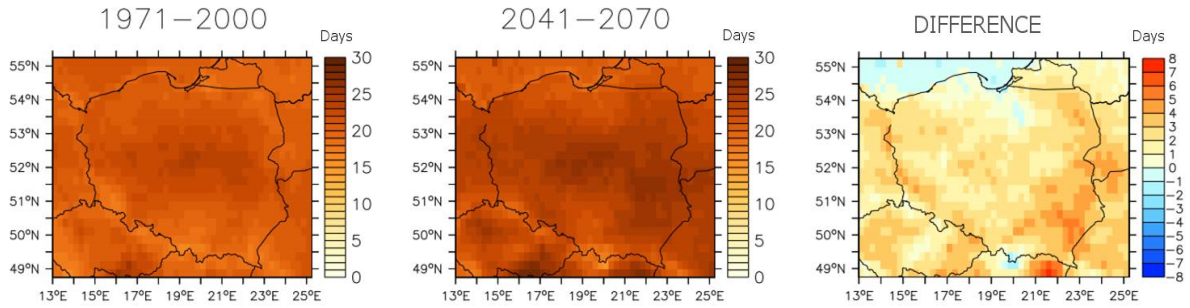


Fig. 6.15. Dry periods in 1971-2000 and 2041-2070 and the difference between these periods. Source: ICM

The number of days with heavy rains (>20 mm/day) grows in Southern Poland, particularly in the area of the Bieszczady Mountains, and diminishes in Central Poland, particularly in its western part (Fig. 6.16).

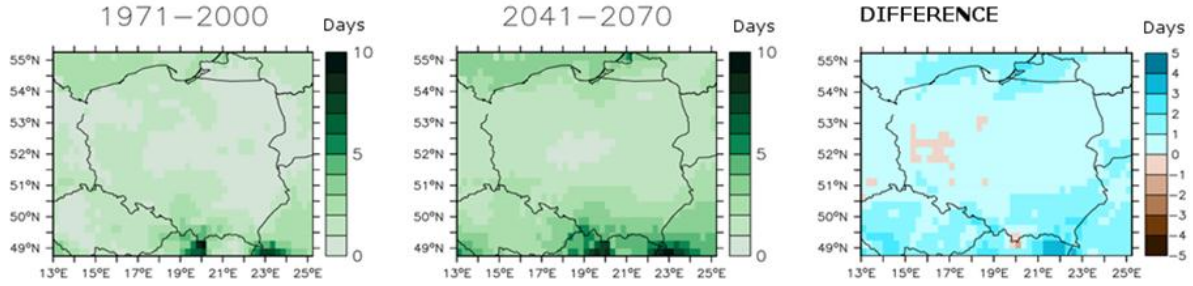


Fig. 6.16. The number of days with large daily precipitation rates >20 mm in 1971-2000 and 2041-2070 and the difference between these periods. Source: ICM

Table 6.1 shows the general features of the expected changes in selected climatic characteristics in Central Poland.

Table 6.1. Changes in selected climatic characteristics until the end of the 21st century.

Characteristics	Average value in the years			
	2010	2030	2050	2070
The number of days in a year with the temperature $T_{min} < 0^{o}C$	101.70	96.82	81.93	72.15
The number of days in a year with the temperature $T_{min} < -10^{o}C$	13.39	11.12	7.56	6.38
The number of days in a year with the temperature $T_{min} < -20^{o}C$	0.7	0.68	0.34	0.3
The number of degree-days in a year for $T_{threshold} < 17^{o}C$	3,379	3,236	3,005	2,803
The number of days in a year with snow cover	75.37	63.43	51.16	43.6
The maximum daily precipitation rate [mm/d]	28.59	31.11	32.17	32.93
The duration of the longest period with a precipitation rate exceeding 1 mm/d [days]	8.72	8.77	8.84	8.66
The number of periods with a precipitation rate exceeding 1 mm/d, longer than 5 days [-]	2.77	2.99	3.11	2.91
The number of days with a precipitation rate exceeding 10 mm	9.96	9.76	10.35	10.53
The number of days with a precipitation rate exceeding 20mm	1.76	2	2.2	2.24
The average daily wind speed v [m/s]	4.22	4.22	4.22	4.21
The number of days in a year with the wind speed $v_{max}>$ 10 m/s]	43.1	42.88	42.66	42.51
The number of days in a year with the wind speed $v_{max}>$ 15 m/s	6.58	6.34	6.37	6.33
The number of days in a year with the wind speed $v_{max}>$ 20 m/s	0.76	0.74	0.78	0.77
The average daily temperature T [^{o}C]	8.11	8.63	9.33	10.10
The number of days in a year with the temperature $T_{maz} > 25^{o}C$	29.80	35.56	37.49	46.28

Source: ICM

Conclusion

- Since the end of the 19th century Poland's climate has been characterised by a systematic tendency for the air temperature to grow, with its significant growth since 1989.
- The precipitation rates do not show trends in one direction and are characterised by periods which are wetter or less wet. In turn, the structure of precipitation has changed, mainly in the warm season of the year; rainfalls are stronger, of short duration, with disastrous impacts, more and more often causing flash floods. At the same, precipitation events below 1 mm/day wane.
- The effects of climate warming include a higher incidence of dangerous weather phenomena.
- The temperature shows a clear tendency to grow throughout the country, with a greater warming rate expected at the end of the century; temperature increases vary from region to regions and from season to season, with the strongest ones in the last thirty

years of the 21st century, above 4.5°C, while in the low temperature range they can be seen in winter in the north-eastern part of the country and in the case of high values in summer in South-Eastern Poland.

- Temperature growth causes changes in the behaviour of all the climate indicators based on this variable, e.g. there is a clear tendency for the thermal vegetation period to become longer, due to its earlier start, the number of days with the minimum temperature below 0°C diminishes, while the number of days with the maximum temperature exceeding 25°C grows; obviously, the values of these characteristics vary from region to region.
- In the case of precipitation, the tendencies are less clear, while simulations indicate that winter precipitation will grow to some extent and summer precipitation will fall at the end of the century.
- The characteristics based on temperature, such as the number of days with high temperatures increase, while the periods with a freezing temperature become shorter and the precipitation characteristics show that the periods without precipitation become longer, the maximum precipitation totals increase and the periods with snow cover become shorter.

6.3. The assessment of the vulnerability of sectors to climate change

6.3.1. Water resources and management

Water resources

Poland is distinguished by relatively small water resources and the efficiency of their use is low: its water consumption per 1,000 USD of the GDP is more than twice as high as in most of the OECD countries. In some parts of Poland, there are periodical difficulties in water supplies and in many areas of the country there are serious flood hazards.

The per capita water resources in Poland are three times lower than the European average (on average 1,660 m^3/year/per capita). Given a clear fall over the last decade in the water withdrawal by industry and households, the quantitative problems of water management (apart from flood hazards and agriculture) have substantially lost in significance.

The surface water resources in Poland are particularly vulnerable to the climate conditions, especially to variations in precipitation and evaporation. Groundwater supply is of marginal importance.

The average annual flows in most of the rivers analysed in the long period from 1951 to 2000 showed a slight tendency to grow. The flow growth could be seen above all in the rivers situated in the eastern parts of the basins of the Vistula and the Odra and in the Pomeranian rivers, with the flow decreasing in the rivers in the western parts of these basins, with the exception of the upper sections of the tributaries of the Odra River in the Sudety Mountains.

The results of simulations using different RCM/GCM models indicate a substantial differentiation of the direction and intensity of the predicted changes. Most of the models

show an increase with varying intensity in the mean annual flow, particularly in the mountain areas, and the absence of changes in the other areas.

Fig. 6.17 shows the relative changes in the mean annual flow in the two periods relative to the reference period (ref) for the median.

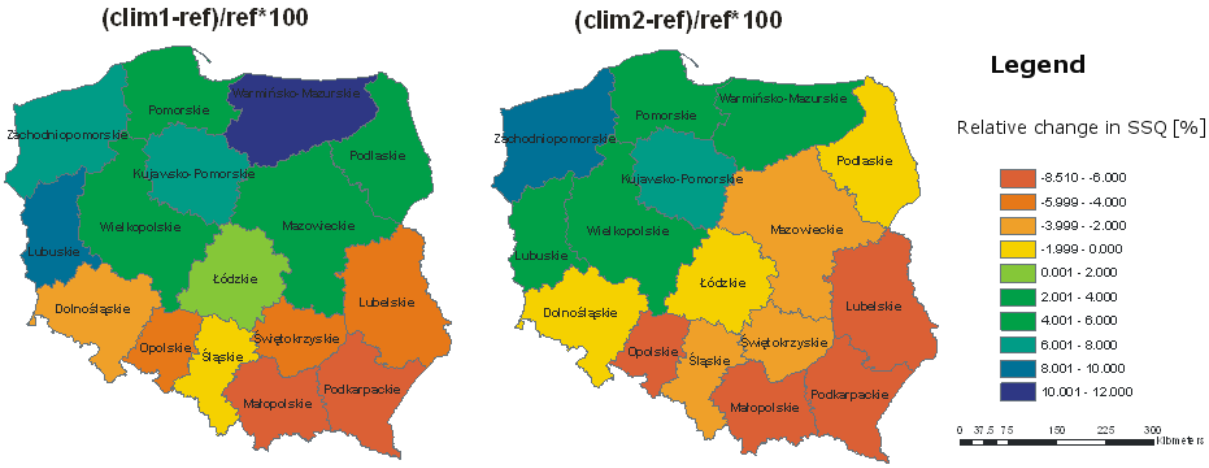


Fig. 6.17. The relative change in the mean annual flow in the two periods (clim1 – 2021–2050, clim 2 – 2071–2100). Source: Kindler J., Osuch M et.al KLIMADA, 2012 [53]“

The estimated changes in the mean annual flow (SSQ), based on the maximum value, show that their value grows. It is predicted that in 2021–2050 SSQ will grow from 14.83% to 111.92%. In the second period with changed climate conditions, the predicted changes are less intense than for the first period with changed climate conditions, varying between 10.76% and 58.76%.

Frequent and very low flows, with relatively low mean flows, were characteristic of 1983–1997. Again in 1997–2003, the frequency of the occurrence of high flows was found to grow and, at the same time, the flows distinctly increased both in the winter and summer half-years. In those years, Poland suffered from a series of catastrophic floods (in 1997, 1998, 2001 and, most recently, in 2010). In seasonal terms, the greatest changes could be seen in the May extremes in the rivers in Central Poland (which fell) and in the January extremes (which grew). The analysis carried out indicates that the differentiated scale of changes in spatial terms is much greater than in seasonal terms, possibly suggesting that the changes observed in the characteristics considered have so far been mainly an effect of anthropogenic transformations in basins and changes in the manner of water management in this part of Poland.

The maximum flows with 1% probability (centenary water) do not show significant trends; however, their frequency doubled in 1981–2000 compared with 1961-1980.

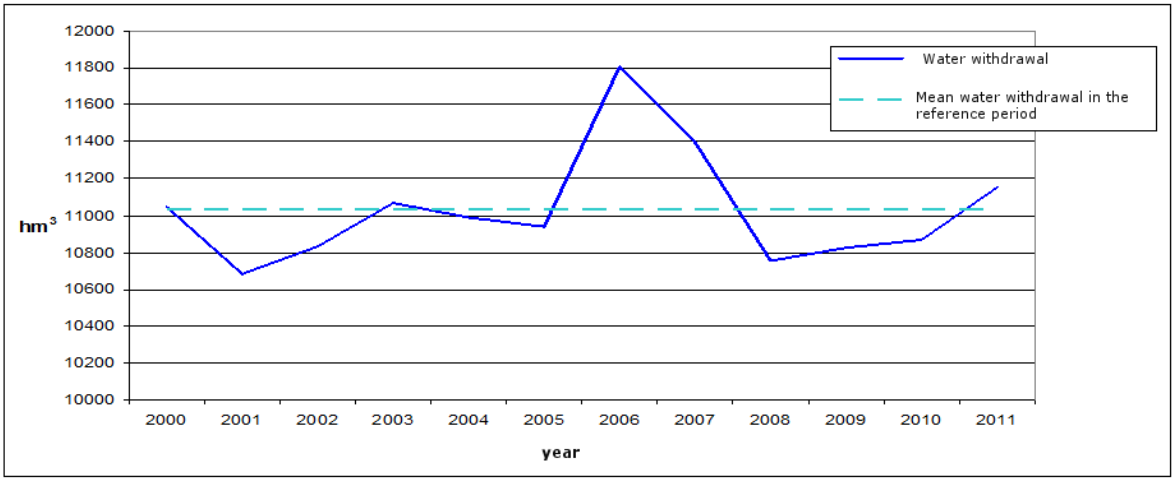
[53] Kindler J., Osuch M Romanowicz R., Berbeka K., Baranowska A.KLIMADA, 2012 “Strategia adaptacji Polski do zmian klimatu w zakresie sektora Zasoby i gospodarka wodna” (“Poland’s Strategy for Adaptation to Climate Change in the Water Resources and Management Sector” – in Polish)

The falling trend in the snowfall rate in winter which was observed in 1971-2000 will continue. In 2021-2050, the period when snow cover will persist will be shorter on average by 28 days than in 1971-2000. At the end of the 21st century (in the period from 2071 to 2100) the period when snow cover will last on average for 37 days only, i.e. it will be shorter on average by 51 days than in the reference period.

There is a growing trend in the water temperature in most rivers. The highest increase in the water temperature, even by as much as 4°C, is predicted for the spring months (April and May) and December.

Water management

The water withdrawals at the beginning of the 21st century were stable, apart from several variations (Fig. 6.18.) The mean water withdrawal level is 11,062 hm^3/year.



RFig.6.18. Water withdrawals to meet the needs of the national economy and the population in the reference period of 2000-2011. Source: GUS.

The changes in the national water needs in the 21st century, including two prediction periods: 2021-2050 and 2071-2100, are shown in Fig. 6.19. In assessing the dynamics of these changes, it should be noted that, irrespective of which scenario is adopted, the mean values of these needs slightly grow until the middle of this century and then continuously fall until the end of the first prediction period. In the later years, the water needs stabilise, to slightly grow in the second prediction period, i.e. in 2071-2100.

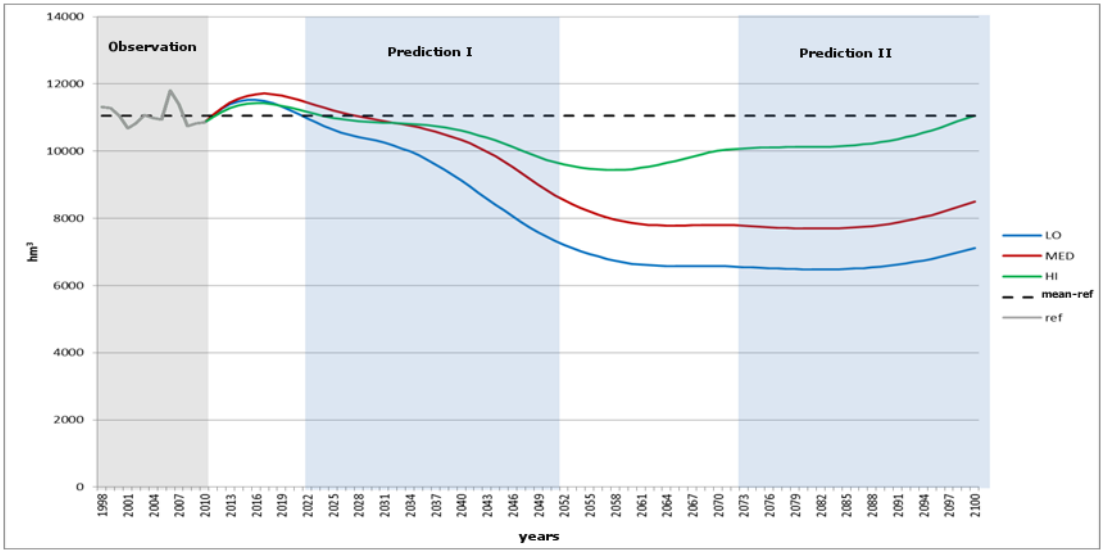


Fig. 6.19. Estimated water needs in 2021-2050 and 2071-2100. Source: Kindler J., Osuch M et.al. KLIMADA, 2012.

Three scenarios of Poland's socio-economic development were used to assess the future water needs. The LOW scenario predicts that the growth will halt in about 2020 – this is a stagnation scenario providing that to a large extent the status quo as in 2012 will persist. The MED scenario provides that the growth will halt in about 2030. Finally, according to the HIGH scenario, the country will develop until about 2040 when it reaches the level of the developed Western European countries.

Under the HIGH scenario, the level of the water needs at the end of the 21st century is close to the average for the reference period, while, according to the other scenarios, the total national water needs are lower by 1.5-2.0 hm^3 than that value. On the basis of this result, a general conclusion can be drawn that in the 21st century the estimated mean annual water needs of Poland's economy and population will not exceed their present level and will rather tend to diminish.

All the development scenarios provide for a continuous fall in the water needs in industry, the energy sector and the municipal economy, starting already in the reference period, mainly as a result of reductions in the water intensity of production, which is almost twice as large as in the Western European countries. Due to the gradual adoption of less water intensive technologies and more efficient use of resources, the water consumption in this sector will fall in the whole prediction period, in spite of a substantial increase in the industrial output.

Agriculture is one of the sectors discussed here where the mean annual water needs show a constant growing trend. At present, the water needs of agriculture are much lower than those of the agriculture of the European Union as a whole. It is assumed that, along with the technological development of agriculture, its economic efficiency will improve, causing higher water consumption. At the same time, as a result of technological progress, the water intensity of agriculture will fall. In the subsequent years, the rate of the fall in water consumption per unit of production will slow down as the possibilities for further reductions in water consumption in agriculture run out and the demographic structure of the population stabilises. Climate change which leads to lesser precipitation and higher evaporation makes it necessary to intensify artificial irrigation for agricultural purposes; this can be distinctly seen

particularly in the second prediction period (with a growing trend in water needs, from 30% in the first period to about 40-125% at the end of the 21st century).

Water needs vary from region to region and depend on development strategies. In the first period, the greatest increase in these needs in relation to the present situation will come in the central and eastern Voivodeships and in Lubuskie Voivodeship, while in the second period this tendency will continue, except for the central Voivodeships, where the water demand will remain at the level of its available resources.

The analysis of the differences between the predicted resources and the needs at the Voivodeship level (Fig. 6.20) indicates a potential risk of water shortage. In the first period, the worst situation comes in Mazowieckie and Świętokrzyskie Voivodeships, where the needs become almost the same as the resources. In the second period, the situation will worsen in Opolskie, Kujawsko-Pomorskie and Lubelskie Voivodeships. Just as in the first period analysed, the Voivodeships with the smallest difference between the predicted resources and the needs are Mazowieckie, Świętokrzyskie and Opolskie.

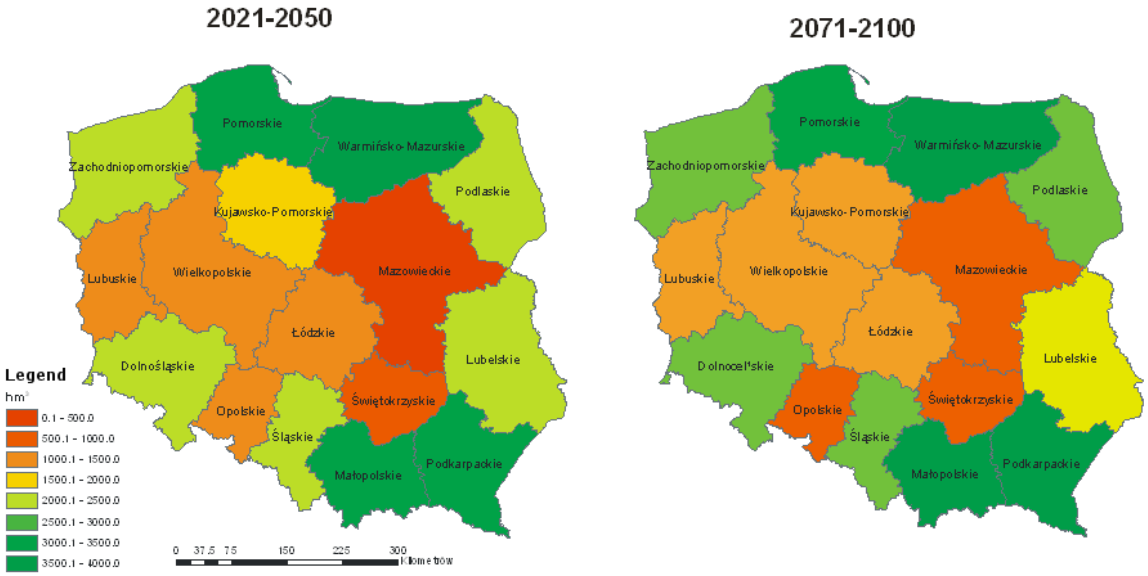


Fig. 6.20. The difference between the mean predicted resources and the mean withdrawals forecast in the MED scenario of socio-economic development. Source: Kindler J., Osuch M.et al KLIMADA, 2012.

6.3.2. Agriculture

As temperatures grow, the climate conditions for the cultivation of thermophilous plants improve in the Poland. Higher temperatures in the late winter and early spring periods speed up the beginning of the vegetation period and enable an earlier start of field works and cattle grazing. Earlier sowing often takes place in sufficiently wet soil, making it possible to avoid the adverse impacts of possible spring droughts.

A longer vegetation season extends the grazing period and the productivity of the plant species and varieties which make up the feed base. In the winter period, moderate temperatures enable the reduction of the costs of heating the buildings in the growing of poultry and pigs.

The greater variability of crop yields from year to year as a result of unfavourable weather conditions has increased the risks related to the running of a farm. There is a growing risk related to a shortage or high prices of fodder in the years which are not favourable for plant production. A higher risk for plants and livestock ensuing from new diseases and pests generates additional costs.

The worsening water shortage in agriculture may gradually reduce the effectiveness of outlays on production. In the plant production, this is manifested by large yield variations (the years of good and poor yields). Both empirical data and practical observations show a simple dependence between the effectiveness of fertilisation and the soil wetness level. A water shortage in soil will generate all the more distinct effects, the higher the fertiliser doses will be – an such doses are required by productive species and varieties of crop plants – and the more advanced production technologies will be used. As the general level of agricultural technology and yield improves, the quantity and quality of water available to plants gains in importance. A shortage of water, and less frequently its surplus, more and more often make it impossible to utilise the production opportunities offered by the thermal and energy conditions of the natural environment and modern technologies. In particular, this is the case in the central part of Poland where water is becoming a factor which limits the effectiveness of plant production.

Because of higher temperatures in summer, grazing is limited and cattle stays in buildings, which makes it necessary to enhance the thermal insulation of ceilings and roofing structures in summer and also to equip livestock housing with systems to cool the air and with greater ventilation capacity, raising the electricity consumption costs. Thermal stress will enhance the demand for water in animal production, it may also contribute to a reduction in the productivity of herds and, in the case of dairy cows, it may worsen the milk yield rate and the qualitative features of milk.

Higher temperatures require an expansion of refrigeration systems, including those for storage of animal products (eggs, milk and meat).

6.3.3. Forestry

Apart from different soil conditions, climate conditions are one of the factors which strongly differentiate the occurrence of forests in Poland. The observed and predicted changes involve a shift of the ecological optimum to the Northeast. The changes unfolding in modern times, mainly changes in temperature and precipitation, do not correspond to the climate conditions in which the ecological optimum of the species of contemporary ecosystems developed, while the pace of these changes exceeds the adaptation capabilities of ecosystems. In the territory of the country, the natural limits of the ranges of the main, forest-forming tree species can be found: common pine (the southern range), spruce (the north-western and south-western ranges), common larch (the northern range), yew (the eastern range), fir (the northern range), white poplar and black poplar (the northern range), beech (the eastern range), sessile oak (the eastern range), sycamore (the eastern range) and broad-leaf lime (the northern range). Forest management is not ready to respond to sudden changes in these limits; in particular, in view of the fact that poor coniferous forest sites dominate in Poland, limiting the possibility of selecting a more appropriate species composition. The existing relations between species will transform and changes, including those at the level of the landscape, will also come in response of species to the abiotic environment.

Phenological phases are observed to come faster (by 2.5/decade on average 1971-2000). An earlier pollination period is indicated as an effect of climate change in the phenology of plants. Climate warming strongly affects the phenology of such animal groups as: butterflies, dragonflies and beetles. Thermophilous species are observed to increase their number and survivability.

As the climate changes, there are more frequent, more dangerous and unpredictable outbreaks of folivores and cambiophages. Climate change favours the enhancement of threats posed by invasive species, e.g. horse-chestnut leaf miner (*Cameraria ohridella*).

Under the effect of climate change, threats emerge and biological structures transform at the different levels of organisation, starting from the genetic level (possible genome changes in the different phases of the reproductive cycle, affecting the genetic diversity of trees), through species and populations, to ecosystems and biomes. The conditions and sustainability of forest production change, and so do the economic relations and social functions of forests. The changes can have both positive impacts, such as a periodical improvement in the conditions of production as a result of the greenhouse effect, and negative ones, in the form of both abiotic damage and threats (fires, floods, hurricanes, droughts etc.) and biotic ones (insects, fungi).

Mountain ecosystems are most vulnerable to climate change. The present mountain forest communities may lose up to 60% of their species, while the productivity of tree-stands and their durability may suddenly break down. Certain subalpine forest types with a share of Swiss pine and larch are strongly threatened.

The severe droughts which occurred in 2003-2004 and 2005-2006 weakened spruce stands and contributed to a rapid growth of threats. An additional factor affecting the health condition of spruce stands was the damage caused by the hurricanes, the most important of which struck the forests in the Beskidy Mountains in November 2004. All this caused an enormous growth of the population of spruce bark beetle and the extinction of about 2 million trees in 2006-2010.

6.3.4. Biodiversity and ecosystems

In Poland, there are 23 national parks, 1465 nature reserves, 122 landscape parks, which, along with Natura 2000 sites, protected landscape areas and other forms of nature protection (ecological sites, documentation sites, nature and landscape complexes, natural monuments, areas protected under the international agreements signed by Poland) occupy about 30% of the territory of the country. The basic function of the different forms of nature protection is biodiversity conservation, but, at the same time, to a large extent, these areas can help mitigate the impacts of climate change.

From the point of the protection of habitats, the threats related to the degradation of wetlands are most important. The disappearance of marshes, small water reservoirs, as well as streams and small rivers is the greatest threat for numerous species, which either live in these areas, or use them as drinking water reservoirs. This is also the case with wet meadows and pastures that are the habitats of many meadow plants, which have been replaced in recent years by grass monocultures, and that are an important nutritional base for numerous animal species.

The expected climate warming will cause intensification of migrations of species from Southern Europe, along with a withdrawal of those species that are not used to high temperatures and drought in summer and tolerate severe frost well.

The impact of climate change should be considered in two aspects: from the point of view of natural habitats and species, and their spatial variability dependent on the geographical position. Specific categories of threats, dependent on the local habitat retirements and the ecological characteristics of the habitat type, can be attributed to most of the habitats listed in the EU Habitats Directive.

The group of coastal habitats and salt meadows, encompassing marine and coastal habitats, is one of those that are most vulnerable to climate change. The rising sea level, higher water temperatures, the enhanced frequency and intensity of storms are the major threats.

The group of habitats of running and standing fresh waters is very vulnerable to climate change effects, such as a greater number of torrential rains, dry spells and the intensification of eutrophication of running and standing fresh waters as a result of growing water temperatures. Taking into account the pace of the waning of lakes and the predicted climate change, it can be expected that the overwhelming majority of Mazurian lakes will disappear over the nearest 100 years.

The group of heathlands and shrubs is threatened by the lowering of the groundwater level and frequent droughts, just as is the group of natural and semi-natural meadow formations and grasslands. These phenomena can occur particularly intensively in the lowland belt and in the uplands. In the mountains, alpine grassland communities are particularly vulnerable to climate change; they are particularly threatened by extinction as the thermal floors move upwards in the Karkonosze Mountains and the Carpathians.

The habitats of the group of peat-bogs, swamplands and inland water-heads are particularly vulnerable to changes in the precipitation regime and enhanced evaporation, combined with anthropogenic drainage.

Among the forest habitats, those of swamp forest are most vulnerable because of the lowering of the groundwater level, and so are high mountains forests, strongly thermophilous oak forests and certain slope forests, on the southern and western slopes, which are particularly vulnerable to the impacts of spring and summer droughts.

The Natura 2000 sites designated to protect a single object, which is, at the same time strongly vulnerable to climate change and, as a result, may suffer a significant deterioration of the structure and function parameters in a relatively short time, will be greatly threatened with the loss of their values. The Natura 2000 sites situated in the Polish Lowland Belt can, in general, be considered strongly vulnerable as a result of the lowering of the groundwater level.

Mountain ecosystems are a group of ecosystems which are particularly vulnerable to climate change. The potential changes in these ecosystems are relatively slow; nevertheless, they strongly depend on the local conditions. Probably, the direct impact of climate factors is less important, taking into account the large phenotypic plasticity of mountain plants and their resilience to the changing and difficult environmental conditions. The indirect impact is more

important, including primarily the succession of vegetation which leads to a reduction in the area of habitats with natural values and changes in their structure and function.

The bird species which are most vulnerable to climate change include those connected ecologically with river valleys, marshlands and peat-bogs, primarily Charadriiformes and Accipitriformes, e.g. spotted eagle (*Aquila clanga*), black-tailed godwit (*Limosa* limosa), dunlin (*Calidris alpina*), or the lamellirostral birds connected with floodplain meadows, e.g. shoveler (*Anas clypeata).* The most vulnerable mammals include spotted souslik (*Spermophilus suslicus*), European souslik (*Spermophilus citellus*) and southern birch march (*Sicista subtilis*), while among reptiles and amphibians mud turtle (*Emys orbicularis*) is most vulnerable. Changes in the climate conditions will also pose danger for fish, cyclostomates and invertebrates; such species as brook lamprey (*Lampetra planeri*), lake minnow (*Phoxinus percnurus*), false ringlet (*Coenonympha oedippus*), Geyer's whorl snail (*Vertigo geyeri*), ornate bluet (*Coenagrio ornatum*) and *Xylomoia strix* may suffer in particular.

The greatest vulnerability to climate change is shown by plant species connected with water and wet habitats, such as sword lily (*Gladiolus palustris*), *Caldesia parnassifolia*, marsh saxifrage (*Saxifraga hirculus*) and fen orchid (*Liparis loeselii*). The group of most endangered plants also includes endemitic plants: *Cochlearia polonica*, *Aconitum firmum moravicum*, and the mountain species *Cochlearia tatrae* and *Campanula bohemia*.

6.3.5. Health

In Poland, the risk of death or disease during a heat wave is related not only to high air temperatures, but also to a large intensity of solar radiation and high air humidity. Its highest growth relates to a large heat stress and is +23% for all the causes of deaths compared with the thermoneutral conditions and +24% for deaths caused by diseases of the circulatory system. In spring, heat waves occur sporadically, but then they lead to a substantial increase in the mortality rate among the city residents who have not yet adapted to the heat-related conditions. On average in Poland, they enhance the overall mortality rate by 15% and the mortality rate for diseases of the circulatory system by 18%. On the days with "very hot" and "extremely hot" thermal sensations, in all towns and cities the number of deaths grew by 18% in Warsaw, by 26% in Cracow and by as much 31% in Poznań. It can be expected that by the end of the century the deaths caused by dysfunctions of the circulatory system will grow on average by about 20-30%.

The elderly and small children whose heat balance can easily be disturbed and persons with specific diseases are the groups which are particularly vulnerable to the impact of high temperature. The analysis of deaths caused by diseases of the circulatory system in 6 biggest cities in Poland in connection with the maximum air temperature in 1999-2006 showed a positive dependence only for the group of persons aged above 70: as the maximum temperature increased by 1°C their risk of death grew from 0.9% to 1.5%.

In the moderate climate, cold waves also cause the growth of the number of deaths, but with a greater delay than heat waves. Large, sudden air temperature drops are most dangerous for the human organism, as they can cause sudden deaths, particularly those of the elderly suffering from artery diseases or the ischemic heart disease. In the conditions of the changing climate and the enhanced variability of phenomena, such situations will become more frequent. On average in Poland, the growth rate of diseases for all the causes and diseases of the circulatory

system related to cold waves is 8%. In relation to progressive warming, the instances of the flue and deaths caused by this disease can be expected to fall by 10-12%. A positive effect of the progressive warming in the winter periods is a distinct fall in the incidence of death caused by hypothermy. At the end of the 21st century, the number of such events may fall by 45-80%.

In Poland, several diseases transmitted by infected ticks can be found; the most frequent and most dangerous of these include: tick-borne encephalitis (TBE), Lyme disease and babesiosis. The incidence of the cases of tick-borne encephalitis grows and, whereas before 1993 4 to 27 cases of this disease occurred annually in Poland, at present there are 200-300 of them. The major endemitic areas of its occurrence can be found in North-Eastern Poland. An outbreak of tick-borne diseases is related to an increase in the air temperature. Over the last 10 years, the incidence of registered cases of tick-borne encephalitis grew and to some extent the growth of the cases of this disease is also related to climate change. The areas which are particularly vulnerable to infection with tick-borne encephalitis include North-Eastern Poland, the belt of lake districts, as well as South-Western and Southern Poland. All the simulations provide that the incidence of tick-borne encephalitis will grow from 20 to 50%.

In Poland, for several dozen years the incidence of pollen allergies has grown, mainly caused by the presence of such allergens in the air as the pollen of anemophilous plants, primarily grasses which induce allergies in almost 90% of patients suffering from pollen allergies. In the summer period, the symptoms of allergic rhinitis are additionally enhanced by high concentrations of the spores of anamorphic fungi. There is a particularly distinct enhanced share of persons suffering from pollen allergies and bronchial asthma in urbanised areas. The air pollution in towns and cities additionally contributes to the growth of part of allergic diseases.

Under the influence of climate change, and, in particular, higher temperatures, e.g. the pollen seasons start increasingly early, particularly in spring: on average by 6 days, the pollen season extends by 10-11 days and the mean annual pollen concentration grows.

The weather conditions, and, in particular, excessive precipitation and high air temperatures, facilitate the development of certain bacteria and pathogenic microorganisms in water. In Poland, salmonellosis is the most common foodborne disease. The infections most often occur in the warm season of the year, which favours the multiplication of bacteria. In summer, when the mean maximum temperature reaches 25ºC, the incidence of this disease grows by a multiple factor (to about 2,500 in a month). The growth of the incidence of salmonellosis is estimated at 8% per degree. The predicted higher temperatures in summer and an increase in the number of hot days by 12-32%, while keeping the present general sanitary level of society, will cause the growth of the incidence of salmonellosis on average by about 85% at the end of the century.

6.3.6. The coastal zone

If no adaptation measures are taken in the coastal zone, climate change and the related physical processes (the rising sea level, the waning of the ice cover, enhanced intensity of sea movements and storm surges) will have an adverse impact.

Storm floods will inundate an area of 2,200 km^2, more than 20% of which are the areas with unique natural values at the European or national levels and more than 7% of which are highly urbanised and deindustrialised areas.

The rising of the groundwater levels in low-lying areas up to +1.25 m a.s.l. will limit the future use of many areas for housing and industrial purposes.

As a result of the coastal erosion, it can be expected that an area of at least 120 km^2 will be lost and that large landslides will emerge on the cliffs due to erosion caused by rainwater after long periods of drought and deep water penetration. Because of the intensification of erosion processes, it will not be possible to continue the basic element of the present programme to protect the seacoast, i.e. to maintain the configuration of the coastline from 2000. It is estimated that only 30% of the Polish seacoast will be covered by full protection, while the remainder will be subjected to different variants of managed retreat. Thus, the determination of the methods and the choice of sections designated for full protection and the elaboration of an appropriate managed retreat strategy for the other sections of the coast will become the main issues of the adaptation of the Polish coastal zones to climate change, starting in the third decade of the 21st century.

About 300,000 persons will be exposed to a direct risk related to the impacts of climate change (the loss of apartments) and about 1.7 million persons will suffer from indirect impacts of climate change (loss of jobs).

Among the areas with unique natural values, those of the Słowiński National Park, the Woliński National Park and the Coastal Landscape Park are vulnerable. Climate change will greatly disturb the functioning of ecosystems in their areas and enhance the costs of maintaining the functions related to nature protection.

The rising sea level and the increasingly substantial weather instability may generate strong winds leading to a periodical occurrence of higher waters and the rising of the sea level in the coastal zone. This will enhance the flood hazards for towns and cities, particularly in the area of Szczecin, Gdańsk, Świnoujście and Kołobrzeg. This threat will additionally enhance the forecast gradual rising of the sea level until the end of the 21st century and the sealing of the surface of the land, reducing or completely eliminating infiltration.

As a result of surges caused by an increasingly large number and the growing strength of storms, the area of the Hel Peninsula and the sand spits of coastal lakes are vulnerable to fragmentation. The vulnerability of part of the Gdańsk region and Żuławy is additionally enhanced by their situation in the depression and in the Vistula delta zone (Sztobryn et al.2012[54]).

The storm floods in the Polish coastal zone of the Baltic Sea are particularly dangerous, if a strong impact of the wind on the state of the sea coincides with a surge, and, in particular, with a flood wave in the mouth of the Odra River or the Vistula River.

[54] Sztobryn et al 2012, Wezbrania sztormowe –geneza, tendencje i skutki działania w strefie brzegowej Bałtyku (Storm surges – the origin, trends and impacts in the coastal zone of the Baltic Sea – in Polish), KLIMAT Project, vol. 3.

At the end of the 20th century, the vulnerability to surges in the Southern Baltic almost doubled in relation to the mid-20th century. Over the last 25 years, the frequency of the occurrence of storm surges on the western coast substantially increased and the highest intensity of the occurrence of storms shifted from November (in 1950-1978) to January (in 1979-2007). In the last 25 years of the 20th century, the frequency of the occurrence of very high storm surges (with the maximum exceeding 640 cm) was also found to grow, while, at the same time, the storm surges with the maximum sea levels of about 570 cm fell.

Climate change will also generate losses related to the ecology of the Baltic Sea, significantly affecting the functioning of the coastal zones in Poland. The decreased inflows of well oxygenated saline surface waters from the North Sea into the Baltic Sea, which have been observed in the recent decades, will enhance its vulnerability to unfavourable ecological changes. This may lead to the disappearance of valuable fish species, the overall biodiversity loss, an invasion of alien species and a deterioration of the conditions for recreation and tourism, thus causing the revenues of these sectors to fall.

6.3.7. Construction

The vulnerability of the construction sector is differentiated depending on the elements considered, such as the localisation of a built site, the laying of its foundations and the foundation work, the bearing structure of the site, the external envelope of the site and its thermal insulation index, internal systems, the execution of construction works, as well as on the stages of the construction and operation of sites, such the design work, the execution of construction works, the relevant technologies, construction products and materials, and the maintenance of built sites.

The residential buildings in urbanised (urban) areas and in rural areas (farm buildings) should be regarded as most vulnerable to climate change. The other two types, i.e. industrial and public utility buildings, show greater resilience to climate change.

Housing consists of multi-storey residential buildings, primarily in the city centres, and single-family houses on the outskirts or in small towns. The latter type of buildings resembles rural buildings in terms of its vulnerability to climate change.

The towns and cities situated in river valleys are vulnerable both to floods related to river flows and to inundations as a result of heavy rainfall and a slight inclination of the terrain preventing a quick runoff of rainwater. The areas in towns and cities where buildings are now situated are those that have not been built up earlier because of the ground with poor bearing strength or those that have been regarded earlier as floodplain areas. This is the main hazard for buildings of this type.

The bearing structure of housing sites in urbanised areas is vulnerable to climate factors. It must be resilient to such threats as temperature variations and wind and snow loads. When the climate conditions change, it will be necessary to adapt the standards and indicators now applied to these changes. If the growing temperature trend persists in the second half of this century, consisting in an increase of the mean daily temperature by several degrees, a shorter heating season and an enhanced frequency of the occurrence of hot weather in summer, it will be necessary to analyse the adequacy of the standards now applied in the scope of thermal

insulation, the principles of the heating, ventilation and air-conditioning of buildings or the principles of snow removal from roofs.

Over the last 100 years, the traditional housing construction has used the envelope of the external walls and flat roofs which have been characterised by poor thermal insulation strength. It entails systemic errors which manifest themselves in the form of non-homogeneity of the thermal insulation of the envelope, which is thus vulnerable to temperature variations and which does not ensure thermal comfort. In the residential buildings now used, the water and wastewater, heating, ventilation and air-conditioning systems are most vulnerable to climate change.

Rural buildings include residential buildings, which as a rule have one or two storeys, and the production buildings of the farms. Rural buildings are most often built in a traditional technology, i.e. they have masonry walls from small blocks and densely ribbed ceilings filled with hollow bricks or ferroconcrete slab ceilings. As a rule, the roof rafter framing is wooden and less often from iron sections. Rural buildings are characterized by specific features, such as:

- spatial dispersion, making the buildings more vulnerable to the extreme climatic phenomena (primarily the impact of the wind),
- the lack of a cellar to ensure protection in case of a tornado,
- the combination of the functions of the investor, builder and user of a site, and also quite often that of a designer, not always by duly authorised persons,
- the presence of unregulated watercourses in their close vicinity,
- a low level of engineering culture of both builders and future users, consisting e.g. in failure to use ring beams or insulation, the absence of anti-corrosion protection features or a drainage system,
- poor or insufficient construction supervision.

The localisation of a building may be of decisive importance for the assessment of the vulnerability of the building to phenomena related to the climate conditions, e.g. flooding, inundation with groundwater or flood water, water deficit, landslide and damage caused by the wind. This may be aggravated by the lack of sufficient knowledge about the methods for preventing such phenomena at the stages of design and construction of buildings (e.g. construction in floodplain and landslide areas or in those exposed to strong winds) or by savings undertaken by the investor. A larger number of heavy rains, the violent nature of these rains, the rising groundwater levels, the rising sea level, with the possible flooding of coastal areas, the rising water levels in rivers, along with a larger number of floods, create new threats for existing buildings and make it necessary to analyse a new approach to the design of new investment projects.

In rural areas, sites are built (e.g. storage sites) which can have non-typical construction: relatively high external bearing walls or pillars (of ferroconcrete or steel), a lightweight roof structure (an unheated roof), with a small number of cross-braces. Such structures are vulnerable to strong wind gusts or to intensive snowfalls. Greenhouses, overhead power lines and manure tanks placed on the ground are also vulnerable to the impact of the wind. In turn, tanks sunk into the ground are vulnerable to groundwater level variations, which in case of its high level can push out the structure from the ground and cause a breakdown of the tank.

Because of the purpose and costs of industrial buildings, the climate and groundwater conditions must be taken into account already at the stage of their design. Apart from resilience to air temperature variations and precipitation, these sites must be resistant to wind or snow loads. Unshielded installations are particularly vulnerable to the climate conditions, especially precipitation, strong winds or atmospheric discharges (towers, masts, cranes, tanks etc.). When wind gusts become stronger they are particularly dangerous for high and very high sites. Apart from very high buildings, hall structures, towers, bridges, including cable-stayed and suspension bridges, viaducts and overpasses are particularly vulnerable to the impacts of the wind.

Exceptional vulnerability to higher temperatures is characteristic of hospitals, hospices, nursing homes and kindergartens, which must be equipped with an air-conditioning system in summer, because of the need to prevent thermal stress from affecting the persons staying in them. Other sites which are particularly vulnerable to the climate factors include ski jumps and lifts, mountain hostels and yacht marinas, which are vulnerable to floods, inundations and squalls. In the changed climate conditions, such phenomena can be expected to intensify. These sites are vulnerable to very high or very low air temperatures, strong winds and intensive precipitation, particularly when construction and repair works are underway.

Historic monuments are a group of sites which are vulnerable to the threats related to climate change. They can be adversely affected by the frequency and severity of precipitation events, with their large variability in time, strong winds and a larger number of floods resulting from heavy, violent rains. In the face of predicted climate change, built historic monuments, which are significant part of the national heritage, need special care. The structural elements which are particularly exposed to the dynamic impacts of wind gusts, intense winds and tornados are the roof structures of historic sites.

A high groundwater level is particularly dangerous for existing buildings, primarily old buildings, including historic ones, without water insulation, both horizontal and vertical, or with damaged insulation.

6.3.8. Transport

Transport is one of those sectors of the economy that are most vulnerable to climate change. For all of its categories, i.e. the road, rail and air modes of transport and inland navigation, the vulnerability to the climate conditions must be considered from the point of view of their three basic elements, i.e. infrastructure, means of transport and social comfort. Whereas transport equipment and social comfort can be adapted on a current basis to the changing conditions, in the case of transport infrastructure, which is built for a long operation period (e.g. 100 years), its vulnerability to change must be defined and adaptation measures must be taken well in advance.

The greatest danger for transport, as indicated in climate scenario in the timeframe until the end of the 21st century, may be posed by changes in the occurrence structure of the extreme phenomena and enhanced winter precipitation. In the period until 2070, first of all, extreme events which will hamper the functioning of the sector can be expected. The analysis of the predicted climate change shows that in a longer term the expected change will have an adverse impact on transport.

The analysis of the vulnerability of transport infrastructure indicates that road and rail infrastructure will still continue to be most vulnerable to rain and wind. Because of the predicted change in the structure of precipitation, it will become even more important e.g. to correctly define the clearance of bridges and culverts, to design the vertical alignment of roads at the approaches to bridges and to consider the problem of landslides and the issues related to the drainage of transport surfaces, underpasses, tunnels and underground stations.

Most of the climate factors affect all the transport modes; however, as analyses indicate, certain climate factors are particularly important for one transport mode. The analysis indicates that the infrastructure of road and rail transport is most vulnerable, in particular, to strong winds, snowfalls, rain and frost.

Road transport

Given its spatial character, the road transport infrastructure is particularly vulnerable to changes in climatic phenomena. They include primarily precipitation and strong winds, as well as hot weather and temperatures varying about zero degrees.

As a result of strong winds, e.g. roads are blocked by fallen trees and power line pillars, roads have to be closed, vehicles and built sites are damaged, loading works are hampered and noise abatement screens are damaged.

Heavy rains and the floods which they cause disturb transport activities due to the closing of traffic on some routes, damage to road infrastructure, landslides and inundations and also cause difficulties in urban transport.

Snowfalls, particularly those of wet snow, and the icing of roads and streets seriously impede the operation of this type of transport, giving rise to blocked roads, late or cancelled travels, road accidents, a deterioration of driving conditions due to lesser traction of wheels on the road surface and higher costs of keeping routes passable.

One of the most harmful phenomena are temperature variations, in particular their co-called zero degree crossings, since, when combined with precipitation or melting snow, they contribute to glazed frost in roads and also intensify the impacts of water on transport infrastructure.

Low values of freezing temperatures are a factor which limits the capabilities of road transport. They contribute to more frequent breakdowns of equipment, reduce the efficiency of the operations of means of transport and the comfort of travel, damage the road surface (winter fractures) and hamper loading works, prolonging the loading and unloading times.

The impact of high temperatures (hot weather) is equally unfavourable, particularly in a long term, causing the overheating of engines and other technical equipment, and deterioration of the working comfort of drivers, service personnel and passengers. In connection with the expected warming, the problem of the impact of high temperature on the surface of transport routes takes on new significance. When selecting materials, designing the mineral and asphalt mixture and assessing its durability, consideration should be given e.g. to its cracking strength at low temperatures and to its permanent deformations at high temperatures. This will also require a review of the maps of Poland's climate zones with a view to selecting an asphalt binder for asphalt surfaces and developing a simplified method for designing new asphalt

surfaces for the conditions corresponding to the highest mean 7-day maximum air temperature.

Fog is a climate factor which causes difficulties in road transport and particularly often occurs in the autumn and winter conditions at near zero temperatures. Limited visibility reduces the operating speeds, causes delays in road traffic, particularly in public transport, and enhances the risk of road accidents.

Rail transport

In rail transport, the vulnerability of infrastructure to the climate conditions is similar to that in road transport. Intensive rainfalls, icing, heavy and torrential rains and strong winds impede the passability of transport routes, the performance of the steering system etc.

High temperatures affect not only infrastructure through track deformations, as a result of the extension of rails, and fires damaging rail infrastructure, but primarily exert their impact on the working conditions (thermal stress) and also contribute to a deterioration of the travel comfort.

Strong winds and tornados which accompany storms damage the traction network and power lines, block railway tracks with fallen trees, tear off roofs and damage technical service buildings. Just as in the case of heavy rains, the frequency of the occurrence of such phenomena should be expected to increase.

In the changed climate conditions, particularly difficult periods will include those with strong temperature drops, short-lasting snowfalls and icing of conductors; they will be of incidental character and, therefore, they can be more dangerous, since the low frequency of occurrence does not mobilise well the services to prevent the impacts of such phenomena and to respond to them.

Air transport

The dependence of air transport on the climate conditions is most important when airplanes take off and land. The air transport infrastructure is exposed to the same climate impacts, just as any other built and technical infrastructure discussed earlier.

The basic threats for airplanes on the ground include a strong wind (its gusts) and icing. The other phenomena, such as heavy rains or large snowfalls, may slow down operations and have an adverse impact on their regularity; however, they do not constitute a direct threat. In turn, a higher air temperature may affect air density and, hence, cause the need to increase the speed of airplanes, particularly when they ascend into the air, and to use more fuel, while in the takeoff stage this will require longer runways or cargo weight reductions.

Inland navigation

In Poland, inland water transport meets less than 1% of total national transport needs and is marginal in the transport system. This mode of transport strictly depends on the water conditions in rivers and is vulnerable to high flood-related water levels and low levels related to periods of drought. In the period analysed, it should be expected that the frequency of both

of the unfavourable phenomena will grow and that the related difficulties will emerge in the navigation operations. Another climate element which affects the navigation is the freezing of rivers. However, as the warming process develops the frequency of these phenomena will fall.

6.3.9. The energy sector

The energy sector is relatively hardly vulnerable to climate change. Higher temperatures are favourable in terms of the demand for electricity and heat. They reduce the demand and level out variations in the load. The reduced demand primarily relates to the need for space heating. The reduction of the difference between the minimum demand and the maximum demand relates to both electricity and heat. Therefore, as regards the demand it is impossible to indicate the probable threats and losses.

The most sensitive component of the energy sector in respect of climate change is the infrastructure used to distribute electricity. Already at present, ample snowfalls related to the temperature crossings through 0^{o}C cause on mass-scale breakdowns of low voltage networks and even blackouts lasting for several days, mainly in rural areas. In the domestic conditions, due to higher temperatures there will be many more days with 0^{o}C in winter. Therefore, the losses caused by electricity blackouts will grow. It is extremely difficult to estimate them, since they depend on the area where they occur, on the time of the day etc. They can be estimated using averaged quantities, on the assumption that, given the contemporary dependence on electricity supply, the absence of the latter makes it impossible to "generate" the gross domestic product (GDP). Assuming that the GDP per capita is about 1.4 trillion PLN/year, then a statistical Pole generates in an hour a GDP worth about 4.2 PLN. A 10-hour outage in an area inhabited by 100,000 persons means on average a loss at the level of 4,20 million PLN, without taking into account the costs to remedy the damage which always have to be incurred in such a case. The publicly available data do not enable an unambiguous estimation of the costs of remedying the damage.

Power plants, heat and power generating plants and heating plants which generate electricity and heat are hardly vulnerable to the predicted climate change. In the case of gas-fired power plants and heat and power generating plants, as the air temperature grows they slightly lose their generating capacity and efficiency. In the case of steam technologies, this impact is practically negligible. In turn, the availability of water for the purposes of cooling and complementing the water in the circulation system is an important problem at thermal power plants.

It can be expected that the future energy generation technologies – RES – will not be practically vulnerable to climate change and this will ensure the appropriate development of the individual technologies and their adaptation to the new conditions. The installed capacity of individual RES technologies, such as hydro-power or installations for biomass combustion (including biomass from including energy plantations), will not grow significantly because of the need to maintain the natural hydrological regime or because of limited biomass resources. Moreover, despite the fact that they are classified as RES, large hydro-power plants disturb the environment to such an extent that they are not considered environment-friendly in all the EU countries. To date, the national system of support for renewable sources has not introduced any distinction in this scope.

The climate change related to higher temperatures will naturally reduce the demand for heat. At the same time, technological progress will reduce the energy intensity of the individual

sectors of the economy. In several dozen years (in about 2050), the construction sector, which is now responsible for more than 40% of the final energy consumption, both in Poland and in Europe as a whole, will not demand heat for heating and cold for cooling or for air-conditioning in buildings. Due to the energy-saving features of built structures, the appropriate materials, a smart envelope of buildings and appropriately managed and controlled utility systems, buildings will become zero-energy structures in terms of heat for space heating. In turn, they will produce electricity and thermal energy to heat utility hot water on the spot using RES resources. As temperatures grow the efficiency of thermal solar systems will improve.

Irrespective of climate change, the combustion of biomass will be limited, primarily in view of CO_2 emissions. The zeroing of CO_2 emissions from the combustion of biomass of vegetal origin must be given up, since it does not reflect the real impact of the pollutant emissions into the environment.

In the case of the energy sector, modern technologies develop very quickly and enormous progress can be seen in improvements in the efficiency of using resources and sources as well as the effectiveness of the operation of equipment and installations, particularly in the case of RES technologies. However, already in several dozen years completely new breakthrough technologies may emerge, enabling energy supply and storage through changing the material properties of media.

The development and implementation of an appropriate system for supporting technologies to minimise climate warming is one of the most important measures which would ensure that the sector can operate correctly in the future.

6.3.10. Spatial development

Climate change does not pose a direct threat for the urban environment; however, the other related phenomena, such as air pollution, inundations or floods are serious problems for many cities. They relate to many aspects of horizontal character, starting with ecosystems (changes in their functions and the ranges of species, the reduction in biodiversity, the extinction of species), through agriculture, forestry and water management (droughts, fires, floods and inundations, a change in the vegetation period and the ranges of crops, a fall in the productivity if plants etc.), industry and the energy sector (changes of technology and those in the demand for water and energy etc.), the safety of humans and property (the exposure to floods and inundations, strong insolation and hot weather, coastal erosion, the rising sea level, landsides and fires), infrastructure (the exposure to water surplus or shortage, windstorms), and ending with tourism, just to give some examples of the relevant areas.

In view of climate change, it becomes important to protect natural structures and to preserve the cohesion and passability of ecological networks at the national, regional, subregional (the metropolitan area) and local levels, which, apart from their nature related functions, also play other functions, e.g. social and climatic ones, since they improve the quality of life, particularly for the residents of big cities (cooling them, ensuring a shade in them, improving the aerosanitary conditions and providing recreation areas).

Observing the effects of climate change which occur in the environment, it should be assumed that they will lead to the enhancement of the problems related to the management of space, including the competition for the use of space. The majority of such effects concern all the regions of Poland; however, some of them would affect mainly selected geographical regions

or functional and spatial areas. Depending on the geographical factors, they can occur with varying intensity. Therefore, the policy of adaptation to climate change requires consideration of the regional aspect, with particular reference to the areas which are most important for spatial development, especially mountain areas, the coast, river valleys and metropolitan areas.

6.3.11. Cities

Climate change is not a direct environmental problem in cities; however, other phenomena related to climate change, such as e.g. air pollution, inundations or floods, constitute serious problems for many cities. The impact of urbanisation processes and intensive economic activities superimpose themselves on global climate change, aggravating the adverse climatic impacts. These processes favour an expansion of cities and their takeover of new areas which are often marginal areas that are particularly vulnerable to the effects of climate change (e.g. floodplain areas). Because of the population density and the diversity of social and age groups, the vulnerability to such change is higher than in areas out of cities.

The threats resulting from the thermal conditions in cities

The threats related to high air temperatures in big cities are enhanced by the urban heat island effect (UHIE). The intensity of UHIE increases linearly with the growth of a city, from values slightly exceeding 0ºC in towns with up to 5,000 inhabitants to 1.5-2.5ºC in Warsaw, which has almost 2 million inhabitants. However, in the extreme thermal conditions, when the temperature reaches more than 35^{o}C in a city with up to 600,000 inhabitants, the intensity of UHIE may reach 7.6^{o}C, whereas in cities with about 1-2 million inhabitants the difference between the air temperatures in a city and open areas may even be as high as 9-10^{o}C.

The results of the surveys carried out for Warsaw indicate that the intensity of UHIE markedly depends on the share of biologically active areas in the settlement and the ventilation system, while the building intensity rate or the function of the distance from the city centre are less important. The share of biologically active areas should not be less than 45-50%.

It should be expected that the predicted increase in the frequency and intensity of heat waves may aggravate the phenomena related to UHIE and its impacts on the conditions of human life and health. The high air temperature in the summer of 1994 (when the temperature in Warsaw exceeded 36^{o}C) caused the mortality rate in Poland to grow by 50–230% compared with the average. There were 47 victims of that heat wave in Warsaw itself, taking into account the natural decrease in mortality which follows a period of its increase in the course of hot weather.

The threats related to water surplus and shortage

The threats related to water surplus in towns and cities basically relate to two issues, i.e. floods and inundations. Whereas floods threaten most of the towns and cities situated in river valleys (river floods) and in the coastal zone (storm floods), inundations may occur everywhere as a result of torrential rains (flash floods) and intensive, long-lasting precipitation events and they can also be caused by meltwater.

The main causes of high losses include the large congestion of urban buildings and the sealing of the ground, reducing or completely preventing infiltration. The effects of a natural disaster may be aggravated further by the rhythm of life in a big city: the working hours and the related rush hours, those of trade, education etc. At the same time, floods in cities generate threats for infrastructures (e.g. those of water supply, waste collection and treatment, waste landfills etc.). Most of metropolitan areas are situated in the valleys of large rivers.

In the face of climate change, more and more frequent urban foods can be expected; they will be caused mainly by torrential rains. The threat posed by this type of flood is enhanced by the poor performance of the drainage system and, to a lesser extent, also by limited water retention. Excessive quantities of water brought by heavy rains pose a great problem in terms of wastewater collection because of the low capacity of existing (or planned) wastewater collection installations. This can cause, in addition, the flooding of all types of manholes and cellars. Precipitation water should be drained form roofs, terraces and low-lying pockets at the external walls of buildings into a separate rainwater collection network or a combined wastewater collection system. Given the expected climate change, it is necessary to enhance the capacity of the rainwater collection network by increasing the diameter of its pipes or expanding the network; this would require modernisation of the water supply and wastewater collection infrastructure throughout the country.

Water supply to inhabitants is a very important element of the functioning of a town or city. In the changing climate conditions, a shortage of water may be one of barriers impeding the development of cities. With the growth of temperatures and the related heat waves and long periods without precipitation, the threat of droughts will grow, aggravating the shortage of water. Long periods without precipitation cause both a fall in soil moisture, as a result of intensive evaporation, and the lowering of flows in rivers and the groundwater table.

In turn, the problem that occurs in cities because of water scarcity is a fall in soil moisture, which is manifested primarily by the excessive drying of plant communities and urban greenery and limits the capacity of vegetation to mitigate the impact of high temperatures.

6.3.12. Local communities

In contrast to mitigation measures, adaptation to climate change is characterised by its regional and local character. Local communities are the group which is most vulnerable to climate change, particularly to emergencies. To a large extent, the effectiveness of adaptation measures depends on the involvement of local communities and authorities in their implementation. For this reason, the education at this level is of particular significance and should both cover the issues of climate change and indicate specific methods of protection against it, taking into account the local specificity. The awareness of the need to take preventive measures grows, particularly in areas where emergencies often occur. A short review of relevant initiatives includes both nongovernmental organisations, local governments and other institutions.

Nongovernmental organisations play an important role in the activities for climate protection and adaptation to climate change.

Social Dialogue Committees, i.e. bodies which propose initiatives and play an advisory role, provide a good model for the cooperation between local authorities and nongovernmental organisations. They have been established by the nongovernmental organisations concerned

and the local authorities. The Committees are also a forum for an exchange of knowledge and experiences and for cooperation among the organisations. Therefore, it is in the interest of local authorities to cooperate with nongovernmental organisations and other partners on adaptation to climate change. The committee on adaptation to climate change may be the best form for debates, consultations and an exchange of knowledge between the representatives of the local community and the local authorities.

Nongovernmental organisations focus primarily on education activities and those that raise the awareness of the public about the issues of climate change. These activities include the Life+ Project "**A Good Climate for Counties**", addressed to local governments, which is implemented by the Institute for Sustainable Development.

The **Mazovian Climate Agenda** is a project implemented by the association The First Warsaw Agenda 21 with the resources of the Civic Initiatives Fund. The Mazowian Climate Agenda plays the role of a forum for cooperation, an exchange of knowledge and good practices of different entities and the integration of different activities to raise the public awareness of the factors which shape the climate in urban agglomerations, using the example of the Warsaw Agglomeration.

The Alliance of Associations The Polish Green Network is a nationwide public benefit organisation which associates the environmental organisations operating in the biggest Polish cities. The Polish Green Network now implements the Project "**The Climate for Farmers".** The Project engages diverse groups concerned with this issue in different activities and discussions, including the associations of farmers and processors, local action groups, individual farmers and processors, representatives of local governments, students, environmental nongovernmental organisations, scientists, persons interested in sustainable development, consumers and Internet users. The Project is part of the international ClimATE Change Project, in which the partners include nongovernmental organisations from Germany, Italy, Malta, France, Africa and South America.

The aim of the **Partnership for Climate Platform** is to carry out, together with its partners, comprehensive, innovative educational and promotional activities related to climate change issues. Within the framework of the Platform, different types of events are organised, including e.g. conferences, debates, happenings and exhibitions intended to raise the public awareness of climate change issues. The Partners in the Partnership for Climate include organisations and institutions representing very diverse communities, including central and local government units, embassies, nongovernmental organisations and institutions for which climate protection is a priority.

At the local level, the initiatives related to adaptation primarily consist of flood protection measures and bring together different local communities and organisations. The examples below illustrate such activities.

"Volunteer Flood Protection – Flood Embankment Unions Return" is a project implemented by the Żuławy Association, within the framework of which training courses will be carried out to prepare volunteers for the role of flood embankment guards. The function of a flood embankment guard is a historic, responsible activity which is strictly related to volunteer flood protection. An agreement will be signed with the participants in the training courses obliging them to organise for payment and independently deliver at least one training course in their communities (e.g. a school, government office, institution, organisation) with

full technical support from the Żuławy Association. Each of the participants will receive the certificate of the Flood Embankment Guard. The training objectives of the course include the acquisition by the participants in the training of knowledge and competences for the dissemination of prevention measures, the management and organisation at the basic level of volunteer flood protection for the residents living in areas which are directly exposed to floods and the creation of human resources able to deliver on their own a training course or class on the basic principles of flood protection.

Neighbour help as an adaptation measure in the Commune of Gnojnik. In 1997-2001, the Commune of Gnojnik (in Małopolskie Voivodeship) suffered from a flood as many as 6 times. In response to so frequent natural disasters, the residents of the Commune established a neighbour help scheme. Within the framework of this neighbour help scheme, each family living in the higher-lying parts of the Commune exercises an emergency care over one family living in the areas exposed to a flood hazard. This means that the former family undertakes thereby to give specific help to the neighbours who have suffered, e.g. by offering them shelter in their own house, to carry their property out of the threatened area etc. This system has already worked well for many years.

The Batory Foundation has initiated and funded the building of the **Naprawmyto.pl** (Let's Fix It) portal. The work to set up the portal has been coordinated by the Unit for Social Innovation and Research – Shipyard. The users of Naprawmyto.pl can notify it of problems in the public space which they have observed in their nearest environment. The basic function of the portal is to map and notify the problems and matters which need to be resolved in the public space, e.g. in such areas as infrastructure, safety or incorrect operations of social services (e.g. in case of a damaged flood embankment). Each notification is registered in the system and an appropriate communication is forwarded to the public institutions responsible for a given issue. In this way, the portal can serve as a two-way communication channel between the authorities and the citizens. So far 8 Communes (Czerwonak, Lublin, Marki, Nysa, Przemyśl, Szczecin, Toruń and Zamość) have taken part in the operations of this portal, its users have submitted 13,200 alerts, of which 4,285 have already been remedied. Many of the submitted alerts have concerned the condition of land amelioration ditches, the rainwater collection system etc. Due to the notifications from residents, the authorities have duly responded to the problems.

In 2009, the County Employment Office in Góra implemented the Programme "**The Unemployed for Water Management and Flood Protection".** The Programme was established on the basis of the agreements on cooperation in the fields of water management, flood protection and limitation of employment in the Communes of Górowski County, signed between the Administration of Land Amelioration and Hydro-engineering Facilities of Dolnośląskie Voivodeship in Wrocław and the County Employment Office in Góra and among the Office of the Town and Commune of Góra, the Office of the Commune of Jemielno, the Office of the Commune of Niechlów and the Town Office of Wąsosz. The aim of the programme was to ensure protection against local flood-related inundations and to create additional jobs in these Communes through the organisation of public works, within the framework of which 24 unemployed persons registered at the County Employment Office in Góra found jobs for 5.5 months. The tasks to be carried out by these persons consisted of the cleaning and maintenance of watercourses, flood embankments and ditches. The programme was implemented from May 2009 to November 2009 and the financial resources mobilised for its implementation were about 230,400 PLN.

6.3.13. The directions of adaptation measures

The identification of the necessary measures which need to be taken in order to effectively implement the strategy for adaptation to climate change is its key element. These measures provide the basis for both the preparation of the executive programme of the strategy and for the assessment of its implementation costs. The preparation of a list of the measures was a multi-stage process. It was based on expert assessments of the vulnerability of given fields of social and economic life to climate change and the determination of the necessary projects to mitigate its adverse impact. The preliminary list was assessed and complemented by the Ministries concerned; subsequently, it was compared with the directions of intervention under government strategies and submitted to experts for their reassessment. The proposed detailed measures were aggregated to produce a list of the directions of measures at the aggregation level close to the directions of interventions provided for in government strategies.

The list enabled the definition of the notion of adaptation measures which meant measures designed to mitigate the impacts of climate change, but did not include the response to damage and the subsequent recovery.

The proposed measures cover the following sectors: water management, agriculture, spatial management, health care, urban areas, construction, transport, the energy sector, biodiversity conservation, forestry and the protection of monuments. In most cases, the adopted directions of measures are horizontal in character and affect the sectors in question to a different degree.

The directions were grouped into four categories: directions related to legal regulations and political directions, investment and technical directions, education and awareness-raising directions, as well as research and development directions. The directions related to the monitoring of the different aspects of adaptation are a separate category and primarily concern warnings against long- and short-term change, as well as vulnerability and response to climate change.

For the most part, the directions of legal measures are consistent with the existing law; still, some need either new legal regulations at the statutory level (e.g. the obligation to prepare local land use plans or the principles of management in vulnerable areas), or at the level of Regulations or other executive acts. The political directions focus on the preparation of new strategies and plans at the different levels of the management of the country.

The investment and technical directions should support the implementation of the legal and political directions through the preparation and application of guidelines and procedures, as well as the direct implementation of investment projects.

Education and raising of the public awareness about the present and expected climate change, their adverse impacts on society and the economy and the methods for their mitigation are the key condition for the successful implementation of the adaptation strategy. The education directions should ensure that such awareness improves. They should be pursued at all the levels of formal education and at the level of broadly understood informal education, particularly at the local level (farmers, local communities) and at the decision-making level (the state and local administration).

The implementation of the strategic adaptation plan is a long-term process, which should start immediately and continue permanently. In some fields, this process is already underway

(flood protection, the mitigation of the impacts of droughts or the protection of the coastal zone); however, the strategic plan intensifies these measures and introduces new elements. Although the timeframe is limited to 2030; still, the proposed measures will also be implemented beyond this timeframe. Their implementation will entail high costs and engage the existing technical and human capacity.

Given the high costs of adaptation measures, it was necessary to define priorities. The measures to prevent floods, the measures to protect the coast and, subsequently, those in agriculture were recognised as the most important ones.

The strategic adaptation plan and, in particular, the directions of adaptation measures cannot be effectively implemented unless they are integrated with other state strategies. For this reason, it was necessary to identify the relations between the directions of interventions laid down in the government strategies and the directions of adaptation measures in order to enable their incorporation into these strategies. Appropriate directions of measures were assigned to the individual directions of intervention (objectives, priorities) in the government strategies the objectives of which correspond to the objectives of adaptation.

6.3.14. Scientific research

The research on the present and future climate change

The research on the past and present climate conditions is the most common type of climate research. It is carried out at most universities and institutes the statutory tasks of which include climate problems. The literature on this subject is extensive, although in most cases it deals with very specialist or local problems. Despite this, the level of knowledge about some climatic phenomena and their variability in time and space is insufficient to verify model simulations and to determine the current trends of change. In particular, this is the case with rare and extreme phenomena.

Much less research is carried out on the scenarios of the future climate change at the national and regional levels. This research is done at two centres, i.e. the Interdisciplinary Centre for Mathematical and Computational Modelling at Warsaw University (ICM) and the Institute for Meteorology and Water Management-National Research Institute (IMGW-NRI), as well as, to some extent, at Łódź University. The aim of the research is to develop national scenarios based on the emission scenarios of the IPCC and on global and regional climate models. In the nearest time, it will become necessary to develop new scenarios in view of changes in the emission scenarios prepared by the IPCC.

The research on the impact of climate change and the vulnerability of the economy and society

This issue is relatively often the object of research which for the most part deals with such areas as: water resources, the coastal zone, agriculture, biodiversity and ecosystems.

Water resources and management: The analyses covered selected rivers in terms of both water supply and its quality, as well as flood hazards. Such research is relatively frequently done at many scientific research centres, including e.g. the Institute of Geophysics and the Institute for Agricultural and Forest Environment of the Polish Academy of Sciences (Poznań), the Institute of Meteorology and Water Management- National Research Institute,

the Cracow University of Technology, the Warsaw University of Technology and the Institute of Technology and Life Sciences.

Agriculture: Fundamental research on the adaptation of agriculture is carried out at many scientific research centres engaged in agricultural sciences. The Institute of Soil Science and Plant Cultivation-National Research Institute, the Warsaw University of Life Sciences, the Institute of Environmental Protection-National Research Institute and the Institute for Agricultural and Forest Environment of the Polish Academy of Sciences (Poznań) have had outstanding achievements in the field of changes in the yields of crop plants. Specialist research on adaptation is done e.g. at the Institute of Plant Protection and the Plant Breeding and Acclimatization Institute-NRI in the scope of the spread of pests and plant diseases, while research on permanent grasslands is carried out at the Institute of Technology and Life Sciences and other centres. Moreover, the Institute of Agricultural and Food Economics-NRI carries out the research project "Soil Quality and Organic Fertilisation as Drivers of the Development of Farms Carrying Out Typical Plant Production and CO_2 Sequestration by Them".

Forestry: Research is done e.g. on the concentrations of CO_2 in the atmosphere and the carbon sequestration capacity of forests (the Poznań University of Life Sciences); the changes in the ranges of the occurrence of forest tree species (the Forest Research Institute); the threats for forests dependent on the state of the atmosphere (the participation of the Forest Research Institute in the PROZA Project); carbon content in wood (the Poznań University of Life Sciences) - for other research, see Emergencies.

Health: In this sector, the research carried out by the Institute of Geography and Spatial Organisation of the Polish Academy of Sciences focuses on the identification of climate-dependent diseases and the frequency of their occurrence, along with the trend of their change in time, as well as on the impact of the urban heat island on stress and thermal stress.

The coastal zone: The problems of climate change and the related sea level changes are analysed at the Institute of Meteorology and Water Management-National Research Institute, the Branch in Gdynia, at the Institute of Hydroengineering of the Polish Academy of Sciences in Gdańsk and at the Branch of the Polish Geological Institute in Gdynia.

Ecosystems: The research on the behaviour and migrations of birds in connection with climate change is carried out at the Institute of Environmental Biology of the Adam Mickiewicz University, the the Poznań University of Life Sciences, the Museum of Natural History of Wrocław University, the Forest Research Institute, the Institute of Environmental Protection-National Research Institute and at the Białowieski, Biebrzański and the Warta Mouth National Parks. Other research on changes in ecosystems, species, invasions of alien species and the ecosystems of wetlands and swamplands is done at the Institute of Nature Conservation of the Polish Academy of Sciences, at national parks, at most universities, at the Warsaw University of Life Sciences, at the Institute of Environmental Protection-National Research Institute and, in the scope of the monitoring of phenological changes at the Institute of Meteorology and Water Management- National Research Institute.

There are practically no analyses of this type for other economic activities, especially infrastructure and social aspects, or economic analyses. The issues which are not considered in almost all the research underway (except for the protection of the coastal zone) are the

costs of losses caused by phenomena related to climatic phenomena and the costs and benefits analyses of the proposed adaptation measures.

Emergencies: Basically, research is done in the scope of monitoring such phenomena as floods, droughts and hurricanes and analyses of its results. This is a statutory task of the Hydrological and Meteorological Service at the Institute for Meteorology and Water Management-National Research Institute-National Research Institute. In the scope of droughts, the monitoring and research is also carried out by the Institute of Soil Science and Plant Cultivation-National Research Institute. The research on the occurrence of fires, floods and hurricanes in forests is done at the Forest Research Institute-National Research Institute. Monitoring is also carried out by other services in the country, e.g. maritime offices.

In two areas: **flood protection and the protection of the coast**, the impact research has entered the stage of implementation in the form of the preparation of flood hazard and risk maps and the implementation of the programme to protect the seacoast and Żuławy.

The research on adaptation methods

The research on the methods for the assessment of impacts and the vulnerability of society, the natural environment and different sectors of the economy to this change, based on scenario analyses, quantitative modelling and computer simulations, is at its initial stage of development. At present, such research is also carried out primarily in the sector of agriculture. Few other projects have the nature of expert studies executed in response to specific needs and are part of EU projects, in which Polish scientists participate, or are an effect of Polish scientists' cooperation in projects carried out by scientific institutions of other Member States of the European Union.

The scientific and development research supporting the adaptation process should focus on the following directions:

- diagnosis of the climate and hydrographic conditions,
- the creation of an integrated system for collecting information on climate change and its effects,
- the elaboration of new climate scenarios,
- the assessment of the present and future costs of climate change and the assessment of the costs and benefits related to the adaptation process, first for the following sectors: the coastal zone, agriculture, flood protection, the energy sector, health care, water management, infrastructure (transport and construction), forestry and biodiversity,
- the assessment of the risk of threats for the most vulnerable sectors and fields of life,
- the elaboration of tools to enable an assessment of adaptation as an element of the decision-making process to set out the priorities of adaptation measures,
- the identification of the impact of the adaptation measures taken on the mitigation of risks and their effectiveness,
- the factors contributing to the enhancement of resilience and adaptation capacity.

As the work proceeds and the research develops, these directions will evolve in order to adapt the research to the current needs.

CHAPTER 7. DEVELOPMENT COOPERATION AND TECHNOLOGY TRANSFER UNDER ARTICLES 4.3, 4.4 AND 4.5 OF THE CLIMATE CONVENTION

The Republic of Poland is not one of the Parties listed in Annex II to the Climate Convention; therefore, it is not obliged to fulfil the commitments under Articles 4.3, 4.4 and 4.5 of the Convention. Joining the EU in 2004, the Republic of Poland took on international commitments concerning the level of development cooperation and its quality.

7.1. Development cooperation

Poland carried out many assistance projects, discerning and understanding the need to support the sustainable development in developing countries and in countries with economies in transition. As a Member State of the European Union, Poland provided most of its assistance as a contribution to its general budget.

As part of multilateral assistance, resources were also provided as contributions within the United Nations System. The other resources were disposed of within the framework of bilateral assistance, implemented according to the priorities set out within the framework of the Development Cooperation Instrument, responding to the needs of the individual countries or regions of the world. In the reporting period, multilateral assistance systematically grew, while bilateral assistance varied between 84 and 104 million USD The levels of Polish development assistance in the individual years are shown in Table 7.1.

Table 7.1. The total development assistance provided by Poland in 2008–2011.

Year	Multilateral assistance		Bilateral assistance	
	Million PLN	Million USD	Million PLN	Million SD
2008	661	274	202	84
2009	841	270	324	104
2010	848	281	290	96
2011	978	330	261	88

Source: Data from the Ministry of Foreign Affairs – Annual reports "Poland's Development Cooperation".

The activities in the scope of environmental protection and tackling of climate change were only a slight part of the total value of development cooperation carried out by Poland. In 2011, about 78% of Polish Official Development Assistance (ODA) was granted by multilateral channel, mainly through the contribution to the EU budget and the payment to the European Development Fund. Whereas 22% of Polish ODA was accounted for bilateral aid, provided by institutions of the public finance sector, Polish diplomatic missions and NGOs.
The list attached to the Communication provides data on the financing of development cooperation in the fields related to environmental protection, particularly the climate. The initiatives supported by Poland in 2011 were expanded with a component related to the protection of environment and to some extent related to adaptation measures in the different regions of the world.The Polish assistance resources directly funded adaptation and capacity building projects (training). The preferential loans to China given in 2010 and 2011 were also classified as Polish development assistance.

The resources distributed via the European institutions were allocated to activities selected as a result of the programming process compliant with the relevant EU legal acts.

The category of climate protection activities also included Poland's contributions to international organisations dealing with climate protection issues, including its broadest aspect, i.e. adaptation to climate change.

In 2008-2011, the assistance granted within the framework of bilateral activities went to the countries of the Eastern Partnership, such as Ukraine, Georgia, Moldova, Belarus, Azerbaijan and Armenia, African countries (Angola, Cameroon, Congo, Ethiopia, Sudan and Tanzania), Afghanistan and Palestine. Poland also funded single projects in other developing countries.

The overwhelming majority of the activities financed by Poland concerned adaptation to climate change; some of them were investment projects, while others aimed at capacity building. Detailed information is given in Annex 3 in the CTF format.

7.2. Information concerning the minimisation of the adverse impacts of climate change in accordance with Article 3.14 of the Kyoto Protocol.

In 2009, the Ministry of the Environment prepared the project GreenEvo – Green Technology Accelerator within the framework of the 14th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change which was convened in Poland in December 2008. It was consistent with the idea of the Poznań Technology Transfer Strategy, adopted at the end of that summit. It provided for the enhancement of the effectiveness of technology transfer through good identification of the needs of developing countries in this scope. Carrying out this project, the Ministry of the Environment implemented in practice the assumptions of the most important strategic document on the environment, i.e. the National Environmental Policy, concerning technology transfer and the implementation of environment-friendly activities. In the course of the 4th edition of the project, 48 companies were selected as the leaders of green technologies in Poland in the fields of water and wastewater technologies, energy saving, air protection, renewable energy sources, waste management and biodiversity conservation. These companies also cooperated in the scope of technologies, including the delivery of pilot or implementation projects for their own solutions, with developing countries, e.g. Ukraine, Moldova, Belarus, Kazakhstan, Armenia, Azerbaijan, Vietnam, Malaysia, Angola, Morocco, Mongolia and North Sudan.

Discerning the potential of Polish companies on the market of environment-friendly Technologies, the Ministry of the Environment tried to support as effectively as possible the development and promotion of green entrepreneurs. Apart from GreenEvo described above, together with the National Fund for Environmental Protection (NFOŚiGW) and the National Centre For Research and Development (NCBiR), workings on the development of a new programme GEKON – Generator of Ecological Concepts were launched. The concept of GEKON is to provide financial support to research and industry consortia for the development and implementation of environment-friendly technologies.
Moreover, the activities launched by Poland to minimise the socially, environmentally and economically adverse impacts on developing countries included the implementation of the declaration of the Polish Government on assistance in the form of fast start finance. It was one of the elements of the so-called Copenhagen Accord of December 2009 and consisted in the provision in 2010-2012 of financial support by developed countries to developing ones for the implementation of the objectives of their climate policy. Within the framework of the abovementioned declaration, in 2010-2012, Poland mobilised 12.75 million EUR.

In 2012, the value of Poland's climate-related assistance was 7.546 million EUR. The activities implemented within the framework of bilateral assistance had the total value of 6.656 million EUR. Poland continued its project in the area of adaptation to climate change which was implemented in China in 2012 with the value of 5.816 million EUR. Other adaptation projects were carried out in Armenia, Ethiopia, Kenya, Kyrgyzstan, Nigeria and Palestine with the total value of 380,000 EUR.

Projects to mitigate greenhouse gas emissions were also carried out in the Crimean Autonomous Republic, Egypt, Moldova, Tanzania and Ukraine with the value of 400,000 EUR. Projects dedicated to both adaption and mitigation with the value of 60,000 EUR were implemented in Azerbaijan and North Korea.

Moreover, contributions were paid to international organisations combating climate change in the amount of 890,000 EUR.

CHAPTER 8. RESEARCH AND SYSTEMATIC OBSERVATIONS

8.1. National activities

8.1.1. Climate research in the national science policy

In 2005, the National Framework Programme was approved. It provided the basis for the Minister responsible for science to announce competitions for commissioned research projects. The environment was one of the strategic research areas, within the framework of which the field of research "The Economy as a Climate Change Factor" was established. The objective of the research in this scope was to identify the ways of reducing greenhouse gas emissions in Poland and to enhance their removals, to limit the consumption of non-renewable energy sources in favour of renewable sources and to counteract the adverse impacts of the emissions of these gases on the economy and nature.

In 2008, the National Programme of Scientific Research and Development was established. It was an instrument of the national science, technological progress and innovation policies. The climate change issues were primarily addressed in two of the following priority research areas: Energy and Infrastructure (the direction of energy generation technologies) and Environment and Agriculture (the directions of environmental diagnosis methods and technologies to reduce threats for the climate, atmosphere and land surface, as well as the development of technologies for the acquisition of information on the environment and precision positioning using satellite techniques).

On 1 October 2010, the National Programme of Scientific Research and Development was replaced by the National Research Programme. The broadly understood issues of climate protection and adaptation to climate change (including greenhouse gas emission reductions, the limitation of the adverse impact of the economy on the environment etc.) are addressed in 3 of 7 strategic, interdisciplinary directions of scientific research and development; specifically: "New technologies in the energy sector", "Advanced materials technologies" and "The natural environment, agriculture and forestry".

One of the strategic programmes of scientific research and development within the framework of the National Research Programme is the programme "Advanced energy generation technologies" implemented in 2010-2015. The scope of this programme includes the implementation of the following four research tasks: "The development of technologies for high-efficiency zero-emission coal-fired units integrated with flue gas CO_2 capture", "The development of the aerobic combustion technologies for pulverised-fuel and fluidised-bed boilers integrated with CO_2 capture", "The development of coal gasification technologies for high-efficiency fuel and electricity production" and "The development of integrated technologies for fuel and electricity production from biomass, agricultural and other waste".

Moreover, the projects "Technologies supporting the development of safe nuclear energy generation" and "An integrated system for reducing the operational energy intensity of buildings" are implemented.

8.1.2. Directions of scientific research on climate change

The scientific research in the field of climatology in Poland covers a wide spectrum, which practically has not changed for many years. The major directions of research include:

- physical climatology,
- topoclimatology (in particular, the climatology of urbanised areas and selected areas with limited local anthropopressure),
- dynamic climatology,
- regional climatology,
- applied climatology
- climate change research.

In the scope of climate change research, the following major issues can be distinguished:

– research on the climate change in the past,
– modelling of climate processes and the development of scenarios of predicted change,
– the impact of climate change on the natural environment, the economy and society,
– the impact of human activities on the climate,
– the social and political aspects of climate change.

Many climatologists in Poland are interested in the climate change in the past. Just as in other countries, most of the research covers mainly the period of instrumental measurements, i.e. approximately from the turn of the 18^{th} and 19^{th} centuries, and the most frequently selected regions of the country - and only sometimes individual localities. This research is limited only to analyses of the variability of thermal and pluvial characteristics. Long-term air temperature and precipitation series have been developed for Warsaw, Cracow, Puławy, Gdańsk, Hel, Koszalin, Szczecin, Bydgoszcz, Łódź, a peak in the Sudety Mountains (Mt. Śnieżka) and the Western Carpathians (the alpine meadow Hala Gąsienicowa – the upper forest limit).

The aim of the studies to reconstruct the climate conditions in the historical period is to seek climate change trends in the past and the possible periodicities of the occurrence of those changes. They usually confirm the results obtained in the neighbouring countries. Research was continued in the scope of attribution of the causes of climate change observed in the Polish territory, producing new scientific facts confirming a linkage between that change and the regional and global processes (changes in the regional atmospheric circulation, the North Atlantic Oscillation, the Arctic Oscillation, a change in the temperature of the surface layer of the North Atlantic etc.).

Research was continued in the scope of the climatology of pollutants (Silesia, Cracow, Tricity), the evolution of the urban boundary layer (Cracow, Łódź, Wrocław), atmospheric ozone and UV radiation (Belsk, Legionowo), changes in the concentrations of greenhouse gases and halogens (Cracow, Mt. Kasprowy Wierch in the Tatra Mountains, Mt. Śnieżka in the Karkonosze Mountains), as well as aerosols and the optical properties of the atmosphere (the Institute of Oceanology of the Polish Academy of Sciences, the Institute of Geophysics of the Polish Academy of Sciences and the Institute of Meteorology and Water Management). This research, though based on relatively short, but contemporary data series, is nevertheless very important and, in a sense, makes modern contributions to the knowledge of Poland's climate.

Research in the scope of climate change modelling and the attempts to forecast it systematically intensify, but the achievements of Polish climatology are still insufficient in this field. This results primarily from the costs which the research of this type requires, their interdisciplinary character and the absence of an adequately large team of experienced experts. The research on the impact of climate change on human activities is most often carried out by the Polish scientific community, focusing mainly on several areas which are most vulnerable to climate change, such as: water resources, agriculture, the coastal zone,

ecosystems, forestry and the energy sector. Since 1994 about 100 research projects have been implemented on climate change and the global warming process, of both national and European importance.

The research on the areas located at high latitudes has a very special position in Polish scientific research. Two polar stations (at Hornsund, SW Spitsbergen, and on King George Island, South Shetland Islands) continued their regular work. In both cases, the issues related to global climate change dominated. Moreover, in the summer season Polish universities carried out very diverse studies on Spitsbergen in the scope of the climatology of polar regions, glaciology and geoecology.

The research in the scope of oceanography and the physics and chemistry of the atmosphere basically focused on the issues related to water circulation, the energy and mass transport to the high latitudes of the Northern Hemisphere, the transport of solar energy into the depths of the ocean, aerosols and the related changes in the optical properties of the atmosphere, as well as the previously mentioned (tropospheric and stratospheric) ozone and changes in UV radiation. The research on the concentrations of greenhouse gases in the atmosphere had an important position.

Moreover, just as in the previous years, scientists from many Polish centres participated in many projects financed with foreign resources, mostly from the EU, concerning climate change and its effects. Scientists from the Institute of Meteorology and Water Management National Research Institute (IMGW-PIB), the University of Łódź (UŁ) and the University of Silesia (UŚ) continued their work in an international team carrying out a regional analysis of climate change and its effects in the Baltic Sea region (Assessment of the Climate Change for the Baltic Sea Basin) which summed up a dozen or so years of studies carried out by many European research centres within the regional BALTEX Project which was part of the global GEWEX Project.

The studies on the characteristics of the climate conditions in Southern Poland, with particular focus on the area of Cracow, both in the pre-instrumental and instrumental periods, were continued within the framework of the EU-financed Millennium Project. Within the framework of the Polish-Swiss Research Programme (CLIMPOL, 2011-2015), the project "Climate of Northern Poland During in the Last 1000 Years" was carried out at the University of Gdańsk.

Research projects on adaptation to climate change and climate change implemented within the Framework Programmes, the EU Operational Programmes, the Polish-Norwegian Research Programme and other international programmes:

- Developing the Methodological Framework for Adaptation of Plant Production at Farms with Different Management Types and Production Levels to the Expected Climate Change, Institute of Environmental Protection-PIB.
- Developing Policies & Adaptation Strategies to Climate Change in the Baltic Sea Region (ASTRA), Polish Geological Institute-NRI, Gdynia (2006-2007).
- Global Climate Change Impact on Building Heritage and Cultural Landscapes (NOAH ARK), Institute of Catalysis and Surface Chemistry of the Polish Academy of Sciences(2004-2006).
- Central and Eastern Europe Climate Change Impact and Vulnerability Assessment (CECILIA), Warsaw University of Technology, (2006-2009).
- Adaptation of Agriculture in European Regions at Environmental Risk under Climate Change (ADAGIO), Poznań University of Life Sciences (2007-2009).

- Projection of Economic impacts of climate change in Sectors of the European Union based on boTtom-up Analysis (PESETA II), Warsaw University of Life Sciences.
- Innovative technologies for safer European coasts in a changing climate **(**THESEUS), IMGW-PIB, Institute of Hydroengineering of the Polish Academy of Sciences (2009-2013).
- Hydrological cycle in the CADSES area (HYDROCARE), IMGW-NRI (2006-2007).
- Impact of climate change on environment, economy and society (changes, effects and methods of reducing them, conclusions for science, engineering practice and economic planning), IMGW-PIB (2009-2012).
- Adaptive management of climate-induced changes of habitat diversity in protected areas (HABIT-CHANGE), Institute of Environmental Protection-NRI, Warsaw University of Life Sciences , Biebrzański National Park (2010-2013).
- ENvironmental Optimization of IRrigAtion Management with the Combined uSe and Integration of High PrecisIon Satellite Data, Advanced Modeling, Process Control and Business Innovation (ENORASIS), Institute of Soil Science and Plant Cultivation - NRI (2012-2014).
- Integrated water resources and coastal zone management in European lagoons in the context of climate change (LAGOONS), Institute of Hydroengineering of the Polish Academy of Sciences (2011-2013).
- Development and application of mitigation and adaptation strategies and measures for counteracting the global Urban Heat Islands phenomenon (UHI), Institute of Geography and Spatial Organisation of the Polish Academy of Sciences (2011-2014).
- Assessing the sensitivity of water resources to global change at the regional, national and global scale - Flood risk on the northern foothills of the Tatra Mountains (FLORIST) Polish-Swiss Research Programme, Institute of Geological Sciences, University of Bern, University of Silesia, Institute of Nature Conservation of the Polish Academy of Sciences in Cracow, Institute of Agricultural and Forest Environment of the Polish Academy of Sciences in Poznań, in cooperation with the Potsdam Institute for Climatic Impact Research (PIK), Germany, Z. Kundzewicz**.** http://www.isrl.poznan.pl/ 2011.
- The Report Climate change impacts and adaptation for international transport networks, B. Rymsza, Road and Bridge Research Institute, 2012 UNECE (ECONOMIC COMMISSION FOR EUROPE).
- The Project The platform supporting operational decisions depending on the atmosphere (PROZA), Interdisciplinary Centre for Mathematical and Computational Modelling of the University of Warsaw, Forest Research Institute, Institute of Horticulture, Institute of Oceanography of the University of Gdańsk, 2008-2013.
- Towards an Integrated Framework for Climate Impact Assessments for International Market Systems with Long-Term Investments, Interdisciplinary Centre for Mathematical and Computational Modelling of the University of Warsaw (CLIMARK US-European project, NSF Award CNH 0909378).
- Climate change impact on hydrological extremes (CHINE), Institute of Geophysics of the Polish Academy of Sciences PAN, 2013 -2015.

National programmes

- The Multiannual Programme of the Institute of Soil Science and Plant Cultivation - PIB, Project 1.1. A system of information on the impact of climate change on agriculture and adaptation methods.

- The System for Monitoring Agricultural Drought in Poland (SMSR), implemented on commission from the Ministry of Agriculture and Rural Development since 2007. Institute of Soil Science and Plant Cultivation- PIB.
- Adaptation of Poland's Vulnerable Sectors and Areas to Climate Change until 2070 (KLIMADA), Institute of Environmental Protection-PIB on commission from the Minister of the Environment (2011-2013).
- An Assessment of the Impact of Climate Change on the Health Condition of Society in Different Regions of Poland and the Prediction until 2100, OPUS Project of the National Science Center, K. Błażejczyk, Institute of Geography and Spatial Organisation of the Polish Academy of Sciences (2011-2014).

8.2. Participation in international programmes

Another initiative which expands the priorities set out in the 7th Framework Programme is Horizon 2020 - the Framework Programme for Research and Innovation for 2014-2020 – adopted in July 2013. In addition to the tasks which have been implemented so far under the EU's 7th Framework Programme (EU FP7), the Horizon 2020 Programme also contains the priorities of the Competitiveness and Innovation Framework Programme in its part related to innovation. The key element of the Horizon 2020 Programme is the integration of scientific research and innovation by creating a uniform and consistent financing system, from the conceptual stage to the placing on the market. The third pillar of the Programme called "Tackling Societal Challenges" consists of the areas within the framework of which the adaptation measures should also be taken:

– health, demographic change and well-being,
– food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the bioeconomy,
– secure, clean and efficient energy,
– smart, green and integrated transport,
– climate action, environment, resource efficiency and raw materials.

Polish research centres took an active part in projects related to broadly understood climate change issues which were carried out within the framework the 7th Framework Programme for research and technological development (for 2007-2013).

8.2.1. Poland's contribution to the research on the problems of the International Geosphere-Biosphere Programme (IGBP) and its sub-programmes

The Polish National Committee of the IGBP continued its long-term activities encompassing a wide range of research and organisational problems, in particular:

- research on the impact of global change in the geosphere, biosphere and anthroposphere on the whole of the natural environment of the country,
- the prediction and determination of the impact of that change on the socio-economic development of the country,
- research on the course, prediction and mitigation of environmental, economic and social effects of the intensifying extreme events, such as floods, flash floods, droughts, hurricanes, landslides, hailstorms, fires and others.

Biospheric Aspects of the Hydrological Cycle (BAHC). In Poland, the previously started studies on the issues related to the impact of the nonstationarity of geophysical processes on the national water resources were continued, with particular consideration given to the

extreme hydrological events, such as floods and droughts. These studies brought new results to confirm the earlier findings, indicating the threats for water resources and the occurrence of the extreme hydrological phenomena caused by temperature changes. Detailed research covered selected areas in the country, mostly the areas of lake districts, swamplands and wetlands. Research continued on changes in the water ad thermal balance in selected areas (Wielkopolska, the Kaszubskie Lake District) and changes in Poland's climatic water balance. The methodology was developed for the assessment of the risk of the occurrence of adverse processes in the coastal zone of the Baltic Sea, particularly in the area of large agglomerations (Szczecin, Tri-City), the delta of the Vistula River and Żuławy, as a result of global warming.

Global Change and Terrestrial Ecosystems (GCTE). Within the framework of the GCTE Programme, studies were carried out on the carbon cycle in selected inland aqueous ecosystems (the Wielkopolskie Lake District, North-Eastern Poland) and research was also continued on the impact of global climate change on the carbon cycle in forest ecosystems and the impact of forest reclamation projects in industrial areas. Within the framework of the cooperation among several European and American research centres, the monitoring of the ion exchange was continued and the changes unfolding in the communities of pine forests along the southern parallel line (from Lapland to the Carpathians) were also analysed, confirming the observed distinct tendency for forest range limits to shift northwards as the climate progressively becomes warmer. In the Carpathians and the Sudety Mountains, the changes in the floors of plant communities caused by higher air temperatures were analysed. Peat-bogs, particularly those situated in Northern Poland, are a separate and extremely interesting field of research. Studies continued on the impact of climate change on the plant production in Poland and in forestry.

Land Surface Biosphere and Atmospheric Chemistry (IGAC). Within the framework of the IGAC Programme, the monitoring of stable and radioactive isotopes in the atmosphere was continued for the purpose of identifying the isotopic composition of CO_2 and CH_4 and progressive changes related to human interference. The scope of the monitoring in place was expanded with quantitative and qualitative measurements of aerosols, both in marine areas (the North Atlantic and the Baltic Sea), in the coastal zone and on land. Due to this, it was possible to monitor the optical properties of the atmosphere and to model their impact on the radiation flow to the Earth's surface. Research was also carried out on the position of the boundary layer in the vertical profile of the atmosphere in cities using sodar and remote sensing methods. Studies on changes in ozone in the atmosphere (in both the vertical profile and the whole column) and UV-B radiation, as well as the variability of the occurrence of ozone at the ground level, built on the abovementioned research. Part of the research in the fields discussed above concerned the methods for the assessment of the impacts of the individual types of activities on the climate and the development of appropriate indicators and standards for greenhouse gas emissions, as well as the elaboration of the methods for mitigating their impacts. Many studies in this range were innovative in character and they were conducted at the world class level.

Past Global Changes (PAGES). The research on past environmental changes continued to focus on the exploration of the mechanisms of changes in the last glacial period and the Holocene. In respect of the glacial period, particular attention was paid to the climate change registered in loess sediments, the course of the deglaciation and the permafrost recession. Research was continued on the sediments in Lake Gościąż and samples taken from a dozen or so lakes situated in Pomerania. In connection with numerous investment projects carried out throughout the country, it was possible to perform extensive archaeological investigations on the investment project sites. Due to this, it was possible to reconstruct the climate conditions in the research area on the basis of biological traces. Polish research centres continued to

participate in interdisciplinary research programmes on the history of Lake Baikal, lakes in Scandinavia. Results are transferred to the European Pollen Database.

Sea Biosphere and Atmosphere (JGOFS). The research on the integration of solar radiation and the biosphere of the marine environment, the modelling of the hydrophysical field structures and the energy supply to the seas through photosynthesis, which had been conducted for a number of years, was continued. The research was conducted in the areas of both the North Atlantic and the Baltic Sea. A number of new methods were developed and implemented. e.g. including those using the satellite technology that are useful for the monitoring of the Baltic Sea environment (the Institute of Meteorology and Water Management-National Research Institute, the Institute of Oceanology of the Polish Academy of Sciences, the University of Gdańsk). Traditionally, Polish research in polar regions made a an important contribution to the exploration of the impact of global warming on oceanic ecosystems.

Land-Ocean Interactions in the Coastal Zone (LOICZ). Traditionally, particular attention was paid to the coastal zone in terms of global warming, leading to rising sea levels and a possible increase in the frequency of the occurrence of storms and their strength, as well as the related more frequent flooding of coastal areas. Research was continued on the dynamics of the coastal zone (the change in the coastline and debris transport) and sea sediments, the evolution of the South Baltic coast in a longer term, the modelling of the physical processes at the river mouths, an exchange of salt and $C0_2$ in the sea contact zones, as well as the chemistry and pollution of coastal waters.

8.2.2. Cooperation within the framework of the World Climate Programme (WCP)

Polish scientists and experts took an active part in the work of the World Meteorological Organisation (WMO), both in its Commissions and Programmes. Traditionally, research was continued within the framework of the World Climate Programme - Water and in the field of marine climatology (JCOMM, WMO/IOC). The Institute of Meteorology and Water Management – National Research Institute organised the Conference “Advances in Marine Climatology, CLIMAR-III", which was attended by more than 70 scientists working on marine climatology from more than 20 countries.

At the IMGW-PIB, the programme to salvage data from Poland’s territory from before World War Two, which had been conducted since 2005, was continued. Documents continued to be scanned and digitalised. Analogous programmes to salvage data were carried out by the University of Gdańsk for Gdańsk and its area and by the Nicolaus Copernicus University for the regions of Northern Poland and polar regions. Continuous research on the variability of the climate conditions in Poland was carried out on the basis of long-term climate data series (Institute of Meteorology and Water Management-National Research Institute and universities).

8.2.3. Global Climate Observing System (GCOS)

The studies under the agenda and time schedule of the Global Climate Observing System were continued. In 2008, a report was prepared on the implementation of the GCOS in Poland. Detailed information on the current research and observation systems within the GCOS: GOOS, GTOS and GAW is presented in Section 8.3.

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

The work for the IPCC was continued by the Polish IPCC Focal Point, situated at the Institute of Meteorology and Water Management-National Research Institute in Warsaw, which was appointed by the Minister of the Environment in 1990 to coordinate the work for the IPCC in Poland, to provide opinions on the IPCC documents and to designate experts to participate in the sessions of working groups and experts' meetings. Polish scientists took part in the preparation and review of IPCC documents and reports. One of the representatives of Polish scientists was the leading author of the technical report "Water and Climate" published in 2008. The Institute of Meteorology and Water Management-National Research Institute organised an IPCC workshop in Poland during which the representatives of both the media, administration and science could become acquainted with the most important findings of the IPCC Fourth Assessment Report. The participants in the workshops listened to presentations made by experts who discussed the results of Polish research, in accordance with the competence of the individual IPPC working groups.

8.2.5. Participation in the work of the European Global Ocean Observing System (EuroGOOS)

Polish institutes (the Institute of Oceanology of the Polish Academy of Sciences and the Maritime Institute) which are members of the EuroGOOS continued to participate in the work to develop European operational oceanography that was intended to make an important contribution to the Global Ocean Observing System - GOOS. The key elements of the work within the framework of the EuroGOOS included the building and development of a stable observing system and oceanographic measurements within the Baltic Sea.

8.3. Systematic observations

Some of the tasks in the scope of the monitoring of selected Essential Climate Variables were carried out by research institutes, including e.g. the Institute of Geophysics of the Polish Academy of Sciences , the Institute of Oceanology of Polish Academy of Sciences , the Institute of Environmental Protection-PIB , the University of Technology and Science (AGH), and universities, including: the Adam Mickiewicz University in Poznań , the University of Gdańsk in Gdańsku, the Jagiellonian University in Cracow, the Maria Curie-Skłodowska in Lublin, the Nicolaus Copernicus University in Toruń, the University of Silesia in Sosnowiec, the University of Warsaw in Warsaw, the University of Wrocław in Wrocław and the Jan Kochanowski University of Humanities and Sciences in Kielce, as well as the Wigierski National Park and the Kampinoski National Park .

The advancement of the development of the individual components of the observing system was different. It was markedly higher in the field of systems for terrestrial measurements of essential climate variables in the scope of meteorology (on land, in oceans and in higher layers of the atmosphere) and hydrology (the monitoring of snow cover, rivers and lakes), carried out within the framework of the State Hydrological and Meteorological Service (PSHM) by the Institute of Meteorology and Water Management-National Research Institute. The degree of the utilisation of satellite systems in the scope of meteorological and oceanographic variables was very high, while it was lower in the scope of hydrological variables and other terrestrial characteristics. The Institute of Meteorology and Water Management-National Research Institute played a leading role in this case, too. However, the activities of other institutions, such as the Institute of Oceanology of Polish Academy of

Sciences in Sopot and the Institute of Oceanography of the University of Gdańsk, mainly in the scope of the optical properties of the atmosphere and observations of the sea surface, significantly expanded this area. Polish institutions, mainly the Institute of the Geophysics of the Polish Academy of Sciences and the University of Silesia, made a very important contribution to the climate observing programme at high latitudes.

8.3.1. Meteorological observing systems

In Poland, observations and measurements within the framework of the global system of meteorological and climatic observation networks were carried out by the State Hydrological Meteorological Service at the Institute of Meteorology and Water Management-National Research Institute. These activities were conducted at 1,259 measurement points throughout the country (Table 8.1). The whole network implemented a measurement and observation programme compliant with the WMO standards, while the measurement and observation equipment installed there underwent continuous control and periodical calibration at the Central Measurement Instrument Laboratory of the Institute of Meteorology and Water Management-National Research Institute.

Table 8.1. The measurement and observation network of the Institute of Meteorology and Water Management-National Research Institute (December 2012)

Name of the unit and the type of the station	Number
First-order to fourth-order weather stations	1,259
First-order weather stations – high-mountain weather observatories	2
First-order and second-order weather stations (synoptic)	60
Third-order and fourth-order climatological stations	210
Fifth-order precipitation stations	987
Aerological measurement stations (GUAN)	3
Weather radars	8
Stations for locating atmospheric discharges	9
Station for receiving satellite data	1

The observation network was complemented by the actinometric network established in the early 1960s, which now consisted of 25 stations. Data from four actinometric stations were sent every quarter to the World Radiation Data Centre (WRDC) in Sankt Petersburg, Russian Federation.

After it had been verified and checked, the information from the network of the measurement and observation stations and posts of the Institute of Meteorology and Water Management-National Research Institute was collected in the national historical database of the Institute, without setting the date of validity, in paper form (with the oldest coming from the end of the 18th century), on microfilms and electronic carriers (with the digital data covering the period since 1951 and for a large measurement range since 1966).

8.3.2. Oceanic observing systems

The research on the marine environment in the Polish zone of the Baltic Sea was carried out by many institutions. The Centre for Oceanography and Baltic Sea Monitoring of the Institute of Meteorology and Water Management-National Research Institute in Gdynia played a leading role, as, on commission from the Chief Inspectorate for Environmental Protection, it monitored the deep-sea zone within the framework of the State Environmental Monitoring System. The monitoring surveys on the coastal zone, bays and lagoons of the Baltic Sea had been carried out since 2007 by the Voivodeship Inspectorates for Environmental Protection.

Within the framework of the programme, in addition to weather observations, physical parameters were measured, such as the temperature of sea water, salinity, sea currents; chemical parameters, such the oxygen concentration, nutrient contents, organic compounds, as well as biological parameters and radionuclide contents. The research programme complied with the requirements of the Marine Strategy Framework Directive (MSFD).

Data from the monitoring of the Baltic Sea were forwarded to the European Environment Agency, the Helsinki Commission (HELCOM) and the International Council for the Exploration of the Sea (ICES). The research on the marine environment of the Polish zone of the Baltic Sea was implemented by the Institute of Meteorology and Water Management-National Research Institute together with the Sea Fisheries Institute, using the sea research vessel r/v Baltica and the special vessel "Littorina", while in Gdynia it was conducted by the Sea Fisheries Institute, the Institute of Oceanology of the Polish Academy of Sciences, the University of Gdańsk and the Maritime Institute.

The Republic of Poland carried out very limited oceanographic research outside the Baltic Sea. One of the exceptions was the research vessel "Oceania" of the Institute of Oceanology of the Polish Academy of Sciences in Sopot, which regularly sailed in the waters of the North Atlantic and the (Norwegian) Arctic. In the course of those voyages, such parameters as the temperature of sea water, salinity, sea currents, the state of the sea, the contents of carbon content in sea water, nutrients and phytoplankton were measured. Moreover, sea aerosol samples were taken.

The Republic of Poland participated in the Global Ocean Observing System within the framework of the VOS and SOOP Programmes. A substantial part of the Polish commercial fleet (82 ships) took part in the weather observing programme on the sea and most of the ships sent data on a current basis to data centres (about 60 ships). Two vessels, both of which sailed in the Baltic Sea, participated in the SOOP Programme.

In December 2008, a station was set up on a drilling rig owned by the gas production company Petrobaltic Beta to operate in a fully automatic mode on the Baltic Sea (at a distance of about 70 km from the land), in the area of Cape Rozewie, recording all the parameters measured.

The network of the coastal posts of the Institute of Meteorology and Water Management-National Research Institute consisted of 36 stations; moreover, 13 posts were located at the river mouth sections, another 5 on the shores of lagoons (the Vistula and Szczecin Lagoons) and the others on the coastal zone of the open sea. Data on the sea level routinely underwent quality control and were then stored in the historical database at the Institute of Meteorology and Water Management-National Research Institute.

At present, on an operational basis Poland submits data on sea levels from one station within the framework of the network of the ESEAS Project.

The work in the field of satellite remote sensing (the acquisition, calibration and interpretation of satellite imagery) of the oceanic Environmental Climate Variables (ECVs) is carried out in Poland by the abovementioned Institute of Meteorology and Water Management-National Research Institute, the University of Gdańsk, the University of Silesia and the Institute of Oceanology of the Polish Academy of Sciences. However, it only covers selected quantities (the wind field, SST (Sea Surface Temperature), ice cover and the colour of the sea).

8.3.3. Terrestrial observing systems

The system of observations on the Terrestrial Essential Climate Variables consisted of the following components: hydrology (GTN-H), river discharge (GTN-R), lakes (GTN-L), glaciers (GTN-G) and permafrost (GTN-P). Within the framework of the GTN-H, the Institute of Meteorology and Water Management – National Research Institute carried out water level measurements at 893 inland posts. The basic measurement range covered observations of the water level, ice phenomena and the thickness of ice cover, the overgrowing of the riverbed by vegetation, the possible registration of the daily water level variations and water temperature measurements (at more than 210 posts).

The density of hydrological measurements depended on the degree of the flood risk in a given area. For this reason, it was distinctly greater in the south of the country.
The thickness of snow cover was determined at 1,314 posts in Poland and 1 post on SW Spitsbergen – the Hornsund Station (of the Institute of Geophysics of the Polish Academy of Sciences). In addition to daily measurements of the thickness of snow cover, at many stations the thickness of snow cover was determined in the form of the water equivalent (mm H_20/cm of the cover thickness).
Within the framework of the GTN-R, hydrometric measurements were carried out at water gauge posts to determine the relationship between the water level and the water discharge.

The network of hydrological inland measurements were complemented by limnological measurements (GTN-L) performed at 15 lakes situated in the northern and western parts of the country. The aim of these measurements was to determine the water balance of the lakes monitored. At all the lakes incorporated into the limnological network, inflow and outflow measurements were carried out. In addition, at three of them, the evaporation from the lake surface was measured. In the case of some lakes, the components of the water balance had been systematically determined from the early 1960s. Moreover, at some lakes the temperatures of the surface water or the water in the vertical section were measured and, periodically, its transparency and quality were determined.

Within the framework of the GTN-G, Polish scientific institutions at high latitudes monitored land glaciers. In the case of the Norwegian Arctic (SW Spitsbergen), the monitoring programme had been carried out for many years, covering many parameters. This Programme was carried out by the University of Silesia and the Institute of Geophysics of the Polish Academy of Sciences. In the case of the Antarctic, glacier research was carried out by the Polish Academy of Sciences periodically in the area of the H. Arctowski Station. However, this research enabled the determination of the pace of the glacier retreat (since the 1950s) and the intensity of the summer discharge.

Within the framework of the GTN-P, regular measurements of the depth of summer thaw and systematic measurements of the ground temperature (down to 1,0 m) had been carried out since 1977 by the Institute of Geophysics of the Polish Academy of Sciences in the area of the Hornsund Station, SW Svalbard.

The Republic of Poland is a member of the International Permafrost Association. It participated in the Circumpolar Active Layer Monitoring (CALM) Programme, which is part of the global climate observing system of the GTN-P. The results of the measurements were forwarded to the CALM data centre at the University in Cincinnati (USA) and to the National Snow and Ice Data Center in Boulder, Colorado (USA).
The tradition of phenological observations in Poland dates back to the late 19th century. These observations, resumed by the Institute of Meteorology and Water Management-National

Research Institute, after World War, ceased in 1992 and were resumed again in 2005. The network of phenological observations made under the supervision of this Institute now consists of 70 posts. Some universities and Agricultural Extension Centres also run their own networks of phenological observations.

In agriculture, the research focused on the assessment of the impact of climate change on the plant production, farming and the range of ecotones, i.e. the limits of climate and vegetation zones, and ecosystems in Poland. These studies were carried out primarily in Puławy and Poznań.

8.3.4. Satellite climate observing systems

The research on the application of satellite products in meteorology (operationally, for the purposes of hydrological and weather forecast: Land-SAF) and indirectly in climatology was carried out at the Satellite Remote Sensing Centre of the Institute of Meteorology and Water Management-National Research Institute in Cracow. The Centre began to operate in the 1960s and since 1967 the satellite products have been generated operationally.

Since the 1960s the Centre has had a station for satellite data reception and processing, which enabled the use of a dozen or so satellites of geostationary and circumpolar systems. In 2012, the Centre received and processed data from the geostationary satellites: METEOSAT-7, 8 and 9, and indirectly from: GOES-E, GOES-W, MTSAT2, from the polar satellites: NOAA-16, 17, 18, 19, METOPA, Fen-gYun-1D, from the circumpolar satellites: TERRA and AQUA, and from the new American satellite NPP placed on the orbit in October 2011. Since 1987 the archives of satellite imagery in the form of photographs from the earlier photorecorders (METEOSAT and NOAA) and raw satellite data have had digital form, enabling their processing into final products using any method (reprocessing). At present, satellite products are used in the LEADS and VMET visualisation and animation systems.

The research in this field focused on the use of satellite information for the purposes of meteorology and hydrology. Moreover, research was done on the use of satellite data in climatology, oceanology, agriculture and studies on the natural environment.

The Republic of Poland is a member of the international consortium EUMETSAT and takes an active part in the projects developed within the framework of its activities. Poland's delegates participated in the work of its bodies: STG – the Scientific and Technical Group, STG-SWG – the Science Working Group, STG-OPSWG – the Operations Technical Group and DPG – the Data Policy Group. Poland cooperated with the WMO in the work of the CAgM Task Team (the Commission for Agricultural Meteorology). In addition to the activities related to the use of the present EUMETSAT products, the aim of the work done by the Centre was also to implement the results of planned programmes, e.g. MTG (Meteosat Third Generation) from 2015.

Studies in the field of satellite imagery reception and interpretation were also carried out to a limited extent at several universities and research institutes of the Polish Academy of Sciences. The received data were processed into the form of images which could be animated and provided to the users. Satellite products were used in the customer service and forecasting systems. The most important types of satellite products which were developed and updated operationally included:

- satellite images in all the spectral channels of satellite sensors (calibrated and adjusted geometrically),
- selected RGB colour compositions from 3 channels,

- the products of satellite atmospheric soundings with ATOYS/NOAA sensors,
- the products of SatRep – satellite image analysis,
- specialised products for the Earth's surface (sea ice cover, snow cover etc.),
- products from other satellites retransmitted by the Meteosat and MSG systems: GOES-E, GOES-W, GMS and JNDOEX images,
- satellite products for the purposes of the media.

8.3.5. Monitoring of greenhouse gases

Six of the Polish measurement and observation stations operated within the Global Atmosphere Watch (GAW) set up in 1989. These stations carried out measurements in accordance with the requirements of the programme of regional GAW stations with an extended range. In addition, the stations at Jarczew, Śnieżka, Diabla Góra in the Borecka Forest and Łeba monitored the background atmospheric pollution under the EMEP Programme implemented on commission from the Chef Inspectorate for Environmental Protection within the framework of the State Environmental Monitoring System. In this scope, all the Polish stations implemented the basic (so-called Level 1) measurement programme, while Borecka Forest station carried out elements of the extended level.

The results of measurements from the GAW stations were forwarded to the archival resources of the databases of the European observation systems: EMEP and COMBINE/HELCOM, and via the EMEP to the global WMO/GAW system with its data centres: for greenhouse gases, the World Data Centre for Greenhouse Gases (WDCGG, Tokyo, Japan), for the chemical composition of precipitation, the World Data Centre for Precipitation Chemistry (WDCPC, Albany, USA), for the chemical composition of atmospheric aerosols, the World Data Centre for Aerosols (WDCA, Ispra, Italy) and for the ground-level ozone, the World Data Centre for Surface Ozone (WDCSO3, Tokyo, Japan).

The research on the state of the ozone layer over Poland and the UV radiation intensity measurements, carried out on commission from the Chief Inspector for Environmental Protection within the framework of the State Environmental Monitoring System, encompassed:

- measurements of the total ozone content in the atmosphere and the vertical ozone distribution,
- measurements of ozone profiles by the sounding method,
- the determination of the total ozone content fields over Europe by the satellite observing method (the development of a satellite map),

and

- measurements of the UV radiation intensity at the stations in: Łeba, Katowice, Legionowo, Mikołajki and Zakopane. The results of these measurements were forwarded to the Norwegian Institute for Air Research in Oslo, the World Ozone and Ultraviolet Data Centre in Toronto, Canada, and the Laboratory of Atmosphere Physics of the University of Thessaloniki.

CO_2 intensity measurements in the ground leyer of the atmosphere were carried out at the Borecka Forest station, monitoring the background atmospheric pollution, by the Institute of Environmental Protection – National Research Institute on commission from the Chief Inspector for Environmental Protection within the framework of the State Environmental Monitoring System. For 10 years the mean annual carbon dioxide concentration had shown a constant growing trend and in 2012 it reached a record value of 415 ppm. The highest values occurred in the period from September to November, which was defined as outstandingly

warm and wet. Over the dozen years or so the annual CO_2 concentration grew by about 4.5 ppm/year.

The CO_2 concentration growth in the warm half of the year – about 5 ppm/year
The CO_2 concentration growth in the cold half of the year – about 3.5 ppm/year

Fig. 8.1. The changes in the CO2 concentration at the station in the Borecka Forest (north-eastern Poland) in 2001-2012: the annual concentration and those in the warm half of the year (April-September) and the cold half of the year (October-March). Source: Chief Inspectorate for Environmental Protection within the framework of the State Environmental Monitoring System.

The mean monthly CO_2 concentrations most often reached the highest values in the cold half of the year, while the lowest ones occurred in the warm half of the year. This cycle resulted from the enhanced combustion of energy fuels in the heating season (winter) and the activity of the biosphere in the vegetation period (summer). The CO_2 concentration grew by about 5 ppm/year in the warm half of the year and only by 3.5 ppm/year in the cold half of the year.

The analysis of the mean hourly CO_2 concentrations shows different behaviour of seasonal variability: the highest and lowest values occurred in the warm half of the year while the average ones could be seen in the cold half of the year. The daily concentration level primarily depended on the meteorological parameters (air temperature and relative humidity), the frequency of the occurrence of temperature inversion and the levels of CO_2 emissions from soils. The mean concentrations behaved differently in the warm and cold halves of the year, depending on CO_2 emissions and the weather conditions. Overall, in the long-term period of 2001-2012 CO_2 concentrations were higher in the cold half of the year.

In Poland, the atmospheric concentrations of carbon dioxide and methane, the main greenhouse gases, have been regularly measured since 1994 at the measurement station in the High Mountain Meteorological Observatory on Mt. Kasprowy Wierch in the Tatra Mountains (49°14'N, 19°56'E, 1987 m a.s.l.). These measurements are carried out by the Environmental Physics Unit at the Faculty of Physics and Applied Computer Science of the University of Science and Technology (AGH) in Cracow, in cooperation with the Institute of Meteorology and Water Management-National Research Institute.

The Observatory is a unique research centre at the national level. Its situation in the undisturbed environment qualifies it for the reference networks of the climate stations of the World Meteorological Organisation and it is part of system of the Network of European High-Mountain Observatories.

The situation of the Observatory at a distance from local greenhouse gas sources guarantees that at least at some hours in the 24-hoor period (night hours) the station measures the concentrations of CO_2 and CH_4 characteristic of the so-called free troposphere. This means that the greenhouse gas emissions observed in these periods are characteristic of a large area of Central and Eastern Europe.

Figs. 8.2 and 8.3 show the variability of the carbon dioxide and methane concentrations on Mt. Kasprowy Wierch in the period from 1994 to 2012. This is an averaged record, based on selected measured data representing measurements in the free troposphere after incorrect measurements have been rejected and local effects have been filtered out. For comparison changes in the concentrations of these gases at the Mace Head measurement station, located in Ireland, are also presented.

The carbon dioxide concentration on Mt. Kasprowy Wierch grew from about 361 ppm (1 ppm = 10^{-6} mol/mol) in 1997 to 394 ppm in 2012 (Table 8.2, Fig. 8.2.), i.e. almost by 9%. A similar growth rate was observed at the Mace Head station. This growth was not uniform and in some years no significant change in the concentration was recorded (e.g. the years 1999-2001). This mainly resulted from variations in the intensity of the global carbon cycle related to the changing CO_2 emissions into the atmosphere (both anthropogenic and natural) and also related to the varying intensity of CO_2 absorption by the Earth's oceans.

Table 8.2. Changes in CO_2 and CH_4 concentrations in the atmosphere measured at the Kasprowy Wierch station in 1995-2012

Year	Mean annual CO_2 concentration [ppm]	Amplitude of seasonal CO_2 variations [ppm]	Mean annual CH_4 concentration [ppb]
1995	361.8	20.7	1849.9
1996	361.9	20.2	1851.8
1997	361.2	18.5	1843.3
1998	364.7	16.0	1851.6
1999	368.1	18.2	1860.5
2000	368.0	19.9	1870.7
2001	369.5	18.6	1868.2
2002	372.9	18.6	1888.6
2003	376.8	14.4	1866.4
2004	377.7	17.9	1861.4
2005	380.8	16.5	1862.5
2006	382.9	19.5	1860.7
2007	385.6	17.3	1865.9
2008	387.4	16.1	1880.8
2009	388.4	17.2	1882.7
2010	390.2	13.6	1885.3
2011	391.3	14.8	1880.4
2012	394.1	13.4	1888.4

Source: AGH.

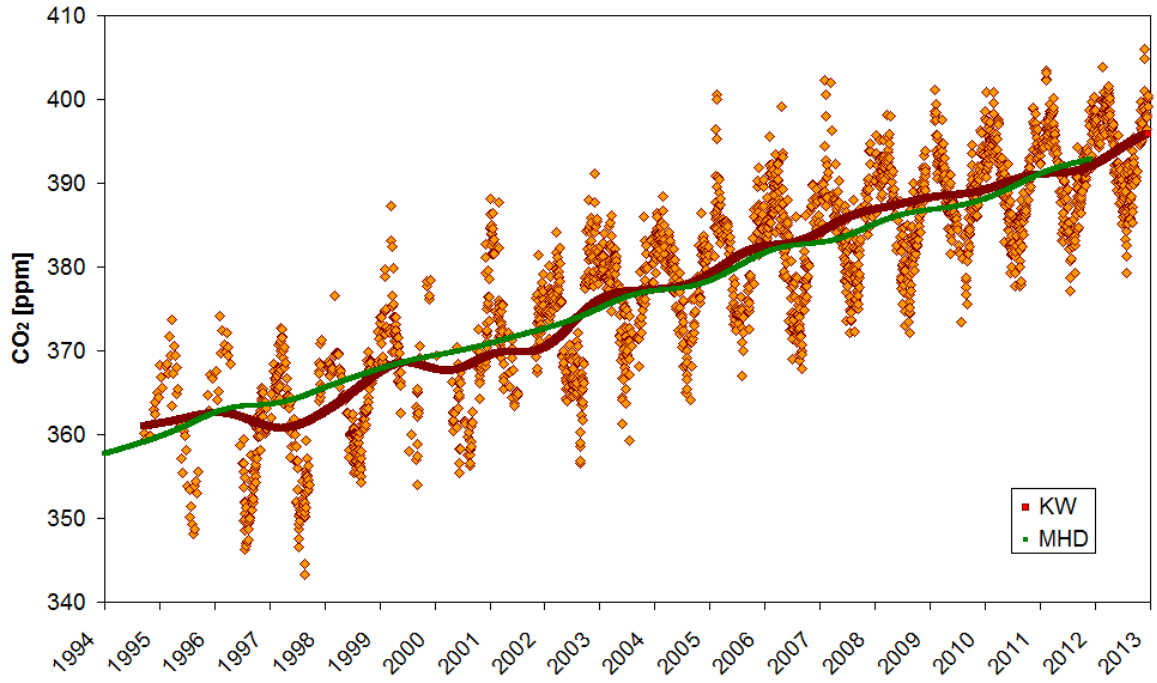


Fig. 8.2. Variations in the carbon dioxide concentration on Mt. Kasprowy Wierch in 1994–2012. The Figure shows, respectively, the selected and averaged monthly measured data representing the CO_2 concentration in the free troposphere (red colour). For comparison variations in the CO_2 concentration observed at the Mace Head Station (MHD) in Ireland are also presented (green colour, NOAA data). Source: AGH.

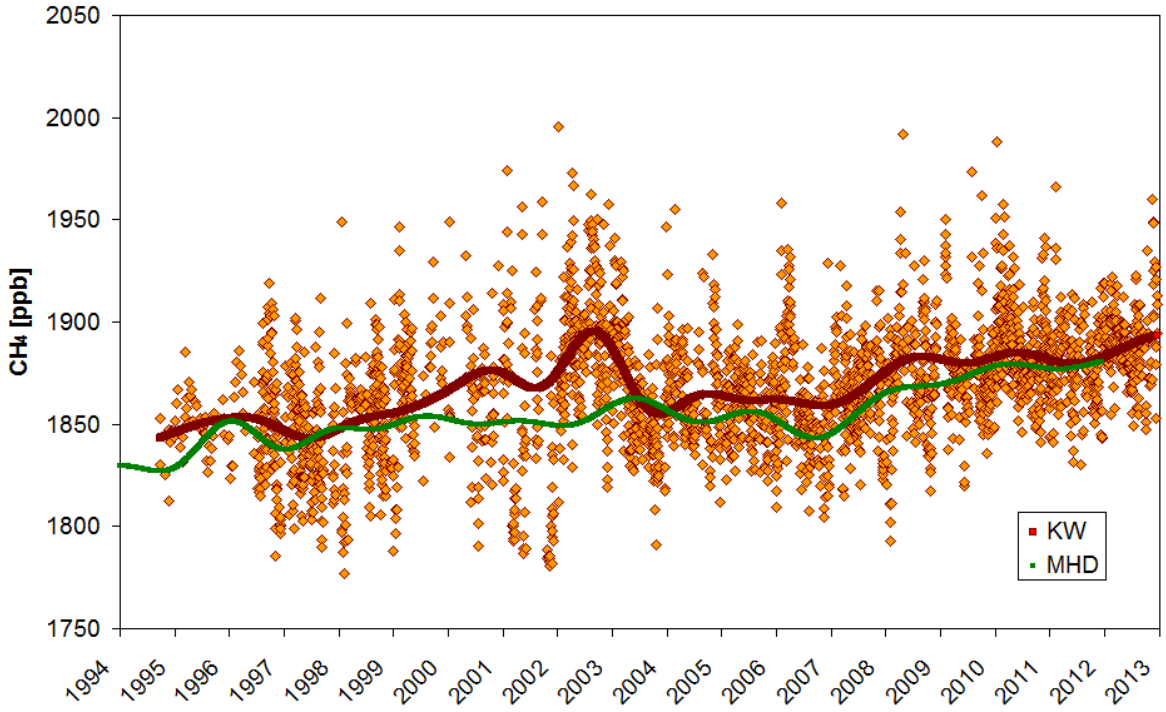


Fig. 8.3. Variations in the methane concentration on Mt. Kasprowy Wierch in 1994–2012. The Figure shows, respectively, the selected and averaged daily measured values representing the CH_4 concentration in the free troposphere (red colour). For comparison variations in the CH_4 concentration observed at the Mace Head Station (MHD) in Ireland are also presented (green colour, NOAA data). Source: AGH.

Since 1997 the team from the Department of Physicochemistry of Ecosystems at the Institute of Nuclear Physics of the Polish Academy in Cracow has carried out measurements of the concentrations of, and studies on, chlorofluorocarbons in the air in Cracow which contribute to the loss of stratospheric ozone and the enhancement of the greenhouse effect. Tables 8.3 present the annual concentrations of freons F-11 and F113, chloroform (CHCI3), methyl chloroform (CH3CCI3) and carbon tetrachloride (CCI4), and since 1999 freon F-12 and SF6. The aim of the measurements was to determine the impact of an urbanised area on the concentrations of the abovementioned compounds and to assess their emissions and sources of origin.

Table 8.3. Variations in the concentrations (ppm)_of chlororoflurocarbons in the air in Cracow in 1997-2012 – The arithmetic mean

DATA	F11	F113	CHCl3	CH3CCl3	CCl4	SF6	F12
1997	278.1	80.5	57.0	86.9	117.1		
1998	274.7	84.6	106.6	78.6	116.5		
1999	274.8	85.7	65.4	63.1	112.0	4.4	572.5
2000	279.6	105.2	136.2	49.5	175.0	4.8	554.7
2001	283.8	122.8	173.9	39.5	188.2	5.1	588.8
2002	265.2	90.7	39.1	32.8	106.6	5.3	556.1
2003	263.8	89.5	50.5	25.0	104.5	5.7	554.2
2004	257.9	91.6	47.5	20.6	104.0	5.9	549.0
2005	252.3	97.0	39.2	18.2	99.7	6.5	548.0
2006	255.9	93.8	42.8	14.4	104.9	6.9	551.5
2007	262.8	87.4	34.1	12.0	102.2	7.3	558.5
2008	272.2	86.9	23.9	10.5	98.2	7.7	539.4
2009	269.4	98.6	18.6	8.2	93.6	7.9	529.2
2010	274.7	115.1	30.6	7.8	97.7	8.1	524.8
2011	283.6	110.7	26.8	7.4	104.8	9.1	542.5
2012	260.7	83.1	32.8	5.6	87.9	8.7	536.7

Source: Institute of Nuclear Physics of the Polish Academy of Sciences.

CHAPTER 9. EDUCATION, TRAINING AND PUBLIC AWARENESS

9.1. Educational policy

All the final documents of the United Nations Conference on Environment and Development provide that education is the basis for the creation and enhancement of human capacity to solve the problems of environmental protection and for the implementation of sustainable and sustained development. The *United Nations Framework Convention on Climate Change* also emphasises the commitments of the Parties related to the need to raise public awareness and lists the relevant tasks in its Article 6. It recommends that appropriate educational programmes at the national level should be promoted, that public access to information on the environment should be ensured, that personnel should be trained and that cooperation and an exchange of experiences at the international level should be implemented.

Education is a process which can be implemented in institutionalised form as formal education at the different teaching levels, regulated by relevant programming documents. It can also be supported by many forms of informal education carried out by different scientific and public institutions outside of the education system, as well as by nongovernmental and church organisations. Education gained due to educational and promotional campaigns, including spots and educational programmes in the media, and spontaneous education through advertisements, films, entertainment programmes on television and as a result of different situations leading to an exchange of experiences, also play a large role. Large importance is also attributed to the education gained in the family. Each of these types of educational impacts should be addressed in their specific manner to all the citizens in the process of lifelong education.

In Poland, the need to raise the environmental awareness of citizens is emphasised in all the strategic documents concerning broadly understood environmental protection. This was taken into account in the *Second Environmental Policy, Poland 2025: The Long-term Strategy for Sustainable and Sustained Development* and *Poland's Climate Policy*. The *New National Environmental Policy in 2009-2912 with an Outlook until 2016*, adopted by the Council of Ministers in December 2008, places large emphasis on consumer education, recommending that a nationwide public campaign should be carried out to shape sustainable consumption patterns. In its directions of measures, the *New Policy* recommends that school education should be developed in the scope of environmental protection, that access to information on the environment should be facilitated and that behaviour consistent with the principle of sustainable development should be promoted. It also recommends closer cooperation with journalists on the education of all the social groups. In the *Act on Environmental Protection Law,* its Part VIII *Environmental education, research in the field of environmental protection and publicity* is devoted to the need for education. In turn, access to information is ensured by the *Act on the Provision of Information on the Environment and Its Protection, Public Participation and Environmental Impact Assessmen*ts in effect since November 2008.

In 2001, the *National Strategy for Environmental Education – Through Education to Sustainable Development*, in effect as the result of an agreement between the Minister responsible for education and the Minister of the Environment, was updated and strengthened with its executive programme. The plan laid down in it covers the individual age and vocational groups and sets out relevant tasks for the entities which carry out education and

proposes ways of its financing. According to the *National Strategy*, the responsibility for environmental education, including the education in the field of climate protection, rests on the Ministry of National Education and the Ministry of the Environment, as the leading entities, with the participation of all the other Ministries (particularly, the Ministry of Agriculture or the Ministry of National Defence) in the scope consistent with their competence. The Ministry of Foreign Affairs has also a special role to play in this respect, as it develops the field of development education which addresses climate issues at the global level, including Poland's responsibility for assisting in the process of improving the capacity to adapt to climate change in developing countries. In 2005, in Vilnius, the UNECE *Strategy Education for Sustainable Development* was adopted at the High-Level Meeting of Education and Environment Ministries. The Strategy, which has been translated into Polish, has been available since 2008 on the website of the Ministry of the Environment, providing valuable guidance for the implementation of comprehensive educational measures, also including the field of climate protection. Within the Ministry of the Environment, the education issues fall within the responsibility of the former Department of Environmental Education, which changed its name to the Department of Environmental Information in 2012.

9.2. Education in the formal education system

The education system in Poland encompasses upbringing at kindergartens, primary schools (the first and second stages of education) and post-primary schools: gymnasiums, post-gymnasium schools, i.e. general and specialised comprehensive secondary schools, basic vocational schools, post-secondary vocational schools and higher education establishments. The Act on the Education System (amended in 2003) provides that "The education system shall ensure in particular (…) the dissemination of the knowledge of the principles of sustainable development among children and youth and the development of attitudes conducive to its implementation at the local, national and global levels". This very provision gives a green light for the education on climate.

The main document which sets out the mandatory content of education establishments is the *Curriculum for Upbringing at Kindergartens and General Education in the Individual School Types*. The *Curriculum* is the principal instrument which regulates the education programmes, the contents of handbooks and the manner of internal and external evaluation. Since 30 January 2009, the Curriculum in effect from February 2002 (along with a number of additional amendments to it, with the last one published in the Official Journal of the Laws of August 2007) has been successively replaced by the Regulation of the Minister of National Education of 23 December 2008. Specifically, the new Curriculum of 2009 has covered the upbringing at kindergartens and has already been fully implemented in them. At primary schools, the new curriculum for general education at primary schools, as laid down in the Annex to the Regulation, was introduced in the school year 2009/2010 in Form I; thus, in the school year 2012/2013 it applies to all the pupils in the first education stage (Forms I-III). The curriculum for general education in gymnasiums has been applied since 2009/2010 in Form I of gymnasiums, whereas in the other Forms the previous curriculum was in effect until the completion of the education cycle. Starting with the school year 2012/2013, the curriculum from 2009 came into effect in Form I of general and specialised comprehensive secondary schools and technical secondary schools, while in 2015/2016 it will become effective for Form I of the supplementary comprehensive secondary and technical secondary schools.

Thus, in the Forms of post-gymnasium schools where the old curriculum is still continued, the subjects related to the issues of sustainable development and climate change are covered as part of different science classes and also in the course of the implementation of the horizontal course on "environmental education". The education contents for these schools include such subjects as the causes and effects of undesirable changes in the atmosphere, biosphere, hydrosphere and lithosphere; the threats for the environment caused by energy production and transport, nuclear energy generation – safety and waste storage; the functioning of Earth's natural system – phenomena, processes, the variability of the environment in time and space, weather variations, natural disasters, ecological equilibrium; threats posed by human development in relation to conventional and nuclear energy generation. Renewable energy sources.

The expected students' achievements include the knowledge of the causes of the present state of the environment, the knowledge of measures to tackle the unfavourable changes and the perception of the relation between the elements of the environment and human activities at the global scale. The aim of the education is to take the responsibility for activities which may have an impact on the environment.

The provisions presented above have already ceased to apply at those education levels where the curriculum in effect since 30 January 209 has already been implemented. In the new curriculum, a good deal of attention is also paid to the different aspects of climate change. One of objectives of upbringing at kindergartens is to *help children understand the atmospheric phenomena and to avoid dangers.* As regards primary schools, both in the first education stage (Forms I –III) and in the second stage (Forms IV –VI), the required education contents and the competences gained by pupils include the impact of daily behaviour on the state of the natural environment and proposals of measures which are favourable for the quality of the environment.

The new *Curriculum* for general education at gymnasiums and post-gymnasium schools indicates as an its important objective the achievement of efficient education in the scope of natural and exact sciences, in accordance with the priorities of the Lisbon Strategy. In its part concerned with local and global environmental problems, the new *Curriculum* provides that: *the student will discuss the causes and analyse the effects of global climate warming.* As an achievement of education, the student will propose e.g. measures to reduce water and electricity consumption in a household.

The pupils which do not choose an extended course on the individual natural subjects in the fourth education stage attend, instead, classes in the course on *Nature* which addresses problematic issues. E.g. this can be the greenhouse effect in physical terms: the controversies concerning the human impact on its enhancement. In general, the aim of the contents of education within this course is to address the individual issues of nature-related knowledge concerning the important issues of our civilisation.

In the curriculum for basic vocational secondary schools, a good deal of attention is paid to the efficiency of teaching natural and exact sciences, in accordance with the priorities of the Lisbon Strategy. Apart from offering vocational skills, the purpose of these schools is to provide their graduates with a basic resource of general knowledge.

According to the *Curriculum* from 2009, the pupils achievements at all the types of schools will include: *the assessment of changes taking place in the natural environment as a result of human impact and their influence on the quality of life and the ability to find remedial measures.*

It is yet difficult to assess how in practice the slightly different situation of the fields of education designed to enhance knowledge concerning the environment will work; here, the absence of environmental education courses integrating nature-related and social issues may give rise to concern. In view of this, in order to take into account to a much more substantial extent the issues related to a broadly conceived scope of sustainable development, in 2013 the Ministry of the Environment initiated the work to prepare thematic complements to the curriculum to be negotiated with the Ministry of Education.

According to the report "Proposed changes to the Curriculum for upbringing at kindergartens and the general education at primary schools, gymnasiums and comprehensive secondary schools in the scope of its contents concerning environmental protection and sustainable development", prepared on commission from the Ministry of the Environment in 2013, the Curriculum enables the delivery of climate education to students of Polish schools, ensuring that they become acquainted with the causes and effects of climate change.

The Curriculum can be effectively implemented when there are competent handbooks, attractive auxiliary materials and well-prepared teachers. The preparation and production of good materials assisting in the teaching process are supported by grants from the National Fund for Environmental Protection and Water Management, as well as those from the Voivodeship Funds. A good example of such enhancement of climate education can be the multi-media teaching aids entitled "Under the Dome or the Weather Forecast" by Witold Lenart (a handbook, class scenarios and a set of DVD films) recommended by the Minister responsible for education and upbringing and funded by the National Fund.

In order to improve the competences of teachers in the delivery of classes and incorporate the principles and practices of sustainable development in the taught subjects, including the issues related to the prevention of climate change and the adaptation to the change, in 2010 the Department of Environmental Education of the Ministry of the Environment commissioned the delivery of training courses for teachers of post-gymnasium schools all over the country. In the school year 2011, such a series of training courses was delivered by the academic teachers from the University Centre for Environmental Studies of Warsaw University and an Internet-based course for teachers "How to Teach Sustainable Development" was also developed; it is available on the website of the Ministry of the Environment in its part concerned with education.

Apart from the education ensuing from the implementation of the Curriculum, a hands-on example of the introduction of the principles of sustainable development in the practice of the management of a school plays a very important role in the shaping of pupils' attitudes. Such good models are provided by diverse activities of the school management ensuring energy saving or waste segregation. These efforts are evaluated as schools seek the Green Certificate. This is as system of evaluations of educational establishments run by the Environmental Education Centre under the patronage of the Minister of the Environment in terms of their comprehensive approach to environmental issues, as regards both teaching innovations and the care of the environment. To date, several hundred Green Certificates have been awarded in the whole of Poland; unfortunately, because of a lack of funds, the programme ended in

2010. At the international level, schools are certified by the Environmental Partnership Foundation within the framework of the School for Sustainable Development. Based on the evaluation of reported comprehensive activities of educational establishments, the title of the Local Centre of Environmental Activity is conferred. This is the first stage in the process of seeking the award of the international Green Flag label of the first and second degrees. This is a certificate based on environmental management systems and the Environmental Partnership plays the role of the national coordinator. Just in 2010, the Jury of the Green Flag awarded the Flag to as many as 69 schools in Poland. Three schools were awarded the highest degree of the Flag conferred for three years.

The formal education system also includes universities. They are regarded as the final stage of the process of the preparation of specialists able to introduce in practice the principles of sustainable development and to take measures related to climate protection. The *environmental protection* course is offered at the majority of public and private universities as a specialisation or a separate faculty and many studies of this type are international in character, such as the Inter-Faculty Studies in Environmental Protection at Warsaw University or even operate on an inter-university basis. In the case of universities, in order to improve the teaching process, every year methodological conferences on *Environmental Protection in University Courses on Natural Sciences* are organised at different universities. According to the data of the Ministry of Science and Higher Education, in 2010, the students of environmental protection represented 1.4% of almost 2 million persons attending Polish universities, more than of which (the total of 28,000 students at all the years) study in technical fields, such as environmental engineering. The classes delivered within the framework of intramural and extramural studies also offer to working persons an opportunity for obtaining their diploma. The fact that the curricula of the studies which prepare staff for the administration include to some extent scheduled classes in the management of environmental protection should be considered a positive arrangement. Apart from the principal courses, many universities also offer lectures addressed to all the students enabling them to become acquainted with the most important environmental challenges related to human development. The series of open popular science lectures delivered for many years by the University Centre for Environmental Studies at Warsaw University and the Centre for the Study on Man and the Environment of the University of Silesia have such a character. In recent years, most of these lectures were devoted to the different aspects of global climate change. Universities also carry out educational and popularising activities for the general public, organising open days and participating in the Science Festivals organised by the Copernicus Science Centre or the Science Picnics of the Polish Radio. In addition, many interesting educational projects in the field of climate protection which raise students' environmental awareness are launched by Students' Scientific Societies. An example of this is the Conference on Light Pollution convened in 2013 together by the Scientific Societies of the Inter-Faculty Studies in Environmental Protection at Warsaw University and several other universities, showing e.g. the impacts on the environment, including energy consumption, caused by excessive lighting of non-built up space.

9.3. General information on training courses

Apart from the formal education at all the levels and the educational activities addressed to wide groups of society in order to shape environment-friendly habits, specialist vocational training courses are also necessary. They are diverse forms of improvement courses, which

raise the level of vocational knowledge in all the aspects related to the environmental protection. Such training courses are applied by companies which intend to implement the quality standards, e.g. ISO 140001, and train all their staff. Training courses for entire sectors are also organised, such as the one in the *Responsible Care* Programme in which several hundred companies in the chemical sector participate. Many training courses are addressed to individual vocational groups and they are organised by different institutions, such as e.g. the training courses organised in the field of sustainable development (in particular, energy savings) for craftsmen within the framework of the EU Grundtvig programme. Certain academic centres and nongovernmental organisations deliver training courses in the field of environmental impact assessments, both for the institutions which carry out the assessments and those for which they are performed. The training courses are also carried out for the representatives of local authorities and self-governments, e.g. on the provision of access to environmental information in practice or training courses in the scope of air protection and the sustainable development of cities. There are also training courses for farmers, which include examples of "good practices" minimising the adverse impact of agriculture on the growth of greenhouse gas emissions and the use of renewable energy sources. The Agricultural Extension Centre in Przysiek is particularly well known for its training courses for farmers.

Training courses in the field of air protection are organised within the framework of the programme to train the human resources of environmental protection, e.g. at the Central Training Centre of Environmental Protection and Water Management Staff in Dębe near Warsaw. In turn, the training courses on the sustainable development of cities are organised within the framework of the project Green Cities – Towards the Future! addressed to the representatives of self-governments. The training courses present examples of modern space management that is friendly for residents and the environment and the benefits which this brings for the residents. The Ministry of the Environment also implements a programme of vocational traineeships for students and the graduates from public and private universities at the Ministry itself and at the supervised ministerial institutes.

In respect of the improvement in the quality of formal education, different training courses complementing knowledge in the field of climate protection and raising the methodological competences of teachers and educators (i.e. persons which teach at establishments other than schools) are of key importance. Such training courses are delivered by the National In-Service Teacher Training Centre (CODN), Regional Methodological Centres and universities. They also include post-graduate courses for teachers which train them in the contents and methods of environmental education, such as those carried out at Warsaw University and at the Cardinal Stefan Wyszyński University. In recent years, the basic subjects of training courses included the issues related to the explanation of the causes and effects of climate change. These training courses are addressed not only to the teachers of natural sciences. A good example of this is the abovementioned series of training courses "How to Teach Sustainable Development" for teachers organised on the initiative of the Ministry of the Environment in 2011, in which, based on its very assumption, the teachers of both natural sciences and humanities participated. The training course organised for its members by the Association of Forest Educators in 2013 also covered the issues of the methodology of education concerning e.g. the role of forests in adaptation to climate change.

In the case of teachers, many teaching programmes assume cascade arrangements for them, i.e. the trained persons are obliged to pass the knowledge which they have acquired to their colleagues in the educational establishments.

9.4. Education outside the formal education establishments

Apart from the curriculum-based activities in the education system, different types of educational, promotional and information measures are also carried out by the state administration institutions, scientific centres and environmental nongovernmental organisations (ENGOs). A large part of these activities is carried out by the Ministry of the Environment under the patronage of the Minister.

An example of such an activity carried out by the Ministry of the Environment is the nationwide educational campaign conducted in 2012 on climate change and greenhouse gas emission reductions called "We Switch Off Electricity, We Start to Save" as one of the elements of the long-term educational programme of the Ministry of the Environment. The aim of the campaign was to encourage the Poles to save energy in households. Its TV component was accompanied by an Internet-based campaign.

Another example is the Project "Educational and promotional activities in the field of energy efficiency and the use of renewable energy including environmentally friendly houses", co-financed with the resources of the EEA Grants.

These activities include the educational and promotional campaign on climate change announced by the European Commission. Its aim is to shape the awareness that the activity of everyone can contribute to greenhouse gas emission reductions through their activity. Within the framework of this campaign, e.g. TV commercials and a number of sponsored radio programmes were created. A large campaign which is conducted throughout Europe is the European Day Without Cars celebrated every year in September. The aim of this campaign is to make the public aware of the impact of transport on greenhouse gas emissions and to promote the public urban transport and bicycles as alternatives to individual car transport. The Ministry of the Environment prepares promotional posters and ensures the media coverage of the Day. In this field, the promotion of a bicycle rental system organised in Warsaw in 2013 is also of large importance.

One of the largest events promoting environmental protection among the wider public is the nationwide celebration of the World Earth Day which has been organised since 1990 in Poland. Every year the celebration of the Earth Day, coordinated by the Environmental Education Centre Foundation, includes some elements related to energy saving (in 2008, it encouraged measures for climate) and CO_2 emission reductions. The aim of a very extensive agenda of the celebration of the Earth Day is to raise the environmental awareness of different social groups using a great variety of means. The information on the measures to mitigate the impacts of climate change reaches all the residents of Warsaw through different means of communication (workshops, concerts, educational games) in the course of the festival in the

Pole Mokotowskie Park broadcast by the Polish Television on a nationwide basis. It is estimated that every year a dozen or so thousand persons participate in the festival.

The World Environment Day celebrated on 5 June provides an opportunity for a wide presentation of nationwide and local measures to protect the climate. The national celebrations which are organized every year in a different Voivodeship emphasise local measures and also present the efforts taken by services and especially meritorious professionals. Similarly, the POLEKO International Trade Fair, which takes place every year in Poznań, is accompanied by a large number of seminars and educational events. The fair exhibitions presenting the most advanced technological solutions which serve e.g. to save energy and to acquire it from alternative sources are visited not only by professionals, but also by school students.

A strong educational base is a network of regional environmental education centres managed by local governments or nongovernmental organisations and centres operating at national and landscape parks. They conduct diverse forms of activities – regular classes, workshops for teachers or thematic competitions and campaigns – which involve local communities and support formal education. The individual activities of different organisations which are engaged in the popularisation of knowledge about the threats related to climate change have been strengthened by the cooperation within the framework of the Climate Coalition. The Coalition is an open agreement concluded by a group of ENGOs (e.g. the Lower Silesian Foundation for Sustainable Development, the Aeris Futuro Foundation, the Polish Foundation for Energy Efficiency, the "Green Action" Legnica Land Environmental Foundation, Greenpeace, the Ecology Foundation ARKA, the Institute for Sustainable Development, the Gaya Club, the League for Nature Protection, the Polish Green Network, 4 Branches of the Polish Ecological Club, the Social Ecological Institute, the Ecological Association Eko-Unia, WWF, Green Mazovia). The Coalition organises workshops, conferences and thematic training courses related to climate change and conducts information campaigns through its website. Apart from the joint actions, each of the organisations has its specificity which is manifested in the forms of education which they carry out.

The expert organisation called the Institute for Sustainable Development (ISD) is particularly very active in the scope of issues related to climate change. E.g. since 2012 the ISD has implemented a nationwide educational project called "Climate and Agriculture" and the project "The Climate for Counties". The preparation of "A Little Lexicon for Journalists Concerning Energy Generation Based on Renewable Energy Sources" has been a particularly valuable initiative supporting the popularisation of climate issues in the media. The Institute carries out many other popularising and educational activities within the framework of the project "Innovation for Climate Protection". In turn, the Aeris Futuro Foundation implements the project "Time for Forest" which makes it possible to offset CO_2 emissions by planting trees in the different regions of the country. In cooperation with the State Forests, the Foundation organised a campaign to plant 7,000 trees in the area of Łódź. The project is part of an international campaign conducted under the patronage of the UNEP and that of the Ministry of the Environment in Poland. Similarly, the Gaya Club has chosen trees to offset carbon dioxide by running the Tree Day campaign on 10 October when people all over the world do it. The aim of the programme where the State Forests is a partner is to mobilise local communities, particularly children and youth. Anyhow, the theme of a forest as an ally in the struggle against global warming is an important issue at the classes delivered in the very extensive system of education conducted and funded with its own resources by the State

Forests. It is also promoted during the national celebrations of a new action to popularise forests - the Feast of the Polish Forget-Me-Not.

At the interface between the education at schools and the one conducted by nongovernmental organisations, there is the Eco-teams Programme initiated in Poland by the GAP Polska Foundation. It consists, among others, in the creation of school teams and their rivalry in reducing the waste of energy and adopting an environment-friendly lifestyle. The GPA Foundation adapts the footprint calculator to the Polish conditions and also trains the leaders of school-based environmental campaigns. The organisation called the Saint Francis of Assisi Movement (REFA) shows a very large educational activity, particularly as regards the shaping of environmental ethics. Its climate education and the promotion of individual preventive measures are also addressed to senior citizens. E.g. since 2012 the Foundation Earth and People has conducted the Green Knowledge programme on sustainable development for the members of the Universities of the Third Age called "The Future We Wish for Our Grandchildren". To a large extent, this programme covers the issues related to the mitigation of the impacts of global warming and adaptation to climate change and it is addressed to the elderly, with the assumption that they will also share this knowledge with their grandchildren. An educational brochure was published and a series of lectures and discussions with very high attendance took place in several dozen Universities of the Third Age. Other Universities of the Third Age associated in the Federation of the Universities of the Third Age, including more than 800 establishments throughout Poland, are encouraged to take the offer of Green Knowledge. The programme was funded from the Civic Initiatives Fund.

It is impossible to mention all the educational initiatives implemented within the framework of informal education. Even a handful of selected examples demonstrates the large activity of organisations and institutions, their potential and the diversification of the forms of the education which they conduct. All these activities also fall within the implementation of the Decade of Education for Sustainable Development declared by the United Nations for 2005-2014. Indeed, one of the tasks of the Decade is the strengthening and coordination of education conducted in accordance with the recommendations of two conventions: both the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change, since many fields of education are common. In order to coordinate and ensure a better flow of information on the course of the Decade in Poland, on the initiative of the University for Environmental Studies, the Working Group for the Decade of Education for Sustainable Development has been established. The Group, to which the Polish UNESCO Committee has extended its patronage, consists of the representatives of key Ministries, educational institutions and nongovernmental organisations which are involved in education for sustainable development.

9.5. Participation in international activities

There is practically no large international programme related to environmental protection in which Polish schools do not participate to a larger or greater extent. In this respect, an example can be the GLOBE Programme (Global Learning and Observations to Benefit the Environment) which has been present in Polish schools since 1997 when an agreement was signed between the Polish Ministry of National Education and the United States National

Oceanic and Atmospheric Administration. In Poland, the Programme in which more than 20,000 schools from 110 countries participate, is coordinated by the Environmental Information Centre UNEP/GRID operating at the National Foundation for Environmental Protection. An important part of the programme consists of systematic observations of the environment, also concerning air pollutants and temperature measurements, which are subsequently forwarded and stored at the NASA database. As statistical data indicate, the largest number of data comes from observations made by Polish schools. Another important international programme is the Baltic Sea Project implemented by the countries of the Baltic Sea Area and involving the UNESCO Schools Network. The Baltic Sea Project consists in an exchange of information and cooperation among schools in projects enabling pupils to become acquainted with different elements of the environment and to protect them, including air protection and energy saving. Successively, each country coordinates the cooperation and is responsible for the publication of its bulletin (in 2007, it was Poland's turn to coordinate it).

Here, one should present the activities of the United Nations representations in Poland which are involved in the promotion of the activities of its agencies, publishing the relevant educational materials and organising educational actions. In cooperation with the Bank for Environmental Protection, the Environmental Information Centre UNEP/GRID prepared an educational material, which was a translation of the official UN guide, entitled "Kick the Habit – Be Environment-Friendly".

Different international organisations, scientific institutions and cultural representations also carry out their activities in Poland in the scope of climate education. The British Council implements one of the most comprehensive and long-term programmes addressed to different social groups. The programme of the British Council for 2007-2011 called Challenge Europe was addressed to young university graduates aged 20-30 which were "climate champions". The Programme consisted of special training courses, study visits, meetings with experts and assistance in managing diverse own projects enabling the transfer of acquired knowledge to the professional community of each of the "champions".

Another good example of international and bilateral cooperation are the educational activities carried out under the patronage of the embassies of European countries. The information campaign conducted by the Danish Embassy on environment-friendly energy, which also promoted education to improve energy efficiency in households, had exactly such a character. This campaign took place under the patronage of the Ministers of the Environment of Denmark and Poland. In addition, other embassies also organised a series of seminars, workshops, study visits and conferences addressed to different groups of participants. In the course of these activities, experts from individual countries present specific solutions contributing to the development of energy generation from renewable sources and new low-emission technologies. Other international organisations and those that represent individual countries also participate in the educational activities. An example of them can be the series of seminars, workshops and conferences organised by the Heinrich Böll Foundation within the framework of its regional programme (Poland, Germany and the Czech Republic) called *Energy Policy and Climate Protection.* The aim of the programme is both to educate and to draw the attention of the public to the importance of the issues related to the prevention of climate change.

Many programmes conducted by the Environmental Partnership Foundation have a similarly regional character. The Foundation, which is the continuator of the Programme

"Environmental Partnership for Central Europe" (implemented by the American Foundation The German Marshall Fund of the US in the 1990s in Poland and other Central European countries), supports the activities for sustainable development by building partnership and disseminating environment-friendly patterns of activities. In the field of climate protection, the Greenways Programme is particularly important; it promotes environment-friendly transport and tree planting along the old routes connecting Central Europe. Similarly, the Clean Business Programme contributes to climate protection, promoting novel environment-friendly initiatives among small and medium-sized companies, including energy saving. The cooperation between the Environmental Partnership Foundation and the British environmental organisation Groundworks plays a special role in creating "clean business". The Foundation also coordinates the programme which was already described previously, i.e. the award of the international certificate of the Green Flag to schools.

An example of a bilateral exchange of educational experiences is the fellowship programme for graduates from environmental protection faculties at Polish universities which is offered by the German foundation DBU. The persons selected for the grant of fellowships can improve their competences further at German institutions and enterprises, gaining practical experience in different fields of environmental protection. In 2013, the 17th edition of the programme took place. The organisation called the Polish-German Youth Cooperation is also particularly active in the Polish-German bilateral cooperation. Every three years this organisation organises the competition for the Polish-German Youth Prize. In 2013, the subject matter were the issues in the thematic field of the United Nations Decade for Education for Sustainable Development. Educational meetings of young people brought many incentives which led to the implementation of diverse projects, including those in the field of climate protection. The prizes were handed out in Berlin in February 2013 in the course of the Polish-German Youth Summit called "Designers of the Future".

An international exchange of experiences in the field of education for climate is particularly obvious in the case of the Regional Environmental Centre for Central and Eastern Europe (REC), given the close cooperation among all the country offices of the REC. E.g. the Polish REC Office disseminates the multi-media educational set for schools called "The Green Pack" concerning the issues of sustainable development and global problems, such as climate change, which has been adapted to the Polish conditions. At the end of 2012, the REC prepared a successive comprehensive educational material called "The Blue Pack" dedicated to water, also in the context of global warming.

Polish organisations and universities participate as partners in many projects designed to disseminate the knowledge and lifestyle related to climate change, which are financed from the European funds, such as Grundtvig or Socrates. These projects produce teaching materials or different types of training courses addressed to various audiences. An example of the international cooperation within the framework of the EU Comenius Lifelong Learning Programme can be the educational project called BEAGLE conducted by a consortium of 6 countries, i.e. Poland, Great Britain, Slovakia, Germany, Norway and Hungary. It consisted in the preparation of teachers for arranging pupils' observations of the impact of climate change on the dates of the phonological phases of the same tree species in different European countries. The project, which was concluded in 2010 with the publication of educational materials and an operational website to collect data from pupils' observations, was coordinated by the University Centre for Environmental Studies.

A similar case of involvement in international activities was Earth Hour, coordinated by the WWF, consisting in the simultaneous switching off of the lights as a sign of solidarity with the measures to protect the climate.

The examples of international cooperation given above are only a selected part of joint projects which were carried out in recent years; however, they very clearly illustrate the degree of utilisation of a wide spectrum of the possibilities for a global transfer of knowledge and experiences in the field of education concerning climate change.

9.6. Education and the raising of the environmental awareness of business

There is a very distinct tendency for the private sector and different business institutions to become involved in activities contributing to the raising of awareness in their own enterprises and to launch or sponsor external actions to educate society in the field of climate. In doing this, they often emphasise their own achievements in the field of energy saving and reductions in the emissions of air pollutants as an example of good practice. Together with the Institute for Sustainable Development, the Bank for Environmental Protection has launched the pilot project called "Zero Emissions", within the framework of which the Bank has been the first financial institution to subject itself to a broad, comprehensive audit in order to examine the impact of the operations of the Bank on the status of the climate. The results of the audit will influence the environmental awareness of its staff, leading to changes in the manner of its management into a more environment-friendly one. Similarly, the purpose of the activities of the owners of small and medium-sized enterprises associated in the Clean Business Clubs is to ensure that they are managed in such a manner or shift to such operations that minimise their adverse impact on the environment. The companies which participate in the Clean Business Programme become involved in the development of the localities and regions where they operate, thus demonstrating that the development based on environmental and social responsibility is possible and that it is a precondition for building a modern economy. In 1998-2008, more than 5,000 enterprises participated in this programme so that the impact of their example on the improvement in the environmental awareness of other entrepreneurs can be very large. Business also initiates many activities to shape the awareness of children and young people. An example of this are competitions of educational character and those that inspire to make observations on the environment: photography competitions for youth and drawing competitions for children organised by the Bayer Company. Hewlett-Packard organises a competition of Master Theses, while the Ford Foundation awards prizes for the most interesting activities of nongovernmental organisations. Corporate staff volunteers play an increasingly large role in shaping the environmental awareness, including e.g. the individual employee actions for the environment inspired by the Foundation of the Bank for Environmental Protection. The efforts taken by business to be awarded the Green Office certificates for sustainable management and the Green Shop certificate established in 2012, which are sought by more and more enterprises in Poland, play a similar educational role with respect to employees.

9.7. The role of the media

The surveys carried out by Burger in 2005 indicate that the Poles gain on average more than 63% of knowledge on the environment from the media and that the role of the media as the main source of information grows as the time passes from the completion of formal education to more than 75%. The role of the media grows dynamically and, as indicated by the 2012

poll by TNS Polska, television is the main source of environmental information for 77% of the Poles.

Television and radio play a special role, since, in contrast to the press, they can be found in almost all households and also make it possible to watch on a current basis reports from places affected by climate change impacts and to present live experts and politicians' debates. Through announcements on the radio and thematic broadcasts, the Ministry of the Environment encourages drivers to reasonably use individual car transport and supports public city transport, cycling and walks, which would contribute to CO_2 emission reductions and an improvement in the air quality in cities.

An example of this can be the television campaign "We Switch Off Electricity, We Start to Save" which reached 93.4% of the target group (anyway, such a percentage of viewers saw the TV spot of the campaign) – there were a total of 3,453,588 persons in this group.

In addition to the productions which emerged on the initiative of the media themselves, many regular radio broadcasts (e.g. the series on renewable energy sources) and television shows have been financed by the National Fund for Environmental Protection and Water Management. Such programmes include e.g. the 12-episode series of educational films for young people broadcast by TVP. Still, although Polish Television S.A. declares that it treats the broadcast of environmental programmes as an integral part of its public mission, more often than not it does not air them at good time.

The role of the press has diminished, but still 22% of respondents learn from it about the environment. That is why the participation of the media is so important for climate education (as provided for in Article 6 of UNFCCC). In recent years, the involvement of the media in the education for climate has intensified; still, each of their types demonstrates it in a different manner. The specialist press, which consists of about 90 titles, devotes most space to it. It includes both the sectoral periodicals, such as the quarterly *Ocen Oddziaływania na Środowisko* (Environmental Impact Assessments) or *Gospodarka Wodna* (Water Management), and those addressed to the environmental administration, such as e.g. *Środowisko* (The Environment) or to entrepreneurs (*Biznes i Ekologia.* (Business and Environmental Protection). Popular science periodicals, such as *Aura* or those published by nongovernmental organisations, such as *Dzikie Życie* (Wildlife) or *Biuletyn Polskiego Klubu Ekologicznego* (The Bulletin of the Polish Ecological Club) are addressed to those who are interested in environmental protection. These periodicals play an important role in the information flow in the communities which are connected with environmental protection professionally or as a hobby, although, as indicated by press research, their readership does not exceed 2% of press readers in Poland. The nationwide press plays the largest role in reaching the wider public; more and more frequently, the main national dailies *Rzeczpospolita* and *Gazeta Wyborcza* publish articles dealing with the causes and effects of global warming and their economic and social implications. With its publications, *Gazeta Wyborcza* has been one of the first newspapers to become engaged in the Partnership for Climate action, thus emphasising its long-term involvement in the provision of information on climate change. From time to time, *Rzeczpospolita* features an insert sponsored by the Ministry of the Environment which presents the directions of Polish activities related to climate protection, e.g. the state and advantages of energy generation from renewable sources. The large opinion-forming magazines, such as the weekly *Polityka*, also influence with their articles the shaping of the public awareness of the threats posed by global warming.

Several hundred titles of the local press covering regional problems, e.g. the emissions of air pollutants, or giving practical advice on energy saving and other environment-friendly consumer activities, play a large role in reaching the residents of smaller localities. There is no doubt that international events, such as the organisation of the 14th Conference of the Parties to the Framework Convention on Climate Change, commonly called the Climate Summit, in Poznań, play a special role in strengthening the public interest in the causes of global warming. Due to the fact that this important international meeting took place exactly in Poland, the frequency of information grew in the media. Similarly, the subsequent Climate Conference in Poland made the media more active. TV debates took place more often than usual and information and discussion articles appeared in the press. It should be hoped that the Climate Conference in November 2013 in Warsaw will also meet with a more vigorous media response.

In Poland, the journalists who specialise in environmental issues, including those of energy policy and climate protection, are associated in the Club of Environmental Journalists EKOS. The Club organises training courses and study visits for them to gain more knowledge concerning climate change and to improve their journalism competences. Quite many valuable materials were created as a result of the competition *The Climate for Climate* for the press, radio and television journalists, organised in 2008 by the Climate Coalition, under the patronage of the EKOS Club, for the best material on climate change and protection.

9.8. The use of the Internet in education

The role of the Internet as a modern medium serving to disseminate information and supporting environmental education grows from year to year.

According to the 2012 poll by TNS carried out on commission from the Ministry of the Environment, the Internet is the main source of information on the environment for 23% of the Poles. In particular, this is the case with younger age groups. In accordance with this trend, the Ministry of the Environment runs the information portal www.ekoportal.gov.pl, where it places e.g. up-to-date information concerning environmental policy and the issues related to climate change. In parallel, the Ministry runs the educational website addressed to children http://dzieci.mos.gov.pl, disseminating the knowledge about the environment in the form of educational fun and games and promoting environment-friendly behaviour. The tab for teachers in this portal provides the information concerning education for sustainable development and scenarios for educational classes.

The Ministry of the Environment usually supports the television campaigns with an Internet-based campaign. E.g. the range of the audience generated by the Internet-based campaign "We Switch Off Electricity, We Start to Save", calculated as the number of unique users, was more than 5 million users.

In addition, the Ministry runs the portal www.ekoszyk.pl, promoting the fashion for the appropriate consumer behaviour and giving practical guidance on living in harmony with the environment.

In 2013, in cooperation with the Institute of Environmental Protection, the Ministry of the Environment launched the information and educational portal **klimada.mos.gov.pl** dedicated to the issues of adaptation to climate change, which is expected to become a platform for an

exchange of information at the national level among local governments, research institutions, enterprises and environmental organisations in the scope of adaptation measures, their financing, costs and current events. The websites of ministerial institutes (the Institute of Environmental Protection-National Research Institute and the Institute of Meteorology and Water Management-National Research Institute) and the Ministry of the Environment also serve as sources of available information and input data which are useful at the different stages of education and the popularisation of the knowledge about the climate issues.

Apart from the more frequent coverage of climate problems on the websites devoted to broadly understood environmental education which have operated for a long time now, recently many new specialist portals were also launched. An example of the first category of portals can be the website www.ekoedu.uw.edu.pl managed by the Centre for Environmental Studies which is dedicated to the education for sustainable development and addressed to teachers and educators. Much information and many articles on climate issues can also be found on the private platform of websites making up the Polish environmental portal www.ekologia.pl.

Similarly, much space is dedicated to the issues related to climate on the websites of large nongovernmental organizations, such as the WWF or Our Earth. The Climate Coalition also runs its own website www.koalicjaklimatyczna.org.

In 2008, the Institute for Sustainable Development launched its professionally run climate portal www.chronmyklimat.pl that makes up a mutually complementing whole with the Climate Bulletin which is published periodically in electronic form.

It is impossible to mention all the websites, since more and more specialist portals are launched; they are dedicated to a wide spectrum of problems related to climate protection and adaptation to climate change.

9.9. Financing of education

The implementation of all the programmes and forms of education needs large financial outlays. In addition to support for environmental education with the resources of local governments, which is particularly the case with schools and local nongovernmental organisations, the National Fund for Environmental Protection and Water Management (NFOŚiGW) is the largest sponsor of environmental education. In successive years since it was founded the level of financial resources allocated for education has systematically grown, reaching about 50 million PLN annually in 2010 and remaining at roughly the same level for the subsequent years. The grants are given for diverse educational projects: training courses, films, radio broadcasts, campaigns, competitions etc. It has also a very important programme to support ENGOs, thus enhancing the potential for civil activities. Similar financial support for projects with a local range is granted by 17 Voivodeship Funds. In 2012, the National Fund and the Voivodeship Funds for Environmental Protection and Water Management adopted their Common Action Strategy for 2013-2016 with an Outlook until 2020. The Common Strategy provides that until 2020 the priority will be the transition to a low-emission economy and efficient use of resources, with consideration given to the threats ensuing from climate change. The horizontal objective to be achieved in this priority area (as well as in other priority areas) is to: *promote environment-friendly behaviour and actions and projects*

to preserve biodiversity and to adapt to climate change. The Strategy also provides for an increase of about 15% in the grants of resources for financing in the timeframe of 2013-2116 compared with the grants in 2009-2012. The planned grants for environmental education in 2013-2016 make up a large amount of 238,000 PLN. The National Fund for Environmental Protection and Water Management also tries itself to enable the beneficiaries to affect the directions of the policy of financing education, convening since 2012 periodical discussion meetings called Environment - Education – Eco-innovation.

A certain part of the resources used to start up investment projects and other demonstration and educational projects which have lasted until today, e.g. those shaping the awareness of beneficiaries in the field of energy saving, also comes from financing with the resources of the Global Environment Facility (UNDP-GEF). In particular, despite the closedown of the activity of the GEF in 2008, the effects of the small grants of the GEF, which were popular with Polish environmental nongovernmental organisations, include the still existing educational elements. The State Forests also allocate large resources for education, maintaining numerous forest education centres, preparing infrastructure (e.g. didactic trails) and holding classes with young people.

European resources increasingly gain in importance as regards the financing of environmental education. Such opportunities are offered by the LIFE+ Programme (its Component III - Information and Communication). There is a large potential within the framework of the Infrastructure and Environment Programme of the European Union. The resources of this Programme are managed by the Coordination Centre for Environmental Projects, which operates within the structure of the State Forests. Here, by way of a competition, co-financing can be sought for projects to shape environment-friendly attitudes and to build partnership in order to integrate local communities in the decision-making process. Projects in the field of education can also be financed from the Financial Mechanism of the European Economic Area and the Norwegian Financial Mechanism. In the scope of formal education, use is made of the possibility for participating in the funded European educational programmes, such as Minerva or Grundtvig. Moreover, many educational projects in the field of climate protection find sponsors in the embassies of different countries and Polish and foreign foundations and they are also financed by business institutions. One of the most active sponsors in this group is the Bank for Environmental Protection, which, apart from its own educational activities, supports the projects of environmental organisations, e.g. the Green Certificate. At present, small grants for achieving the objectives of educational projects at schools are awarded by way of a competition by the Foundation of the Bank for Environmental Protection. By way of competition, too, financing can be obtained for educational projects related to climate projects from the Social Initiatives Fund.

It can be concluded that the resources allocated for education come from very diverse sources and that many large projects and campaigns, such as the organisation of the Earth Day, have multiple sponsors at the same time. Unfortunately, this does not mean that they fully meet the needs of education and that it is easy to obtain the money.

9.10. The public awareness of global climate change

The effectiveness of all the educational activities presented here and the results of social communication on climate change can only be evaluated when their impact on the environmental awareness of the public is considered. Environmental awareness is a set of information and beliefs regarding the natural environment, the perception of the relations between the state and character of the natural environment and the conditions and quality of human life, and the translation of this into one's own attitudes and behaviour.

Environmental awareness, particularly in the field of climate change, is the subject matter of sociological surveys and polls carried out by the editorial offices of newspapers and public opinion polling organisations. Since 2011, on commission from the Ministry of the Environment, systematic surveys on the environmental awareness and behaviour of Poland's population have been carried out as an element of a long-term research programme (the so-called tracking surveys). When a question is asked about the important problems which our country has to resolve only 7% of the respondents mention environmental protection, indicating that the environmental issues are absent from the list of most urgent difficulties. However, when a question is asked about the greatest problems of the natural environment in Poland, climate change takes the fifth position. It is only preceded by the problems related to waste, water and air pollution, and natural disasters. (According to the poll carried out on commission from the Editorial Office of the daily Rzeczpospolita at the end of November 2008, on the eve of COP 14, according to 30% of the respondents it took the third position after water and air pollution.) Climate change is the most important threat for the environment for 25% of the respondents only. However, characteristically, 31% of twenty year olds believe that it is. When asked whether they know and understand the notion of climate change 84% of the respondents give a positive answer (for comparison only 38% of them know and understand the notion of biodiversity). In parallel, it follows from the Flash Eurobarometer report, *Attitudes of Europeans towards the issue of biodiversity*, from the surveys carried out in 2010 on commission from the European Commission that the Poles' awareness of the relation between biodiversity loss and climate change is greater than the average for Europe. Although the public does not perceive climate change as one of the main threats for the environment, almost everyone (87%) regards it as important. The Poles also believe that, in addition to authorities, everyone should take measures to minimise the impacts of climate change. The overwhelming majority of Poles (68%) see the need to reduce greenhouse gas emissions, while the relative majority (42%) believe that this should be done as soon as possible. The respondents' opinions on this issue are consistent and they are not different in individual social and demographic groups. Fewer than 10% of the respondents believe that Poland should not reduce gas emissions. It is difficult to assess whether in 2012, given the change in the economic situation, fewer Poles than in 2011 do not save energy (11% in 2011 and 6% in 2012). In both years, among younger persons there was a lower percentage of those who did not save energy. Every fifth household plans to take additional measures in the nearest future to enhance energy efficiency and to reduce energy bills. Positively, 94% of the respondents declare that they save energy and, moreover, they do it in several ways. The most popular ways include switching off the light in unused rooms (78%), using energy saving light sources (53%) and sealing of windows (48%). However, only 2% of the respondents use systems for energy supply from renewable sources.

Motives related to broadly understood environmental protection affect the market choices of consumers to a lesser extent. It is difficult to indicate a social group which clearly prefers the environment-friendly criteria for their choice. Also, for industrial goods – household

appliances and radio and television sets – the basic criterion for choice is the price (70%). As regards the recognisability of eco-labels, every fourth respondent (23%) never pays attention to eco-labels and, among these labels, the Energy Star labels related to energy efficiency are recognised by 29% of the respondents only. Those who are most convinced that society is responsible for climate change include white-collar workers, pupils, students and the residents of the biggest cities.

These results indicate the effectiveness of educational activities in enhancing the interest in and the knowledge of global warming; however, this translates relatively more slowly into a change in consumer behaviour, although this process is sped up by the conviction that a deteriorating economic situation encourages savings.

ANNEX 1. ABBREVIATIONS

AGH	University of Technology and Science
ARE SA	Energy Market Agency,
BULiGL	Office for Forest Planning and Management
CDI	Climatic Drought Index
CDM	Clean Development Mechanism
CODN	National In-Service Teacher Training Centre
DSRK	Long-Term National Development Strategy,
ETS	National Emission Allowance Trading Scheme
EU ETS	EU Emissions Trading Scheme.
GEKON	Generator of Ecological Concepts Programme
GIS	National Green Investment Scheme
GreenEvo	Green Technology Accelerator Project
GUS	Central Statistical Office
IBL	Forest Research Institute
IETU	Institute for Ecology of Industrial Areas,
IMGW-PIB	Institute of Meteorology and Water Management – National Research Institute
IOS-PIB	Institute of Environmental Protection – National Research Institute
ITS	Motor Transport Institute
JI	Joint Implementation
KLIMADA	Project " Development and Implementation of a Strategic Adaptation Plan for Sectors and Areas Vulnerable to Climate Change"
KOBIZE	National Centre for Emissions Management -Institute of Environmental Protection – National Research Institute,
KPB	National Research Programme
KPBNiPR	National Programme of Scientific Research and Development
KPGO	National Waste Management Plan
KPL	National Forest Policy
KPR	National Reform Programmes
KPRU	National Allowance Allocation Plan
KPZK	National Spatial Development Concept
KPZL	National Programme for the Augmentation of the Forest Cover
NCBiR	National Centre For Research and Development
NFOSiGW	National Fund for Environmental Protection and Water Management
NPRGN	National Programme for the Development of a Low-Emission Economy
OZE	Renewable Energy Sources
PIG-PIB	National Geological Institute- National Research Institute
PSHM	State Hydrological and Meteorological Service
RES	Renewable Energy Sources
SEMS	State Environmental Monitoring System
SPA 2020	Strategic Adaptation Plan by 2020
SRK	Medium-Term National Development Strategy 2020
SRT	Transport Development Strategy
UHIE	urban heat island effect
URE	Energy Regulatory Office
ZBIRE	Emission Balancing and Reporting Unit

ANNEX 2. NATIONAL EMISSION OF GREENHOUSE GASES FOR 1988−2011 ACCORDING TO GASES

Carbon dioxide CO_2 [Gg eq. CO_2]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total CO_2 emission including net CO_2 from LULUCF	**461 277.49**	**437 704.75**	**353 746.11**	**350 479.75**	**350 467.76**	**350 058.44**	**348 211.13**	**350 447.29**	**362 655.03**	**353 757.57**	**325 835.63**	**315 323.80**	**305 018.53**
Total CO_2 emission excluding net CO_2 from LULUCF	**469 073.95**	**449 431.81**	**372 288.35**	**370 479.67**	**361 097.07**	**361 410.39**	**357 130.66**	**358 302.29**	**371 682.59**	**362 466.34**	**335 326.82**	**326 065.72**	**3159.64**
1. Energy	**443 271.99**	**424 671.48**	**353 325.49**	**354 140.45**	**345 598.06**	**346 436.58**	**339 705.14**	**340 279.87**	**354 800.15**	**344 881.95**	**319 207.17**	**310 998.72**	**298 959.42**
A. Fuel Combustion (Sectoral Approach)	439 951.83	421 212.07	350 668.73	352 364.93	343 751.36	344 786.86	339 169.14	338 775.37	353 525.12	342 474.82	318 237.21	308 940.32	296 090.30
1. Energy Industries	262 783.55	258 690.71	234 685.68	228 633.94	219 440.16	206 647.16	205 781.28	190 585.55	197 184.71	191 525.47	184 627.85	179 061.70	176 596.26
2. Manufacturing Industries and Construction	54 068.04	51 307.17	42 211.15	39 333.58	36 838.48	47 297.68	48 037.01	62 413.90	66 969.30	63 231.23	54 709.43	47 031.37	47 449.17
3. Transport	20 185.42	20 133.25	20 177.57	21 208.53	21 666.34	21 206.24	22 256.64	23 012.72	25 459.70	26 910.68	28 327.37	30 876.14	27 155.00
4. Other Sectors	102 914.83	91 080.94	53 594.33	63 188.88	65 806.39	69 635.78	63 094.21	62 763.20	63 911.41	60 807.44	50 572.56	51 971.12	44 889.87
5. Other	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO
B. Fugitive Emissions from Fuels	3 320.16	3 459.40	2 656.76	1 775.52	1 846.69	1 649.73	536.00	1 504.50	1 275.04	2 407.13	969.96	2 058.39	2 869.11
1. Solid Fuels	3 274.21	3 414.65	2 611.01	1 729.93	1 789.76	1 582.89	456.51	1 422.67	1 186.50	2 325.97	869.62	1 938.61	2 689.41
2. Oil and Natural Gas	45.95	44.75	45.76	45.59	56.93	66.84	79.48	81.83	88.54	81.16	100.33	119.78	179.70
2. Industrial Processes	**24 352.02**	**23 414.42**	**18 010.66**	**15 453.06**	**14 682.04**	**14 199.52**	**16 648.20**	**17 236.84**	**16 066.47**	**16 770.69**	**15 277.68**	**14 297.71**	**15 637.81**
A. Mineral Products	10 774.23	10 956.41	8 460.24	7 730.66	7 932.20	7 545.75	9 139.90	9 030.89	8 503.18	9 082.41	8 506.21	8 254.93	8 310.15
B. Chemical Industry	5 262.34	5 253.88	3 462.61	3 405.95	3 058.55	3 093.63	3 631.58	4 129.60	3 989.94	3 993.18	3 596.36	3 172.01	3 889.61
C. Metal Production	7 521.40	6 467.84	5 549.39	3 942.23	3 334.59	3 208.65	3 504.63	3 654.53	3 197.88	3 308.50	2 646.81	2 358.40	2 844.27
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
G. Other	794.06	736.29	538.41	374.22	356.69	351.49	372.09	421.81	375.47	386.61	528.29	512.38	593.78
3. Solvent and Other Product Use	**882.46**	**822.14**	**505.23**	**484.22**	**434.57**	**395.36**	**397.05**	**400.81**	**426.00**	**424.63**	**428.44**	**423.19**	503.89
4. Agriculture	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	NO
5. Land Use. Land-Use Change and Forestry*	**-7 796.46**	**-11 727.05**	**-18 542.24**	**-19 999.92**	**-10 629.31**	**-11 351.95**	**-8 919.53**	**-7 854.99**	**-9 027.57**	**-8 708.77**	**-9 491.19**	**-10 741.92**	**-10 521.11**
A. Forest Land	-17 229.17	-19 971.88	-25 840.53	-26 269.10	-16 566.24	-17 318.81	-15 035.98	-14 229.69	-15 366.72	-15 126.70	-15 575.52	-16 664.38	-16 355.44
B. Cropland	5 420.00	4 452.92	3 511.30	2 547.95	2 105.97	2 097.96	2 199.45	2 463.76	2 480.30	2 506.96	2 337.45	2 187.24	2 025.63
C. Grassland	724.82	739.85	754.51	780.57	810.02	818.26	823.94	902.03	830.23	819.50	696.10	705.20	630.34
D. Wetlands	2 800.85	2 828.62	2 837.66	2 851.13	2 860.55	2 873.18	2 872.90	2 890.34	2 905.85	2 904.03	2 908.01	2 925.46	2 940.23
E. Settlements	487.04	223.43	194.82	89.53	160.39	177.46	220.15	118.56	122.78	187.45	142.76	104.56	238.12
F. Other Land	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
6. Waste	**567.47**	**523.76**	**446.97**	**401.94**	**382.40**	**378.92**	**380.27**	**384.77**	**389.97**	**389.06**	**413.54**	**346.10**	**438.52**
A. Solid Waste Disposal on Land	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
B. Waste-water Handling	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Waste Incineration	567.47	523.76	446.97	401.94	382.40	378.92	380.27	384.77	389.97	389.06	413.54	346.10	438.52
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

*net sink **NA – not applicable. NE – not estimated. IE – included elsewhere. NO – not occurring**

Carbon dioxide CO_2 [Gg eq. CO_2] cont.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total CO_2 emission including net CO_2 from LULUCF	**298 552.68**	**286 198.95**	**297 553.04**	**297 590.37**	**294 146.08**	**304 269.83**	**308 549.37**	**300 308.23**	**284 431.97**	**305 309.21**	**306 138.93**
Total CO_2 emission excluding net CO_2 from LULUCF	**312 083.43**	**300 519.43**	**312 481.07**	**316 204.78**	**318 019.54**	**331 550.47**	**332 612.82**	**326 847.15**	**311 773.19**	**332 573.75**	**330 309.43**
1. Energy	**297 570.45**	**287 419.81**	**297 829.37**	**300 843.24**	**298 781.93**	**310 370.93**	**309 920.87**	**304 011.12**	**294 182.46**	**312 978.65**	**308 389.70**
A. Fuel Combustion (Sectoral Approach)	295 335.83	285 005.28	294 914.47	298 159.50	295 615.43	306 887.04	306 635.23	301 187.72	291 900.22	310 172.94	304 568.18
1. Energy Industries	178 213.13	172 063.48	180 391.51	178 395.28	177 244.80	182 473.24	179 195.90	173 440.85	166 021.42	172 549.98	173 821.99
2. Manufacturing Industries and Construction	42 379.07	39 783.58	38 859.35	39 630.19	33 284.99	33 312.80	36 295.77	32 133.99	29 297.79	30 764.05	31 062.53
3. Transport	26 955.10	26 028.98	28 461.71	32 188.24	34 597.84	38 369.57	42 408.22	44 574.67	45 002.70	47 425.62	47 987.70
4. Other Sectors	47 788.53	47 129.23	47 201.91	47 945.79	50 487.79	52 731.44	48 735.35	51 038.21	51 578.31	59 433.28	51 695.95
5. Other	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO
B. Fugitive Emissions from Fuels	2 234.61	2 414.53	2 914.90	2 683.73	3 166.51	3 483.88	3 285.64	2 823.40	2 282.24	2 805.72	3 821.52
1. Solid Fuels	2 023.77	2 214.55	2 705.12	2 440.53	1 851.09	2 121.67	2 130.33	1 523.97	999.56	1 624.73	2 097.42
2. Oil and Natural Gas	210.84	199.98	209.78	243.20	1 315.42	1 362.21	1 155.32	1 299.43	1 282.68	1 180.98	1 724.10
2. Industrial Processes	**13 586.85**	**12 128.77**	**13 776.84**	**14 533.90**	**18 374.08**	**20 248.94**	**21 800.30**	**21 927.06**	**16 732.33**	**18 717.85**	**21 029.08**
A. Mineral Products	6 911.99	6 548.78	6 520.35	7 136.33	7 785.66	8 929.59	10 168.99	9 850.75	8 433.09	9 221.91	10 711.41
B. Chemical Industry	3 691.03	2 862.28	4 150.89	4 248.42	4 502.52	4 276.75	4 244.16	4 276.37	3 493.24	3 622.92	3 968.60
C. Metal Production	2 358.23	2 192.63	2 566.01	2 694.56	5 698.99	6 680.44	7 027.37	7 412.21	4 406.07	5 536.84	6 006.06
D. Other Production	NA.NO	NA.NO	NA.NO	NA.NO	0.08	0.05	0.08	6.32	8.62	8.60	8.20
G. Other	625.61	525.07	539.59	454.59	386.83	362.12	359.70	381.41	391.31	327.58	334.81
3. Solvent and Other Product Use	**507.77**	**537.01**	**521.02**	**553.09**	**563.75**	**637.46**	**597.65**	**673.18**	**627.41**	**655.40**	**664.67**
4. Agriculture	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
5. Land Use. Land-Use Change and Forestry*	**-13 530.75**	**-14 320.48**	**-14 928.03**	**-18 614.41**	**-23 873.45**	**-27 280.64**	**-24 063.44**	**-26 538.91**	**-27 341.22**	**-27 264.54**	**-24 170.50**
A. Forest Land	-19 311.08	-20 118.38	-21 046.92	-24 942.42	-30 163.49	-33 267.43	-29 942.77	-32 691.70	-33 859.75	-34 019.81	-31 019.63
B. Cropland	2 109.42	2 191.21	2 364.18	2 656.24	2 734.65	2 342.88	2 315.25	2 538.62	2 960.49	3 214.99	3 316.34
C. Grassland	584.78	551.47	508.49	429.76	378.73	416.78	305.71	334.05	266.06	251.28	220.88
D. Wetlands	2 931.93	2 946.56	3 026.86	3 042.36	3 053.04	3 057.81	3 084.06	3 099.08	3 100.62	3 141.07	3 145.92
E. Settlements	154.20	108.65	219.36	199.65	123.62	169.31	174.30	181.03	191.36	147.92	165.99
F. Other Land	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
6. Waste	**418.36**	**433.85**	**353.83**	**274.56**	**299.78**	**293.14**	**294.00**	**235.79**	**230.99**	**221.84**	**225.98**
A. Solid Waste Disposal on Land	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
B. Waste-water Handling	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Waste Incineration	418.36	433.85	353.83	274.56	299.78	293.14	294.00	235.79	230.99	221.84	225.98
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

*net sink

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

Methan CH_4 [Gg eq. CO_2]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total CO_2 emission including net CO_2 from LULUCF	**55 062.55**	**54 417.43**	**49 362.87**	**47 862.47**	**45 801.77**	**45 365.80**	**45 657.31**	**45 613.49**	**45 685.96**	**46 011.73**	**44 661.45**	**44 528.69**	**41 567.84**
Total CO_2 emission excluding net CO_2 from LULUCF	**52 872.47**	**52 222.97**	**47 166.41**	**45 686.82**	**43 418.00**	**43 156.35**	**43 445.64**	**43 410.47**	**43 445.54**	**43 805.65**	**42 469.64**	**42 314.05**	**39 361.03**
1. Energy	**24 799.40**	**23 081.41**	**18 989.46**	**18 665.28**	**17 700.33**	**18 723.86**	**19 122.46**	**19 671.58**	**20 152.66**	**19 844.35**	**17 817.97**	**18 024.54**	**17 055.39**
A. Fuel Combustion (Sectoral Approach)	4 601.32	4 132.76	2 565.80	3 175.85	3 296.43	4 144.17	3 743.05	3 723.97	3 848.22	3 444.58	2 922.46	2 944.86	2 396.49
1. Energy Industries	77.39	75.40	69.11	66.98	66.23	60.37	60.63	48.34	50.04	48.69	47.84	45.80	45.25
2. Manufacturing Industries and Construction	82.42	81.07	66.91	69.19	64.64	87.39	88.60	123.87	133.17	121.86	104.02	91.66	89.32
3. Transport	100.92	107.76	96.97	109.36	113.46	115.89	127.78	126.44	128.79	127.84	117.89	125.55	95.29
4. Other Sectors	4 340.59	3 868.52	2 332.82	2 930.32	3 052.10	3 880.52	3 466.04	3 425.31	3 536.21	3 146.19	2 652.71	2 681.84	2 166.63
5. Other	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO
B. Fugitive Emissions from Fuels	20 198.08	18 948.66	16 423.66	15 489.44	14 403.90	14 579.69	15 379.41	15 947.61	16 304.44	16 399.77	14 895.51	15 079.68	14 658.90
1. Solid Fuels	16 745.00	15 584.63	13 328.41	12 555.16	11 663.31	11 649.63	12 452.89	12 760.34	12 968.01	13 072.08	11 524.38	11 810.70	11 122.52
2. Oil and Natural Gas	3 453.08	3 364.02	3 095.25	2 934.27	2 740.60	2 930.06	2 926.51	3 187.27	3 336.43	3 327.69	3 371.13	3 268.99	3 536.38
2. Industrial Processes	**314.97**	**315.19**	**213.09**	**201.66**	**193.06**	**207.58**	**242.29**	**277.74**	**271.14**	**280.32**	**254.67**	**223.76**	**274.12**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	276.84	280.84	181.69	178.45	171.02	186.08	217.82	252.26	246.22	253.75	231.33	202.10	248.67
C. Metal Production	38.12	34.35	31.40	23.20	22.04	21.50	24.46	25.47	24.92	26.58	23.34	21.66	25.45
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
4. Agriculture	**19 100.98**	**19 892.41**	**18 889.02**	**17 405.58**	**16 013.57**	**14 590.17**	**14 417.42**	**13 893.14**	**13 304.13**	**13 658.77**	**14 038.06**	**13 446.06**	**12 539.87**
A. Enteric Fermentation	15 665.63	16 396.06	15 561.56	13 862.06	12 559.01	11 572.93	11 348.30	10 764.15	10 413.35	10 772.05	11 035.20	10 445.20	9 717.92
B. Manure Management	3 418.28	3 478.16	3 310.64	3 527.18	3 440.34	3 000.27	3 054.85	3 112.30	2 874.54	2 871.08	2 985.57	2 985.03	2 807.11
D. Agricultural Soils(3)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	17.06	18.20	16.82	16.35	14.23	16.97	14.28	16.70	16.24	15.65	17.29	15.84	14.84
5. Land Use. Land-Use Change and Forestry*	**2 190.08**	**2 194.47**	**2 196.45**	**2 175.65**	**2 383.77**	**2 209.46**	**2 211.67**	**2 203.02**	**2 240.42**	**2 206.08**	**2 191.81**	**2 214.64**	**2 206.81**
A. Forest Land	35.79	35.74	35.83	12.90	217.05	38.36	40.79	23.91	64.36	29.76	18.25	36.49	31.08
B. Cropland	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO
C. Grassland	8.69	8.69	8.69	8.69	8.69	8.69	8.69	12.58	4.40	6.06	3.01	6.23	2.26
D. Wetlands	2 145.60	2 150.03	2 151.93	2 154.07	2 158.03	2 162.40	2 162.19	2 166.53	2 171.66	2 170.26	2 170.54	2 171.91	2 173.47
E. Settlements	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
F. Other Land	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
6. Waste	**8 657.12**	**8 933.96**	**9 074.84**	**9414.2924**	**9 511.04**	**9 634.74**	**9 663.47**	**9 568.02**	**9 717.60**	**10 022.21**	**10 358.94**	**10 619.68**	**9 491.65**
A. Solid Waste Disposal on Land	6 933.95	7 193.54	7 414.08	7 537.11	7 612.61	7 676.05	7 721.59	7 775.78	7 899.23	8 037.86	8 230.53	8 394.13	8 539.68
B. Waste-water Handling	1 723.17	1 740.41	1 660.76	1 877.18	1 898.43	1 958.69	1 941.88	1 792.24	1 818.38	1 984.35	2 128.41	2 225.56	951.97
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

*net sink

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

Methan CH_4[Gg eq. CO_2] cont.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total CO_2 emission including net CO_2 from LULUCF	**40 927.07**	**39 900.64**	**40 344.32**	**40 092.68**	**40 547.64**	**40 953.95**	**40 243.46**	**39 355.20**	**38 189.86**	**38 682.41**	**37 787.07**
Total CO_2 emission excluding net CO_2 from LULUCF	**38 742.34**	**37 701.27**	**38 056.54**	**37 885.74**	**38 325.61**	**38 723.15**	**38 023.22**	**37 127.90**	**35 959.16**	**36 448.45**	**35 537.91**
1. Energy	**17 090.96**	**16 087.77**	**16 560.91**	**16 717.95**	**16 666.98**	**16 719.82**	**15 844.09**	**15 515.98**	**14 581.78**	**15 208.49**	**14 718.00**
A. Fuel Combustion (Sectoral Approach)	2 592.24	2 444.51	2 386.91	2 479.77	2 622.21	2 907.97	2 721.77	2 871.31	2 914.97	3 406.04	3 037.86
1. Energy Industries	46.81	46.29	47.70	49.84	55.69	59.07	60.98	67.86	77.05	86.02	94.55
2. Manufacturing Industries and Construction	82.06	79.95	76.78	76.65	67.52	68.30	70.92	69.44	69.43	74.33	77.73
3. Transport	91.59	89.34	92.18	100.29	97.04	104.42	106.22	106.85	105.77	107.49	105.90
4. Other Sectors	2 371.78	2 228.93	2 170.25	2 253.00	2 401.95	2 676.18	2 483.65	2 627.16	2 662.72	3 138.20	2 759.67
5. Other	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO		IE.NO	IE.NO	IE.NO	IE.NO	IE.NO
B. Fugitive Emissions from Fuels	14 498.72	13 643.26	14 174.00	14 238.18	14 044.77	13 811.85	13 122.32	12 644.67	11 666.81	11 802.44	11 680.13
1. Solid Fuels	10 803.01	10 035.58	10 201.26	10 026.74	9 725.53	9 384.98	8 722.82	8 237.25	7 426.05	7 341.22	7 182.86
2. Oil and Natural Gas	3 695.71	3 607.68	3 972.73	4 211.44	4 319.24	4 426.87	4 399.50	4 407.42	4 240.76	4 461.22	4 497.28
2. Industrial Processes	**257.66**	**206.38**	**274.64**	**304.82**	**315.08**	**306.73**	**319.09**	**321.10**	**260.19**	**270.51**	**305.79**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	234.62	184.17	250.35	277.31	281.69	269.44	280.31	283.81	234.42	240.26	270.88
C. Metal Production	23.04	22.21	24.30	27.51	33.39	37.29	38.77	37.29	25.76	30.25	34.91
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
4. Agriculture	**12 165.88**	**12 215.07**	**12 188.25**	**11 821.81**	**12 207.24**	**12 576.94**	**12 710.82**	**12 401.03**	**12 188.24**	**12 204.23**	**12 113.40**
A. Enteric Fermentation	9 342.69	9 067.86	9 017.41	8 761.54	8 945.48	9 164.34	9 301.38	9 303.81	9 200.47	9 227.18	9 286.65
B. Manure Management	2 805.76	3 131.31	3 155.67	3 041.58	3 245.61	3 396.94	3 394.00	3 078.02	2 967.12	2 959.23	2 809.12
D. Agricultural Soils[3]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	17.43	15.90	15.16	18.70	16.15	15.66	15.44	19.19	20.65	17.82	17.62
5. Land Use. Land-Use Change and Forestry*	**2 184.73**	**2 199.37**	**2 287.78**	**2 206.94**	**2 222.04**	**2 230.80**	**2 220.24**	**2 227.31**	**2 230.70**	**2 233.96**	**2 249.16**
A. Forest Land	15.01	22.91	93.98	16.80	25.53	25.96	15.44	13.33	19.66	9.73	12.48
B. Cropland	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO
C. Grassland	2.63	4.42	6.63	4.21	4.02	8.70	1.30	5.12	0.99	1.25	1.21
D. Wetlands	2 167.09	2 172.05	2 187.17	2 185.93	2 192.49	2 196.15	2 203.50	2 208.86	2 210.04	2 222.98	2 235.46
E. Settlements	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
F. Other Land	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
6. Waste	**9 227.83**	**9 192.04**	**9 032.74**	**9 041.15**	**9 136.31**	**9 119.65**	**9 149.22**	**8 889.80**	**8 928.96**	**8 765.23**	**8 400.72**
A. Solid Waste Disposal on Land	8 280.87	8 228.62	8044.97	8 037.19	8 118.27	8 088.74	8 095.46	7 821.02	7 841.93	7 660.88	7 290.34
B. Waste-water Handling	946.97	963.42	987.77	1 003.97	1 018.04	1 030.92	1 053.76	1 068.78	1 087.03	1 104.35	1 110.38
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

*net sink

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

Nitrous oxide N_2O [Gg eq. CO_2]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total CO_2 emission including net CO_2 from LULUCF	**40 088.78**	**42 102.69**	**37 453.55**	**30 967.64**	**28 805.22**	**28 981.07**	**29 351.55**	**30 390.65**	**30 089.71**	**30 292.72**	**30 314.33**	**29 386.34**	**29 193.09**
Total CO_2 emission excluding net CO_2 from LULUCF	**40 071.30**	**42 085.69**	**37 437.00**	**30 956.80**	**28 748.17**	**28 965.36**	**29 335.75**	**30 378.30**	**30 070.45**	**30 281.46**	**30 306.87**	**29 368.29**	**29 176.30**
1. Energy	**2 131.88**	**2 046.30**	**1 754.32**	**1 788.25**	**1 781.05**	**1 930.80**	**1 897.99**	**1 916.50**	**2 029.89**	**1 998.37**	**1 891.40**	**1 866.97**	**1 783.03**
A. Fuel Combustion (Sectoral Approach)	2 131.77	2 046.19	1 754.24	1 788.15	1 780.96	1 930.68	1 897.87	1 916.38	2 029.76	1 998.25	1 891.26	1 866.82	1 782.84
1. Energy Industries	1 184.17	1 166.38	1 063.01	1 049.71	1 011.44	948.24	937.64	861.84	894.27	867.89	838.23	811.09	794.83
2. Manufacturing Industries and Construction	177.37	174.16	142.74	147.48	137.82	188.13	190.25	266.34	287.75	263.33	224.71	197.45	191.04
3. Transport	177.29	176.93	198.20	205.44	213.26	206.95	212.42	227.07	270.44	290.25	315.94	343.58	299.68
4. Other Sectors	592.93	528.73	350.28	385.52	418.42	587.36	557.55	561.12	577.30	576.77	512.39	514.71	497.29
5. Other	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO
B. Fugitive Emissions from Fuels	0.12	0.11	0.08	0.09	0.10	0.12	0.12	0.13	0.13	0.13	0.14	0.15	0.19
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	0.12	0.11	0.08	0.09	0.10	0.12	0.12	0.13	0.13	0.13	0.14	0.15	0.19
2. Industrial Processes	**4 993.43**	**5 067.65**	**3 678.35**	**3 278.15**	**3 225.42**	**3 674.02**	**3 667.29**	**4 057.55**	**4 056.94**	**3 818.76**	**3 544.07**	**3 485.43**	**4 242.10**
A. Mineral Products	NA	NA	NA	NA	**NA**	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	4 993.43	5 067.65	3 678.35	3 278.15	3 225.42	3 674.02	3 667.29	4 057.55	4 056.94	3 818.76	3 544.07	3 485.43	4 242.10
C. Metal 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
D. Other Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**
4. Agriculture	**31 662.86**	**33 695.11**	**30 766.32**	**24 635.11**	**22 486.05**	**22 114.55**	**22 563.96**	**23 184.70**	**22 760.83**	**23 258.56**	**23 637.28**	**22 781.90**	**21 922.97**
A. Enteric Fermentation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Manure Management	8 033.03	8 141.94	7 911.00	7 518.50	7 154.61	6 535.95	6 569.89	6 490.73	6 178.27	6 327.84	6 541.42	6 268.90	5 831.47
D. Agricultural Soils[3]	23 618.32	25 541.41	22 844.44	17 106.22	15 321.86	15 566.52	15 984.79	16 683.64	16 571.66	16 920.63	17 084.83	16 503.26	16 081.74
F. Field Burning of Agricultural Residues	11.51	11.75	10.88	10.38	9.59	12.08	9.29	10.33	10.90	10.09	11.03	9.74	9.76
5. Land Use. Land-Use Change and Forestry*	**17.48**	**17.00**	**16.55**	**10.83**	**57.05**	**15.71**	**15.80**	**12.35**	**19.26**	**11.26**	**7.46**	**18.05**	**16.79**
A. Forest Land	8.19	8.17	8.19	2.95	49.64	8.77	9.33	5.47	14.72	6.81	4.17	8.35	7.11
B. Cropland	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO		IE.NO		IE.NO	IE.NO	IE.NO	IE.NO
C. Grassland	1.99	1.99	1.99	1.99	1.99	1.99	1.99	2.88	1.01	1.39	0.69	1.42	0.52
D. Wetlands	7.31	6.84	6.37	5.90	5.42	4.95	4.48	4.01	3.54	3.07	2.59	8.28	9.16
E. Settlements	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
F. Other Land	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
6. Waste	**1 159.12**	**1 152.63**	**1 114.01**	**1 131.31**	**1 131.64**	**1 121.98**	**1 082.51**	**1 095.55**	**1 098.78**	**1 081.76**	**1 110.12**	**1 109.99**	**1 104.21**
A. Solid Waste Disposal on Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Waste-water Handling	1 140.13	1 135.17	1 099.31	1 118.19	1 119.19	1 109.67	1 070.16	1 083.02	1 086.06	1 069.05	1 093.44	1 096.37	1 087.21
C. Waste Incineration	18.99	17.46	14.70	13.11	12.45	12.31	12.35	12.53	12.72	12.72	16.68	13.61	17.01
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

*net sink

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

Nitrous oxide N_2O [Gg eq. CO_2] cont.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total CO_2 emission including net CO_2 from LULUCF	**29 337.84**	**28 407.77**	**28 590.99**	**28 897.62**	**29 287.76**	**30 497.23**	**31 402.22**	**30 960.80**	**27 313.07**	**26 868.99**	**27 249.62**
Total CO_2 emission excluding net CO_2 from LULUCF	**29 328.65**	**28 392.43**	**28 558.89**	**28 883.07**	**29 271.96**	**30 483.24**	**31 392.31**	**30 950.55**	**27 302.49**	**26 860.62**	**27 240.63**
1. Energy	**1 777.20**	**1 719.29**	**1 771.47**	**1 812.07**	**1 845.98**	**1 886.11**	**1 911.36**	**1 941.49**	**1 953.40**	**2 088.21**	**2 098.26**
A. Fuel Combustion (Sectoral Approach)	1 776.99	1 719.08	1 771.26	1 811.83	1 845.75	1 885.88	1 911.14	1 941.28	1 953.20	2 088.02	2 098.07
1. Energy Industries	804.03	773.61	809.74	799.77	811.72	836.41	827.40	810.19	803.04	837.71	854.35
2. Manufacturing Industries and Construction	174.72	169.55	162.16	161.62	142.09	142.43	147.90	144.29	143.72	153.64	160.44
3. Transport	294.27	277.27	303.84	344.87	374.16	419.73	480.42	519.95	539.34	580.59	593.62
4. Other Sectors	503.97	498.65	495.51	505.57	517.78	487.31	455.43	466.85	467.10	516.08	489.65
5. Other	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO
B. Fugitive Emissions from Fuels	0.21	0.21	0.21	0.24	0.23	0.22	0.21	0.21	0.20	0.20	0.19
1. Solid Fuels	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA
2. Oil and Natural Gas	0.21	0.21	0.21	0.24	0.23	0.22	0.21	0.21	0.20	0.20	0.19
2. Industrial Processes	**4 350.09**	**3 612.10**	**4 296.27**	**4 400.66**	**4 631.36**	**4 607.06**	**4 780.36**	**4 033.44**	**1 096.93**	**1 174.57**	**1 083.42**
A. Mineral Products	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical Industry	4 350.09	3 612.10	4 296.27	4 400.66	4 608.38	4 579.85	4 753.97	4 009.45	1 083.76	1 160.48	1 064.65
C. Metal Production	NA.NO	NA.NO	NA.NO	NA.NO	22.98	27.20	26.39	23.99	13.17	14.09	18.78
D. Other Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**	**124.00**
4. Agriculture	**21 973.31**	**21 822.16**	**21 251.71**	**21 453.56**	**21 579.81**	**22 772.93**	**23 458.76**	**23 765.29**	**23 021.37**	**22 356.33**	**22 816.40**
A. Enteric Fermentation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Manure Management	5 701.37	5 839.84	5 687.05	5 362.46	5 483.39	5 673.56	5 653.51	5 385.68	5 165.52	5 206.16	5 108.51
D. Agricultural Soils[3]	16 260.94	15 972.47	15 554.95	16 079.97	16 087.03	17 090.04	17 796.91	18 368.39	17 844.09	17 140.20	17 697.57
F. Field Burning of Agricultural Residues	11.00	9.85	9.71	11.13	9.39	9.33	8.35	11.23	11.76	9.97	10.31
5. Land Use. Land-Use Change and Forestry*	**9.19**	**15.34**	**32.11**	**14.55**	**15.79**	**13.99**	**9.90**	**10.25**	**10.58**	**8.37**	**8.99**
A. Forest Land	3.43	5.24	21.49	3.84	5.84	5.94	3.53	3.05	4.50	2.22	2.86
B. Cropland	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO	IE.NO
C. Grassland	0.60	1.01	1.52	0.96	0.92	1.99	0.30	1.17	0.23	0.29	0.28
D. Wetlands	5.15	9.09	9.10	9.75	9.04	6.07	6.07	6.03	5.86	5.86	5.86
E. Settlements	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
F. Other Land	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
6. Waste	**1 104.04**	**1 114.88**	**1 115.44**	**1 092.78**	**1 090.81**	**1 093.14**	**1 117.84**	**1 086.32**	**1 106.78**	**1 117.51**	**1 118.55**
A. Solid Waste Disposal on Land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Waste-water Handling	1 083.60	1 093.82	1 097.37	1 077.32	1 075.77	1 078.13	1 103.06	1 078.43	1 097.77	1 108.20	1 108.44
C. Waste Incineration	20.44	21.06	18.07	15.46	15.04	15.01	14.78	7.90	9.01	9.31	10.11
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

*net sink

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

HFCs PFCs SF_6 [Gg eq. CO_2]

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
HFCs	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	189.90	292.49	415.91	505.30	724.26	1 127.78
PFCs	127.55	127.77	122.88	122.40	116.61	125.47	132.33	148.96	139.45	149.56	150.87	145.27	151.88
SF_6	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	13.91	30.53	24.95	24.02	25.09	24.64	24.18

HFCs PFCs SF_6 [Gg eq. CO_2] cont.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
HFCs	1 717.39	2 221.21	2 723.42	3 482.23	4 424.87	5 053.80	5 641.57	5 114.06	5 453.34	5 694.34	6 210.80
PFCs	168.74	177.61	172.31	175.86	160.65	166.08	158.41	139.85	59.24	56.13	49.88
SF_6	23.96	24.41	21.72	23.44	28.09	34.80	32.66	34.46	39.42	37.07	40.90

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

ANNEX 3. THE FIRST BIENNIAL REPORT TO THE CONFERENCE OF THE PARTIES TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Table 1

Emission trends: summary

GREENHOUSE GAS EMISSIONS	Base year (1988)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	(%)
CO_2 emissions including net CO_2 from LULUCF	461 277,49	353 746,11	350 479,75	350 467,76	350 058,44	348 211,13	350 447,29	362 655,03	353 757,57	325 835,63	315 323,80	305 018,53	298 552,68	286 198,95	297 553,04	297 590,37	294 146,08	304 269,83	308 549,37	300 308,23	284 431,97	305 309,21	306 138,93	-33,63
CO_2 emissions excluding net CO_2 from LULUCF	469 073,95	372 288,35	370 479,67	361 097,07	361 410,39	357 130,66	358 302,29	371 682,59	362 466,34	335 326,82	326 065,72	315 539,64	312 083,43	300 519,43	312 481,07	316 204,78	318 019,54	331 550,47	332 612,82	326 847,15	311 773,19	332 573,75	330 309,43	-29,58
CH_4 emissions including CH_4 from LULUCF	55 062,55	49 362,87	47 862,47	45 801,77	45 365,80	45 657,31	45 613,49	45 685,96	46 011,73	44 661,45	44 528,69	41 567,84	40 927,07	39 900,64	40 344,32	40 092,68	40 547,64	40 953,95	40 243,46	39 355,20	38 189,86	38 682,41	37 787,07	-31,37
CH_4 emissions excluding CH_4 from LULUCF	52 872,47	47 166,41	45 686,82	43 418,00	43 156,35	43 445,64	43 410,47	43 445,54	43 805,65	42 469,64	42 314,05	39 361,03	38 742,34	37 701,27	38 056,54	37 885,74	38 325,61	38 723,15	38 023,22	37 127,90	35 959,16	36 448,45	35 537,91	-32,79
N_2O emissions including N_2O from LULUCF	40 088,78	37 453,55	30 967,64	28 805,22	28 981,07	29 351,55	30 390,65	30 089,71	30 292,72	30 314,33	29 386,34	29 193,09	29 337,84	28 407,77	28 590,99	28 897,62	29 287,76	30 497,23	31 402,22	30 960,80	27 313,07	26 868,99	27 249,62	-32,03
N_2O emissions excluding N_2O from LULUCF	40 071,30	37 437,00	30 956,80	28 748,17	28 965,36	29 335,75	30 378,30	30 070,45	30 281,46	30 306,87	29 368,29	29 176,30	29 328,65	28 392,43	28 558,89	28 883,07	29 271,96	30 483,24	31 392,31	30 950,55	27 302,49	26 860,62	27 240,63	-32,02
HFCs	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	189,90	292,49	415,91	505,30	724,26	1 127,78	1 717,39	2 221,21	2 723,42	3 482,23	4 424,87	5 053,80	5 641,57	5 114,06	5 453,34	5 694,34	6 210,80	100,00
PFCs	127,55	122,88	122,40	116,61	125,47	132,33	148,96	139,45	149,56	150,87	145,27	151,88	168,74	177,61	172,31	175,86	160,65	166,08	158,41	139,85	59,24	56,13	49,88	-60,89
SF_6	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	13,91	30,53	24,95	24,02	25,09	24,64	24,18	23,96	24,41	21,72	23,44	28,09	34,80	32,66	34,46	39,42	37,07	40,90	100,00
Total (including LULUCF)	**556 556,37**	**440 685,41**	**429 432,26**	**425 191,36**	**424 530,79**	**423 366,23**	**426 820,82**	**438 887,58**	**430 651,51**	**401 492,67**	**390 133,00**	**377 083,30**	**370 727,68**	**356 930,59**	**369 405,80**	**370 262,20**	**368 595,09**	**380 975,69**	**386 027,69**	**375 912,60**	**355 486,89**	**376 648,14**	**377 477,20**	**-32,18**
Total (excluding LULUCF)	**562 145,27**	**457 014,65**	**447 245,69**	**433 379,85**	**433 657,57**	**430 058,30**	**432 460,44**	**445 655,46**	**437 142,93**	**408 784,60**	**398 642,23**	**385 380,81**	**382 064,51**	**369 036,35**	**382 013,94**	**386 655,12**	**390 230,71**	**406 011,53**	**407 860,99**	**400 213,95**	**380 586,83**	**401 670,35**	**399 389,55**	**-28,95**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1988)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	O_2 equivalent	(%)
1. Energy	470 203,27	374 069,28	374 593,98	365 079,44	367 091,25	360 725,59	361 867,95	376 982,71	366 724,67	338 916,54	330 890,23	317 797,83	316 438,61	305 226,87	316 161,75	319 373,26	317 294,89	328 976,85	327 676,32	321 468,59	310 717,64	330 275,36	325 205,95	-30,84
2. Industrial Processes	29 787,98	22 024,98	19 055,26	18 217,13	18 206,60	20 704,02	21 941,52	20 851,44	21 459,27	19 757,68	18 901,07	21 457,87	20 104,70	18 370,47	21 265,20	22 920,91	27 934,13	30 417,41	32 732,38	31 569,96	23 641,43	25 950,46	28 719,88	-3,59
3. Solvent and Other Product Use	1 006,46	629,23	608,22	558,57	519,36	521,05	524,81	550,00	548,63	552,44	547,19	627,89	631,77	661,01	645,02	677,09	687,75	761,46	721,65	797,18	751,41	779,40	788,67	-21,64
4. Agriculture	50 763,84	49 655,35	42 040,69	38 499,62	36 704,72	36 981,38	37 077,84	36 064,97	36 917,34	37 675,34	36 227,97	34 462,84	34 139,19	34 037,24	33 439,96	33 275,37	33 787,05	35 349,87	36 169,59	36 166,32	35 209,61	34 560,56	34 929,80	-31,19
5. Land Use, Land-Use Change and Forestry[5]	-5 588,89	-16 329,24	-17 813,43	-8 188,49	-9 126,78	-6 692,07	-5 639,62	-6 767,88	-6 491,43	-7 291,93	-8 509,23	-8 297,52	-11 336,83	-12 105,77	-12 608,14	-16 392,92	-21 635,62	-25 035,84	-21 833,30	-24 301,36	-25 099,94	-25 022,21	-21 912,35	292,07
6. Waste	10 383,71	10 635,81	10 947,54	11 025,08	11 135,64	11 126,25	11 048,33	11 206,35	11 493,03	11 882,60	12 075,77	11 034,38	10 750,24	10 740,77	10 502,01	10 408,49	10 526,90	10 505,94	10 561,06	10 211,91	10 266,73	10 104,57	9 745,25	-6,15
7. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
Total (including LULUCF)[6]	**556 556,37**	**440 685,41**	**429 432,26**	**425 191,36**	**424 530,79**	**423 366,23**	**426 820,82**	**438 887,58**	**430 651,51**	**401 492,67**	**390 133,00**	**377 083,30**	**370 727,68**	**356 930,59**	**369 405,80**	**370 262,20**	**368 595,09**	**380 975,69**	**386 027,69**	**375 912,60**	**355 486,89**	**376 648,14**	**377 477,20**	**-32,18**

Table 1
(cont.) **Emission trends (CH4)**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1988)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	1 180,92	904,26	888,82	842,87	891,61	910,59	936,74	959,65	944,97	848,47	858,31	812,16	813,86	766,08	788,61	796,09	793,67	796,18	754,48	738,86	694,37	724,21	700,86	-40,65
A. Fuel Combustion (Sectoral Approach)	219,11	122,18	151,23	156,97	197,34	178,24	177,33	183,25	164,03	139,16	140,23	114,12	123,44	116,41	113,66	118,08	124,87	138,47	129,61	136,73	138,81	162,19	144,66	-33,98
1. Energy Industries	3,69	3,29	3,19	3,15	2,87	2,89	2,30	2,38	2,32	2,28	2,18	2,15	2,23	2,20	2,27	2,37	2,65	2,81	2,90	3,23	3,67	4,10	4,50	22,17
2. Manufacturing Industries and Construction	3,92	3,19	3,29	3,08	4,16	4,22	5,90	6,34	5,80	4,95	4,36	4,25	3,91	3,81	3,66	3,65	3,22	3,25	3,38	3,31	3,31	3,54	3,70	-5,69
3. Transport	4,81	4,62	5,21	5,40	5,52	6,08	6,02	6,13	6,09	5,61	5,98	4,54	4,36	4,25	4,39	4,78	4,62	4,97	5,06	5,09	5,04	5,12	5,04	4,94
4. Other Sectors	206,69	111,09	139,54	145,34	184,79	165,05	163,11	168,39	149,82	126,32	127,71	103,17	112,94	106,14	103,35	107,29	114,38	127,44	118,27	125,10	126,80	149,44	131,41	-36,42
5. Other	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	0,00
B. Fugitive Emissions from Fuels	961,81	782,08	737,59	685,90	694,27	732,35	759,41	776,40	780,94	709,31	718,08	698,04	690,42	649,68	674,95	678,01	668,80	657,71	624,87	602,13	555,56	562,02	556,20	-42,17
1. Solid Fuels	797,38	634,69	597,86	555,40	554,74	592,99	607,64	617,52	622,48	548,78	562,41	529,64	514,43	477,88	485,77	477,46	463,12	446,90	415,37	392,25	353,62	349,58	342,04	-57,10
2. Oil and Natural Gas	164,43	147,39	139,73	130,50	139,53	139,36	151,77	158,88	158,46	160,53	155,67	168,40	175,99	171,79	189,18	200,54	205,68	210,80	209,50	209,88	201,94	212,44	214,16	30,24
2. Industrial Processes	**15,00**	**10,15**	**9,60**	**9,19**	**9,88**	**11,54**	**13,23**	**12,91**	**13,35**	**12,13**	**10,66**	**13,05**	**12,27**	**9,83**	**13,08**	**14,52**	**15,00**	**14,61**	**15,19**	**15,29**	**12,39**	**12,88**	**14,56**	**-2,91**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
B. Chemical Industry	13,18	8,65	8,50	8,14	8,86	10,37	12,01	11,72	12,08	11,02	9,62	11,84	11,17	8,77	11,92	13,21	13,41	12,83	13,35	13,51	11,16	11,44	12,90	-2,15
C. Metal Production	1,82	1,50	1,10	1,05	1,02	1,16	1,21	1,19	1,27	1,11	1,03	1,21	1,10	1,06	1,16	1,31	1,59	1,78	1,85	1,78	1,23	1,44	1,66	-8,42
D. Other Production																								
E. Production of Halocarbons and SF_6																								
F. Consumption of Halocarbons and SF_6																								
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
3. Solvent and Other Product Use																								
4. Agriculture	**909,57**	**899,48**	**828,84**	**762,55**	**694,77**	**686,54**	**661,58**	**633,53**	**650,42**	**668,48**	**640,29**	**597,14**	**579,33**	**581,67**	**580,39**	**562,94**	**581,30**	**598,90**	**605,28**	**590,53**	**580,39**	**581,15**	**576,83**	**-36,58**
A. Enteric Fermentation	745,98	741,03	660,10	598,05	551,09	540,40	512,58	495,87	512,95	525,49	497,39	462,76	444,89	431,80	429,40	417,22	425,98	436,40	442,92	443,04	438,12	439,39	442,22	-40,72
B. Manure Management	162,78	157,65	167,96	163,83	142,87	145,47	148,20	136,88	136,72	142,17	142,14	133,67	133,61	149,11	150,27	144,84	154,55	161,76	161,62	146,57	141,29	140,92	133,77	-17,82
C. Rice Cultivation	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	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
D. Agricultural Soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
F. Field Burning of Agricultural Residues	0,81	0,80	0,78	0,68	0,81	0,68	0,80	0,77	0,75	0,82	0,75	0,71	0,83	0,76	0,72	0,89	0,77	0,75	0,74	0,91	0,98	0,85	0,84	3,28
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
5. Land Use, Land-Use Change and Forestry	**104,29**	**104,59**	**103,60**	**113,51**	**105,21**	**105,32**	**104,91**	**106,69**	**105,05**	**104,37**	**105,46**	**105,09**	**104,03**	**104,73**	**108,94**	**105,09**	**105,81**	**106,23**	**105,73**	**106,06**	**106,22**	**106,38**	**107,10**	**2,70**
A. Forest Land	1,70	1,71	0,61	10,34	1,83	1,94	1,14	3,06	1,42	0,87	1,74	1,48	0,71	1,09	4,48	0,80	1,22	1,24	0,74	0,63	0,94	0,46	0,59	-65,12
B. Cropland	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	0,00
C. Grassland	0,41	0,41	0,41	0,41	0,41	0,41	0,60	0,21	0,29	0,14	0,30	0,11	0,13	0,21	0,32	0,20	0,19	0,41	0,06	0,24	0,05	0,06	0,06	-86,08
D. Wetlands	102,17	102,47	102,57	102,76	102,97	102,96	103,17	103,41	103,35	103,36	103,42	103,50	103,19	103,43	104,15	104,09	104,40	104,58	104,93	105,18	105,24	105,86	106,45	4,19
E. Settlements	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	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
F. Other Land	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	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
6. Waste	**412,24**	**432,14**	**448,30**	**452,91**	**458,80**	**460,17**	**455,62**	**462,74**	**477,25**	**493,28**	**505,70**	**451,98**	**439,42**	**437,72**	**430,13**	**430,53**	**435,06**	**434,27**	**435,68**	**423,32**	**425,19**	**417,39**	**400,03**	**-2,96**
A. Solid Waste Disposal on Land	330,19	353,05	358,91	362,51	365,53	367,69	370,28	376,15	382,76	391,93	399,72	406,65	394,33	391,84	383,09	382,72	386,58	385,18	385,50	372,43	373,43	364,80	347,16	5,14
B. Waste-water Handling	82,06	79,08	89,39	90,40	93,27	92,47	85,34	86,59	94,49	101,35	105,98	45,33	45,09	45,88	47,04	47,81	48,48	49,09	50,18	50,89	51,76	52,59	52,88	-35,56
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0,00**
Total CH_4 emissions including CH_4 from LULUCF	**2 622,03**	**2 350,61**	**2 279,17**	**2 181,04**	**2 160,28**	**2 174,16**	**2 172,07**	**2 175,52**	**2 191,03**	**2 126,74**	**2 120,41**	**1 979,42**	**1 948,91**	**1 900,03**	**1 921,16**	**1 909,18**	**1 930,84**	**1 950,19**	**1 916,36**	**1 874,06**	**1 818,56**	**1 842,02**	**1 799,38**	**-31,37**
Total CH_4 emissions excluding CH_4 from LULUCF	**2 517,74**	**2 246,02**	**2 175,56**	**2 067,52**	**2 055,06**	**2 068,84**	**2 067,17**	**2 068,84**	**2 085,98**	**2 022,36**	**2 014,95**	**1 874,33**	**1 844,87**	**1 795,30**	**1 812,22**	**1 804,08**	**1 825,03**	**1 843,96**	**1 810,63**	**1 768,00**	**1 712,34**	**1 735,64**	**1 692,28**	**-32,79**
Memo Items:																								
International Bunkers	0,16	0,12	0,05	0,07	0,04	0,04	0,05	0,05	0,07	0,08	0,11	0,09	0,08	0,08	0,09	0,08	0,10	0,09	0,08	0,09	0,08	0,07	0,06	-62,68
Aviation	0,01	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	17,28
Marine	0,15	0,12	0,05	0,07	0,04	0,04	0,04	0,05	0,06	0,08	0,11	0,08	0,08	0,08	0,08	0,07	0,09	0,09	0,07	0,08	0,07	0,06	0,05	-66,78
Multilateral Operations	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
CO_2 Emissions from Biomass																								

Table 1
(cont.) **Emission trends (N2O)**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1988)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**6,88**	**5,66**	**5,77**	**5,75**	**6,23**	**6,12**	**6,18**	**6,55**	**6,45**	**6,10**	**6,02**	**5,75**	**5,73**	**5,55**	**5,71**	**5,85**	**5,95**	**6,08**	**6,17**	**6,26**	**6,30**	**6,74**	**6,77**	**-1,58**
A. Fuel Combustion (Sectoral Approach)	6,88	5,66	5,77	5,75	6,23	6,12	6,18	6,55	6,45	6,10	6,02	5,75	5,73	5,55	5,71	5,84	5,95	6,08	6,16	6,26	6,30	6,74	6,77	-1,58
1. Energy Industries	3,82	3,43	3,39	3,26	3,06	3,02	2,78	2,88	2,80	2,70	2,62	2,56	2,59	2,50	2,61	2,58	2,62	2,70	2,67	2,61	2,59	2,70	2,76	-27,85
2. Manufacturing Industries and Construction	0,57	0,46	0,48	0,44	0,61	0,61	0,86	0,93	0,85	0,72	0,64	0,62	0,56	0,55	0,52	0,52	0,46	0,46	0,48	0,47	0,46	0,50	0,52	-9,55
3. Transport	0,57	0,64	0,66	0,69	0,67	0,69	0,73	0,87	0,94	1,02	1,11	0,97	0,95	0,89	0,98	1,11	1,21	1,35	1,55	1,68	1,74	1,87	1,91	234,83
4. Other Sectors	1,91	1,13	1,24	1,35	1,89	1,80	1,81	1,86	1,86	1,65	1,66	1,60	1,63	1,61	1,60	1,63	1,67	1,57	1,47	1,51	1,51	1,66	1,58	-17,42
5. Other	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	0,00
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	64,91
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
2. Oil and Natural Gas	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	64,91
2. Industrial Processes	**16,11**	**11,87**	**10,57**	**10,40**	**11,85**	**11,83**	**13,09**	**13,09**	**12,32**	**11,43**	**11,24**	**13,68**	**14,03**	**11,65**	**13,86**	**14,20**	**14,94**	**14,86**	**15,42**	**13,01**	**3,54**	**3,79**	**3,49**	**-78,30**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
B. Chemical Industry	16,11	11,87	10,57	10,40	11,85	11,83	13,09	13,09	12,32	11,43	11,24	13,68	14,03	11,65	13,86	14,20	14,87	14,77	15,34	12,93	3,50	3,74	3,43	-78,68
C. Metal 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	0,07	0,09	0,09	0,08	0,04	0,05	0,06	100,00
D. Other Production																								
E. Production of Halocarbons and SF_6																								
F. Consumption of Halocarbons and SF_6																								
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
3. Solvent and Other Product Use	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,00
4. Agriculture	**102,14**	**99,25**	**79,47**	**72,54**	**71,34**	**72,79**	**74,79**	**73,42**	**75,03**	**76,25**	**73,49**	**70,72**	**70,88**	**70,39**	**68,55**	**69,21**	**69,61**	**73,46**	**75,67**	**76,66**	**74,26**	**72,12**	**73,60**	**-27,94**
A. Enteric Fermentation																								
B. Manure Management	25,91	25,52	24,25	23,08	21,08	21,19	20,94	19,93	20,41	21,10	20,22	18,81	18,39	18,84	18,35	17,30	17,69	18,30	18,24	17,37	16,66	16,79	16,48	-36,41
C. Rice Cultivation																								
D. Agricultural Soils	76,19	73,69	55,18	49,43	50,21	51,56	53,82	53,46	54,58	55,11	53,24	51,88	52,45	51,52	50,18	51,87	51,89	55,13	57,41	59,25	57,56	55,29	57,09	-25,07
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
F. Field Burning of Agricultural Residues	0,04	0,04	0,03	0,03	0,04	0,03	0,03	0,04	0,03	0,04	0,03	0,03	0,04	0,03	0,03	0,04	0,03	0,03	0,03	0,04	0,04	0,03	0,03	-10,41
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
5. Land Use, Land-Use Change and Forestry	**0,06**	**0,05**	**0,03**	**0,18**	**0,05**	**0,05**	**0,04**	**0,06**	**0,04**	**0,02**	**0,06**	**0,05**	**0,03**	**0,05**	**0,10**	**0,05**	**0,05**	**0,05**	**0,03**	**0,03**	**0,03**	**0,03**	**0,03**	**-48,57**
A. Forest Land	0,03	0,03	0,01	0,16	0,03	0,03	0,02	0,05	0,02	0,01	0,03	0,02	0,01	0,02	0,07	0,01	0,02	0,02	0,01	0,01	0,01	0,01	0,01	-65,12
B. Cropland	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	0,00
C. Grassland	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	-86,08
D. Wetlands	0,02	0,02	0,02	0,02	0,02	0,01	0,01	0,01	0,01	0,01	0,03	0,03	0,02	0,03	0,03	0,03	0,03	0,02	0,02	0,02	0,02	0,02	0,02	-19,84
E. Settlements	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	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
F. Other Land	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	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
6. Waste	**3,74**	**3,59**	**3,65**	**3,65**	**3,62**	**3,49**	**3,53**	**3,54**	**3,49**	**3,58**	**3,58**	**3,56**	**3,56**	**3,60**	**3,60**	**3,53**	**3,52**	**3,53**	**3,61**	**3,50**	**3,57**	**3,60**	**3,61**	**-3,50**
A. Solid Waste Disposal on Land																								
B. Waste-water Handling	3,68	3,55	3,61	3,61	3,58	3,45	3,49	3,50	3,45	3,53	3,54	3,51	3,50	3,53	3,54	3,48	3,47	3,48	3,56	3,48	3,54	3,57	3,58	-2,78
C. Waste Incineration	0,06	0,05	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,05	0,04	0,05	0,07	0,07	0,06	0,05	0,05	0,05	0,05	0,03	0,03	0,03	0,03	-46,76
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0,00**
Total N_2O emissions including N_2O from LULUCF	**129,32**	**120,82**	**99,90**	**92,92**	**93,49**	**94,68**	**98,03**	**97,06**	**97,72**	**97,79**	**94,79**	**94,17**	**94,64**	**91,64**	**92,23**	**93,22**	**94,48**	**98,38**	**101,30**	**99,87**	**88,11**	**86,67**	**87,90**	**-32,03**
Total N_2O emissions excluding N_2O from LULUCF	**129,26**	**120,76**	**99,86**	**92,74**	**93,44**	**94,63**	**97,99**	**97,00**	**97,68**	**97,76**	**94,74**	**94,12**	**94,61**	**91,59**	**92,13**	**93,17**	**94,43**	**98,33**	**101,27**	**99,84**	**88,07**	**86,65**	**87,87**	**-32,02**
Memo Items:																								
International Bunkers	**0,08**	**0,05**	**0,03**	**0,04**	**0,03**	**0,03**	**0,04**	**0,04**	**0,04**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,06**	**0,06**	**0,06**	**0,07**	**0,07**	**0,06**	**0,06**	**-27,40**
Aviation	0,04	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,02	0,03	0,02	0,02	0,03	0,03	0,03	0,04	0,04	0,05	0,04	0,05	0,04	21,60
Marine	0,04	0,03	0,01	0,02	0,01	0,01	0,01	0,01	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02	0,01	-66,78
Multilateral Operations	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
CO_2 Emissions from Biomass																								

Table 1
(cont.) **Emission trends (N2O)**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1988)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**6,88**	**5,66**	**5,77**	**5,75**	**6,23**	**6,12**	**6,18**	**6,55**	**6,45**	**6,10**	**6,02**	**5,75**	**5,73**	**5,55**	**5,71**	**5,85**	**5,95**	**6,08**	**6,17**	**6,26**	**6,30**	**6,74**	**6,77**	**-1,58**
A. Fuel Combustion (Sectoral Approach)	6,88	5,66	5,77	5,75	6,23	6,12	6,18	6,55	6,45	6,10	6,02	5,75	5,73	5,55	5,71	5,84	5,95	6,08	6,16	6,26	6,30	6,74	6,77	-1,58
1. Energy Industries	3,82	3,43	3,39	3,26	3,06	3,02	2,78	2,88	2,80	2,70	2,62	2,56	2,59	2,50	2,61	2,58	2,62	2,70	2,67	2,61	2,59	2,70	2,76	-27,85
2. Manufacturing Industries and Construction	0,57	0,46	0,48	0,44	0,61	0,61	0,86	0,93	0,85	0,72	0,64	0,62	0,56	0,55	0,52	0,52	0,46	0,46	0,48	0,47	0,46	0,50	0,52	-9,55
3. Transport	0,57	0,64	0,66	0,69	0,67	0,69	0,73	0,87	0,94	1,02	1,11	0,97	0,95	0,89	0,98	1,11	1,21	1,35	1,55	1,68	1,74	1,87	1,91	234,83
4. Other Sectors	1,91	1,13	1,24	1,35	1,89	1,80	1,81	1,86	1,86	1,65	1,66	1,60	1,63	1,61	1,60	1,63	1,67	1,57	1,47	1,51	1,51	1,66	1,58	-17,42
5. Other	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	0,00
B. Fugitive Emissions from Fuels	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	64,91
1. Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
2. Oil and Natural Gas	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	64,91
2. Industrial Processes	**16,11**	**11,87**	**10,57**	**10,40**	**11,85**	**11,83**	**13,09**	**13,09**	**12,32**	**11,43**	**11,24**	**13,68**	**14,03**	**11,65**	**13,86**	**14,20**	**14,94**	**14,86**	**15,42**	**13,01**	**3,54**	**3,79**	**3,49**	**-78,30**
A. Mineral Products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
B. Chemical Industry	16,11	11,87	10,57	10,40	11,85	11,83	13,09	13,09	12,32	11,43	11,24	13,68	14,03	11,65	13,86	14,20	14,87	14,77	15,34	12,93	3,50	3,74	3,43	-78,68
C. Metal 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	0,07	0,09	0,09	0,08	0,04	0,05	0,06	100,00
D. Other Production																								
E. Production of Halocarbons and SF_6																								
F. Consumption of Halocarbons and SF_6																								
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
3. Solvent and Other Product Use	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,40	0,00
4. Agriculture	**102,14**	**99,25**	**79,47**	**72,54**	**71,34**	**72,79**	**74,79**	**73,42**	**75,03**	**76,25**	**73,49**	**70,72**	**70,88**	**70,39**	**68,55**	**69,21**	**69,61**	**73,46**	**75,67**	**76,66**	**74,26**	**72,12**	**73,60**	**-27,94**
A. Enteric Fermentation																								
B. Manure Management	25,91	25,52	24,25	23,08	21,08	21,19	20,94	19,93	20,41	21,10	20,22	18,81	18,39	18,84	18,35	17,30	17,69	18,30	18,24	17,37	16,66	16,79	16,48	-36,41
C. Rice Cultivation																								
D. Agricultural Soils	76,19	73,69	55,18	49,43	50,21	51,56	53,82	53,46	54,58	55,11	53,24	51,88	52,45	51,52	50,18	51,87	51,89	55,13	57,41	59,25	57,56	55,29	57,09	-25,07
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
F. Field Burning of Agricultural Residues	0,04	0,04	0,03	0,03	0,04	0,03	0,03	0,04	0,03	0,04	0,03	0,03	0,04	0,03	0,03	0,04	0,03	0,03	0,03	0,04	0,04	0,03	0,03	-10,41
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
5. Land Use, Land-Use Change and Forestry	**0,06**	**0,05**	**0,03**	**0,18**	**0,05**	**0,05**	**0,04**	**0,06**	**0,04**	**0,02**	**0,06**	**0,05**	**0,03**	**0,05**	**0,10**	**0,05**	**0,05**	**0,05**	**0,03**	**0,03**	**0,03**	**0,03**	**0,03**	**-48,57**
A. Forest Land	0,03	0,03	0,01	0,16	0,03	0,03	0,02	0,05	0,02	0,01	0,03	0,02	0,01	0,02	0,07	0,01	0,02	0,02	0,01	0,01	0,01	0,01	0,01	-65,12
B. Cropland	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	IE,NO	0,00
C. Grassland	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	-86,08
D. Wetlands	0,02	0,02	0,02	0,02	0,02	0,01	0,01	0,01	0,01	0,01	0,03	0,03	0,02	0,03	0,03	0,03	0,03	0,02	0,02	0,02	0,02	0,02	0,02	-19,84
E. Settlements	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	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
F. Other Land	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	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0,00
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
6. Waste	**3,74**	**3,59**	**3,65**	**3,65**	**3,62**	**3,49**	**3,53**	**3,54**	**3,49**	**3,58**	**3,58**	**3,56**	**3,56**	**3,60**	**3,60**	**3,53**	**3,52**	**3,53**	**3,61**	**3,50**	**3,57**	**3,60**	**3,61**	**-3,50**
A. Solid Waste Disposal on Land																								
B. Waste-water Handling	3,68	3,55	3,61	3,61	3,58	3,45	3,49	3,50	3,45	3,53	3,54	3,51	3,50	3,53	3,54	3,48	3,47	3,48	3,56	3,48	3,54	3,57	3,58	-2,78
C. Waste Incineration	0,06	0,05	0,04	0,04	0,04	0,04	0,04	0,04	0,04	0,05	0,04	0,05	0,07	0,07	0,06	0,05	0,05	0,05	0,05	0,03	0,03	0,03	0,03	-46,76
D. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	0,00
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**0,00**
Total N_2O emissions including N_2O from LULUCF	**129,32**	**120,82**	**99,90**	**92,92**	**93,49**	**94,68**	**98,03**	**97,06**	**97,72**	**97,79**	**94,79**	**94,17**	**94,64**	**91,64**	**92,23**	**93,22**	**94,48**	**98,38**	**101,30**	**99,87**	**88,11**	**86,67**	**87,90**	**-32,03**
Total N_2O emissions excluding N_2O from LULUCF	**129,26**	**120,76**	**99,86**	**92,74**	**93,44**	**94,63**	**97,99**	**97,00**	**97,68**	**97,76**	**94,74**	**94,12**	**94,61**	**91,59**	**92,13**	**93,17**	**94,43**	**98,33**	**101,27**	**99,84**	**88,07**	**86,65**	**87,87**	**-32,02**
Memo Items:																								
International Bunkers	**0,08**	**0,05**	**0,03**	**0,04**	**0,03**	**0,03**	**0,04**	**0,04**	**0,04**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,05**	**0,06**	**0,06**	**0,06**	**0,07**	**0,07**	**0,06**	**0,06**	**-27,40**
Aviation	0,04	0,02	0,02	0,02	0,02	0,02	0,02	0,03	0,03	0,03	0,02	0,03	0,02	0,02	0,03	0,03	0,03	0,04	0,04	0,05	0,04	0,05	0,04	21,60
Marine	0,04	0,03	0,01	0,02	0,01	0,01	0,01	0,01	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02	0,03	0,02	0,02	0,02	0,02	0,02	0,01	-66,78
Multilateral Operations	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,00
CO_2 Emissions from Biomass																								

Table 3. Progress in the achievement of the quantified economy-wide emission reduction target: information on mitigation measures and their effects

No	Name of mitigation action	Sector(s) affected	GHG(s) affected	Objective and/ or activity affected	Type of instrument	Status of implementation	Brief description	Start year of implementation	Implementing entity or entities	Estimate of mitigation impact (not cumulative, in kt CO2eq)	
										20XX	2020
TRANSPORT											
1	**Reduction in the environmental annoyance of goods road transport**	Transport	CO_2, N_2O	Reductions in vehicle exhaust gas emissions	legal, financial, technical, educational	implemented	Differentiated rates of charges for travels on national roads, depending on the levels of vehicle exhaust gas emissions, charges for the use of motor fuels generated from non-renewable sources, the information system concerning fuel consumption and CO_2 emissions from new passenger cars, the mandatory control of exhaust gas emissions as part of inspections of the technical condition of vehicles, support for the purchase of environment–friendly vehicles within the framework of *regional operational programmes* and the *Green Investment Scheme*, the adoption of more stringent emission standards for internal-combustion engines. Preferential tax rate on LPG in comparison to traditional fuels, tax reliefs for bio-components for motor fuels (dehydrated alcohols, ethers and esters), special prices of gaseous fuel, mechanisms supporting the construction of installations to produce bio-components and biofuels, as well as promoting the use of these fuels (the production of biofuels for own use, selected fleets, the excise tax).Improvements in the efficiency of fuel consumption in new commissioned cars, trucks and buses (the development of the electric drive technology of the plug-in and hybrid types in buses).The conduct of public campaigns on the impact of the operation of roadworthy vehicles and the limitation of the speed of motor vehicles on reductions in environmental pollution, including greenhouse gas emissions.		Minister responsible for transport, Minister responsible for the economy, Minister responsible for regional development, Minister responsible for finance, Minister responsible for the environment, National Road Traffic Safety Council, National Fund for Environmental Protection and Water Management (NFOŚiGW)	2015: 2,241.39 Gg [2)]	2020: 3,246.5 Gg [2)] 2025: 4,982.59 Gg [2]
2	**Enhanced share of alternative fuels in transport**	Transport	CO_2	Enhanced use of LPG and biofuels	financial	implemented	Preferential tax rate on LPG in comparison to traditional fuels, tax reliefs for bio-components for motor fuels (dehydrated alcohols, ethers and esters), special natural gas prices and the obligation to introduce bio-components into fuels, mechanisms supporting the construction of installations to produce bio-components and biofuels.		Minister responsible for the economy, Minister responsible for finance, Minister responsible for transport, Minister responsible for regional development, Minister responsible for the environment, NFOŚiGW	5.75%[1)]	2015: 7.1% 2020: 10%
3	**Rail transport**	Transport	CO_2	Improvements in	legal, financial	implemented	Modernisation of rail infrastructure (including railway		Minister	NA	NA

				energy efficiency			stations), the purchase and modernisation of rolling stock. Putting in operation lightweight railcars, i.e. railbuses designed to serve the local traffic,. adapting the number of train carriages to the transport needs and replacing traditional trains by lightweight railcars on lines with lesser passenger streams. Modernisation of rail infrastructure enabling higher traffic speeds and travel frequency of trains.		responsible for transport, State Railways Track Manager (PKP PLK), territorial self-government units		
4	**Sea shipping**	Transport	CO_2, N_2O	Improvements in energy efficiency	legal	implemented	Drafting and adoption of international regulations concerning the Energy Efficiency Design Index (EEDI) for newly built ships.		Minister responsible for transport	NA	NA
5	**Air transport**	Transport	CO_2, N_2O	Reductions in fuel consumption	legal, technical	implemented	Activities to establish the Single European Sky (SES), carbon accreditations ACI, restructuring of the system of air traffic routes, strengthening of emission standards, economical management of propellants		Minister responsible for transport	NA	NA
6	**City transport, including public transport**	Transport	CO_2, N_2O	A decrease in the traffic of passenger cars, improvements in energy efficiency	legal, administrative, technical	implemented	Use of a system of incentives encouraging the use of collective transport. Construction of ring roads (both outside cities and the so-called internal city ring roads), the improvement of the condition of the road surface and the appropriate change in the traffic organisation.		territorial self-government units and other entities, mainly General Directorate of National Roads and Motorways (GDDKi)A	NA	NA
7	**Intermodal transport**	Transport	CO_2, N_2O	A decrease in road transport	legal, administrative, financial	implemented	Development of intermodal transport as an alternative to the dominating road transport through the construction and modernisation of terminals, the purchase of a fleet and cut rates of charges for access to rail infrastructure.		Minister responsible for transport, carriers, terminal managers	NA	NA
8	**Cycling transport**	Transport	CO_2, N_2O	An increase in cycle traffic	legal, administrative	implemented	Amendments to legal regulations, the construction of cycle paths, the introduction of a system of public cycle hire facilities in cities and the promotion of the bicycle as a means of transport; promotion of cycling transport.		Minister responsible for transport, Minister responsible for regional development, Minister responsible for sports, territorial self-government units	NA	NA
CONSTRUCTION											
9	**The requirements related to the energy standard in construction**	Construction	CO_2	A decrease in energy consumption	legal	implemented	Expansion and modification of technical construction regulations concerning the thermal protection of buildings.		Minister responsible for construction	NA	NA
10	**The assessment**	Construction	CO_2	A decrease in	legal	implemented	Energy performance certificates and inspections of		Minister	NA	NA

	of the energy performance of buildings			energy consumption			heating and air-conditioning systems.		responsible for infrastructure and development		
11	**The promotion of the use of renewable energy sources**	Construction	CO_2	An increase in RES consumption	legal, financial	implemented	Promotion of high-efficiency systems for supply of electricity and heat using energy from renewable sources.		Minister responsible for infrastructure and development Minister responsible for the economy, National Fund for Environmental Protection and Water Management (NFOŚiGW),Minister responsible for the environment	NA	NA
12	**Thermal modernisation of buildings**	Construction	CO_2	A decrease in energy consumption	legal, financial	implemented	Financial support for thermal modernisation projects.		Minister responsible for construction	2010: [3] 15,673 Gg 2015: [3] 16,000 Gg	2020: [3] 16,000 Gg 2025: [3] 16,000 Gg
13	**The raising of the awareness of managers and owners of buildings concerning energy savings**	Construction	CO_2	Improvements in energy efficiency	educational	implemented	Popularisation of measures to save energy.		Minister responsible for construction	NA	NA
AGRICULTURE											
14	**The rationalisation of the use of fertilisers, including nitrogen fertilisers**	Agriculture	N_2O	Correct use of fertilisers	legal, organisational	implemented	A limitation of the natural fertiliser dose to 170 kg N/ha/year, a ban on the use of natural fertilisers from the end of November to the beginning of March, mandatory training courses for farmers who use fertilizers and a ban on the use of fertilisers on water-saturated, snow-covered and frozen soils and in fields with a slope of more than 10% were introduced. The obligation to prepare a fertilisation plan was imposed on large commercial farms. The fertiliser extension system is disseminated. The mineral nitrogen content in the soils of arable lands and grasslands is also monitored on a regular basis.		institutes, chemical and agricultural stations, farmers	NA	NA
15	**The rationalisation of energy management in agriculture, including the production of**	Agriculture	CO_2, CH_4	A decrease in energy consumption and the use of RES	legal, organisational, research, educational	implemented	Continued process of building new biogas plants, urine and liquid manure tanks and manure plates; adaptation of local boiler-houses to burn wood biomass and straw; increased consumption of ethanol and bioethanol in fuels; use of more energy efficient agricultural machinery and equipment; improvements in the biogas production processes at agricultural		self-government administration, advisers, entrepreneurs, farmers, institutes	NA	In 2025: CO_2 – by 3.47424 Gg CH_4 – by 0.01302 Gg

	energy from biomass from waste, liquid manure and solid manure						biogas plants; research and development work to develop technologies to increase the yield rate and methane content in biogas from locally acquired substrates and feeds on the sites where agricultural biogas plants are built; promotion of the use of renewable energy in agriculture.				
16	**Improvements in animal feeding techniques and feed management**	Agriculture	CO_2, CH_4	A decrease in gas emissions	legal, organisational	implemented	Implementation of breeding programmes and precise animal feeding standards combined with higher productivity and the resulting reduction in the livestock population.		farmers	NA	In 2025: CO_2 – by 0.800 Gg CH_4 – by 0.100 Gg
17	**Afforestation of agricultural land and non-agricultural land**	Agriculture	CO_2	Greater CO_2 removals	legal, organisational, financial	implemented	Afforestation of agricultural land and non-agricultural land within in the framework of the Rural Development Programme .		Agency for Restructuring and Modernisation of Agriculture , farmers	data in Gg [8]: 2008: 60.253 2009: 200.409 2010: 368.634 2011: 432538	NA
18	**Preferences for crops with high CO_2 capture**	Agriculture	CO_2	Greater CO_2 removals	legal, financial, research, educational	implemented	Support for the cultivation of plants for energy purposes. Improvements in technologies for growing and harvesting energy plants and research to develop technologies and to implement the cultivation of new species of energy plants.		Agricultural Property Agency (ANR), farmers, institutes	NA	2025: CO_2 – by 16.640 Gg
19	**The rational management of farmland (arable land and permanent grassland)**	Agriculture	CO_2	Protection of soil against mineralisation	legal, organisational, financial, research, educational		The requirement to comply with the practices of good agricultural culture, such as the minimum soil cover and crop rotation under the EU Common Agricultural Policy. Dissemination of conservation methods for soil cultivation without ploughing designed to reduce gas emissions from mineralisation of organic matter. Research on the halting of mineralisation of organic soils used as meadows and pastures by their irrigation and the limitation of groundwater runoff.		institutes, advisers, agricultural machinery industry	NA	NA
20	**Improvements in livestock keeping systems, reductions in methane emissions from animal excreta**	Agriculture	CH_4, N_2O, NH_3		research	implemented	Research and development work to develop new technological systems of buildings and new livestock keeping methods - partial covering of the coop by a grid, increasing the angle of inclination of the floor (faster excreta runoff) , the storage and disposal of animal excreta.		institutes, farmers	NA	<u>in 2020:</u> 1) keeping of animals : CH_4 – by 3.285Gg NH_3 – by 0.13 Gg <u>in 2025:</u> 1) storage and disposal of excreta CH_4 – by 0.600 Gg N_2O – by 1.000 Gg 2) keeping of animals: CH_4 – by 3.285Gg NH_3 – by 0.13 Gg
21	**The elimination of gaseous pollutants**	Agriculture	CH_4, NH_3	Reductions in pollutants	research	The technology been	Research to estimate and select the most suitable plants for applications of this type; moreover, the development of modified henhouses with solar		institutes, production enterprises	NA	NA

	emitted from poultry buildings by using phytomediation and solar ventilation					developed and the implementation agreement has been signed	ventilation is envisaged.				
WASTE											
22	**Enhanced recycling of municipal waste**	Waste	CH_4, CO_2, N_2O	Enhanced recycling	legal, organisational	continuous measure	Increasing the recycling of selected fractions of municipal waste. The achievement of the levels of recycling and preparing for the re-use of paper, metals, plastics and glass of at least 50% by weight by the end of 2020.		self-government administration	1) "Avoided" emissions in Gg CO_2 eq.[4]): 2008: 641.3 2009: 574.1 2010: 663.5 2011: 779.2 2) "Avoided" emissions in 2015[5]: 3,000 – 3,500 Gg CO_2 eq./Mg of waste	"Avoided" emissions in 2020 [4]): 4,000 – 4,500 Gg CO_2 eq./Mg of waste
23	**Waste as a source of energy**	Waste	CH_4, CO_2	Energy supply from waste	legal, organisational	continuous measure	Energy supply as a result of the application of waste incineration processes and the processing of landfill gas.		self-government administration, inspection services (environmental inspectorate), entrepreneurs	"Avoided" emissions in Gg CO_2 eq [6]): 2008: 159.2 2009: 210.8 2010: 271.0 2011: 373.9	
24	**The reduction of the quantity of waste, including biodegradable waste, going to landfills of non-hazardous and inert (municipal) waste**	Waste	CH_4, CO_2	Reduction of the quantity of waste deposited at landfills	legal, organisational	continuous measure	Reduction of the quantity of waste (including biodegradable waste) going to municipal waste landfills.		government administration, self-government administration (Marshals' Offices), inspection services (environmental inspectorate),	In 2015 [7]: emission reduction by at least 5-10% relative to 2010 (by 383-766 Gg CO_2 eq.)	In 2020 [7]): emission reduction by at least 5-10% relative to 2015 (by 345-728 Gg CO_2 eq.)
FORESTRY											
25	**Taking action against land use change**	Forestry	CO_2	Maintenance of the existing forest areas	legal	implemented	Conversion of forest land to non-forest uses is of marginal significance in relation to the continuously growing total surface area of forests and is slight.		State Forests National Forest Holding	NA	NA
26	**The rationalisation of forest management, incentives and measures supporting**	Forestry	CO_2	Enhancement of forest areas	legal	implemented	Afforestation of non-forest lands, reforestation, the enhancement of standing timber resources and timber logging which cannot exceed 50–60% of the annual increment. In 2006, the afforestation took place on a total of 22,800 ha of lands, including 4,800 ha of the State Treasury lands, and in 2007, respectively, on 9,000 ha and 3,200 ha of lands.		State Forests National Forest Holding	NA	NA

	afforestation and the protection of the ecological stability of forests										
ENERGY SECTOR											
27	**Stimulation of the development of cogeneration**	Energy sector	CO_2	Improvements in energy efficiency	legal, financial, organisational	implemented	A system of mechanisms of support for combined heat and power production.		Minister responsible for the economy	In 2010: [3] 223.474 Gg in 2015: [3] 199.890 Gg	In 2020: [3] 30.005 Gg in 2025: [3] 30.005 Gg
28	**Modernisation of local heating networks and the connection of heat users**	Energy sector	CO_2	Improvements in energy efficiency	legal, financial	implemented	A system of mechanisms of support for energy efficiency improvement .		Minister responsible for the economy	In 2010: [3] 84.956 Gg in 2015: [3] 143.063 Gg	In 2020: [3] 127.140 Gg in 2025: [3] 171.565 Gg
29	**Modernisation of heat sources**	Energy sector	CO_2	Improvements in energy efficiency	legal, financial	implemented	A system of mechanisms of support for energy efficiency improvement.		Minister responsible for the economy	In 2010: [3] 60.885 Gg in 2015: [3] 287.556 Gg	In 2020: [3] 96.601 Gg in 2025: [3] 119.971 Gg
30	**Modernisation of industrial installations**	Energy sector	CO_2	Improvements in energy efficiency	legal, financial	implemented	A system of mechanisms of support for energy efficiency improvement.		Minister responsible for the economy	In 2010: [3] 4.352 Gg in 2015: [3] 5.719 Gg	NA
31	**Modernisation of lighting systems**	Energy sector	CO_2	Improvements in energy efficiency	legal, financial	implemented	A system of mechanisms of support for energy efficiency improvement .		Minister responsible for the economy	In 2010: [3] 0.221 Gg in 2015: [3] 0.609 Gg	NA
32	**Support for the use of methane from hard coal mines to produce electricity and heat**	Energy sector	CH_4	Use of methane for energy purposes	legal, financial and organisational	implemented	Industrial use of methane from methane removal from hard coal mines.		Minister responsible for the economy	In 2010: [3] 265. 322 Gg	NA
33	**Support for the development of energy from renewable sources**	Energy sector	CO_2, CH_4	Enhanced use of RES	legal, financial and organisational	implemented	The sales of electricity from RES were exempted from the excise tax. The obligation to obtain a specific number of certificates of origin for electricity generated from renewable energy sources was imposed on energy companies selling electricity to end users.		Minister responsible for the economy Minister responsible for finance	In 2010: [3] 135.087 Gg in 2015: [3] 187.048 Gg	In 2020: [3] 163.846 Gg in 2025: [3] 169.853 Gg
INDUSTRY											
34	**Improvements in technical standards of installations and equipment**	Industry	CO_2	Improvements in energy efficiency	legal	implemented	Improvement in the energy efficiency of industrial production.		Minister responsible for the economy		

35	**Fluorinated greenhouse gases**	Industry	HFCs PFCs SF_6	Reductions in the consumption of the gases	legal, financial, organisational	planned	Introduction of mechanisms for monitoring and control of consumption.		Minister responsible for the environment Minister responsible for the economy		
36	**Implementation of the best available techniques**	Industry	All GHGs	Emission reductions	legal, financial organisational	implemented planned	Prevention and minimisation of emissions.		Minister responsible for the environment		
37	**Reductions in methane emissions from fuel production and distribution processes**	Industry	CH_4	Reduced losses in fuel trading	legal	implemented	Introduction of hermetic systems at fuel stations to gain savings in trading in liquid fuels (on average 0.37%).		Minister responsible for the economy		
38	**Promotion of environmentally friendly and effective practices and technologies in industrial activities and support for the development of environment-friendly and technically cost-effective methods for greenhouse gas emission reductions**	Industry	CO_2	Dissemination of environmentally friendly practices and technologies	educational	implemented	Popularisation of the best techniques in the individual fields of production.		Minister responsible for the economy		
39	**Technological modernisation at industrial plants**	Industry	CO_2	Improvements in energy efficiency and lower emission intensity	legal, financial, organisational	implemented	Improvement in energy efficiency and the replacement of fuels by low-emission ones.		Minister responsible for the economy		

NA – Not Available

[1] The recorded or predicted share of bio-components and other renewable fuels in the total quantity of liquid fuels and liquid biofuels used in the course of a calendar year in transport. On the basis of the values of the National Overall Target pursuant to the *Regulation of the Council of Ministers of 23 July 2013 on the National Overall Targets for 2013-2018* (Official Journal of the Laws, Item 918) and the information provided in the *Report to the European Commission on the support for the use of biofuels and other renewable fuels in transport in 2012*.

[2] Own calculations based on "Expert forecasts of changes in the activity of the road transport sector (in the context of the Act on the System to Manage the Emissions of Greenhouse Gases and Other Substances of 17 July 2009)", Motor Transport Institute, Warsaw 2012; "Forecasts of transport demand in Poland until 2020 and 2030", Jan Burnewicz, Sopot 2012. The forecast emission reductions were determined in relation to 2010.

[3] The effect of projects supported with the resources of the Voivodeship Funds for Environmental Protection and Water Management.

[4] Calculations based on data from GUS Yearbooks and the document "Recycling for climate protection. Reducing greenhouse gas emissions – showing responsibility towards future generations" ALBA Group. The following indicators were used (calculated after the document of ALBA Group):

Type of recycled material	GHG emissions [t] "avoided" per 1t of recycled material
WEEE	1.016
Plastics	0.958
Paper, cardboard, paperboard	0.402
Glass	0.295

[5] Expert assessment – estimates based on statistical data from GUS on the quantities of the individual fractions of municipal waste collected selectively in a given year (assuming its linear growth); the document "Waste and Climate Change: Global Trends and Strategy Framework", UNEP 2010. The following indicators were used:

Type of recycled material	CO_2 emissions [kg CO_2 eq.] "avoided" per 1t of recycled material
Plastics	500
Aluminium	10,000
Steel	2,000
Paper	1,550
Glass	500

[6] Calculations based on:
- GUS statistical data on the quantity of heat [GJ] and electricity [MWh] produced in a given year
- assumptions (sources: "Methane Tracking and Mitigation Options - EPA-CMOP", *www.epa.gov;* "Optimising anaerobic digestion", C. Banks, *www.forestry.gov.uk):*

Calorific value of CH_4= 37 MJ/m^3 = 0.037 GJ/m^3
1m^3 CH_4= 0.662 kg CH_4
1 kg CH_4 = 21 kg CO_2 eq
1m^3 CH_4= 10 kWh = 0.01 MWh

[7] Expert assessment – an estimate based on calculations of "unavoided" CO_2 eq emissions in 2005-2011 from waste landfills. The following information was used: the CO_2 eq emissions per kg of waste deposited at landfills – 0.39m^3 (source: http://marekpilawski.com, accessed on 24 May 2013), CO_2 density – 1.96 kg/m^3 and GUS data on the quantity of waste deposited at landfills in a given year

[8] based on the methodology and data used in the national inventory to assess the carbon balance in afforestation projects under the KP-LULUCF

Table 4.

Reporting on progress[a, b]

	Total emissions excluding LULUCF	Contribution from LULUCF[d]	Quantity of units from market based mechanisms under the Convention		Quantity of units from other market based mechanisms	
Year[c]	(kt CO_2 eq)	(kt CO_2 eq)	(number of units)	(kt CO2 eq)	(number of units)	(kt CO2 eq)
Base year/base period	563 442,77	NA	NA	NA	NA	NA
2011	399 389,55	-8 963,15	200 110 158,00	200 110,00	NA	NA
2012			1 000,00	1,00	NA	NA

Abbreviation: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] For the base year, information reported on the emission reduction target shall include the following: (a) total GHG emissions, excluding emissions and removals from the LULUCF sector; (b) emissions and/or removals from the LULUCF sector based on the accounting approach applied taking into consideration any relevant decisions of the Conference of the Parties and the activities and/or land that will be accounted for; (c) total GHG emissions, including emissions and removals from the LULUCF sector. For each reported year, information reported on progress made towards the emission reduction targets shall include, in addition to the information noted in paragraphs 9(a–c) of the UNFCCC biennial reporting guidelines for developed country Parties, information on the use of units from market-based mechanisms.

[c] Parties may add additional rows for years other than those specified below.

[d] Information in this column should be consistent with the information reported in table 4(a)I or 4(a)II, as appropriate. The Parties for which all relevant information on the LULUCF contribution is reported in table 1 of this common tabular format can refer to table 1. ***Custom Footnotes***

Table 4(a)II.
Progress in achievement of the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the counting of emissions and removals from the land use, land-use change and forestry sector in relation to activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol [a,b, c]

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	BY[5]	Net emissions/removals[1]					Accounting Parameters[7]	Accounting Quantity [8]
		2008	2009	2010	2011	Total[6]		
	(Gg CO_2 equivalent)							
A. Article 3.3 activities								
A.1. Afforestation and Reforestation								-22 686,20
A.1.1. Units of land not harvested since the beginning of the commitment period[2]		-5 158.57	-5 515.64	-5 819.83	-6 192.16	-22 686.20		-22 686,20
A.1.2. Units of land harvested since the beginning of the commitment period[2]								IE,NO
A.2. Deforestation		258.02	268.07	229.03	235.67	990.78		990,78
B. Article 3.4 activities								
B.1. Forest Management (if elected)		-27 408.87	-28 168.61	-28 043.34	-25 232.72	-108 853.53		-15 033,33
3.3 offset[3]							0.00	0,00
FM cap[4]							15 033.33	-15 033,33
B.2. Cropland Management (if elected)	0.00	NA	NA	NA	NA	NA	0.00	0,00
B.3. Grazing Land Management (if elected)	0.00	NA	NA	NA	NA	NA	0.00	0,00
B.4. Revegetation (if elected)	0.00	NA	NA	NA	NA	NA	0.00	0,00

[1] All values are reported in table 5(KP) of the CRF for the relevant inventory year as reported in the current submission and are automatically entered in this table.
[2] In accordance with paragraph 4 of the annex to decision 16/CMP.1, debits resulting from harvesting during the first commitment period following Afforestation and Reforestation since 1990 shall not be greater than credits accounted for on that unit of land.
[3] In accordance with paragraph 10 of the annex to decision 16/CMP.1, for the first commitment period, a Party included in Annex I that incurs a net source of emissions under the provisions of Article 3.3 may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under Forest Management under Article 3.4, up to a level that is equal to the net source of emissions under the provisions of Article 3.3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3.3.
[4] In accordance with paragraph 11 of the annex to decision 16/CMP.1, for the first commitment period only, additions to and subtractions from the assigned amount of a Party resulting from Forest Management under Article 3.4, after the application of paragraph 10 of the annex to decision 16/CMP.1 and resulting from Forest Management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix of the annex to decision 16/CMP.1, times five.
[5] Net emissions and removals in the Party's base year, as established by decision 9/CP.2.
[6] Cumulative net emissions and removals for all years of the commitment period reported in the current submission.
[7] The values in the cells "3.3 offset" and "FM cap" are absolute values.
[8] The accounting quantity is the total quantity of units to be added to or subtracted from a Party's assigned amount for a particular activitity in accordance with the provisions of Article 7.4 of the Kyoto Protocol.

Table 4(b).
Reporting on progress [a, b, c]

	Kyoto Protocol units [d] ($kt CO_2 eq$)										Other units [d,e] ($kt CO_2 eq$)			
	AAUs		ERUs		CERs		tCERs		lCERs		Units from market-based mechanisms under the Convention		Units from other market-based mechanisms	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Quantity of units	184 381,734	0	1 816,297	0	13 912,127	1,000	NO	NO	NO	NO	NO	NO	NO	NO
Total	184 382	0	1 816	0	13 912	1	NO	NO	NO	NO	NO	NO	NO	NO

Note: 2013 is the latest reporting year

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] For each reported year, information reported on progress made towards the emission reduction target shall include, in addition to the information noted in paragraphs 9 (a-c) of the reporting guidelines, on the use of units from market+based mechanisms.

[c] Parties may include this information, as appriopriate and if relevant to their target.

[d] Units surrendered by the Party for that year that have not been previously surrendered by that or any other Party.

[e] Additional columns for each market-based mechanism should be added, if applicable.

Table 5. Summary of key variables and assumptions used in the projections analysis

Table 5.1. A synthetic forecast of the growth rate of the Gross Domestic Product and the value added

Years	2016-2020	2021-2025	2026-2030	2007-2030
GDP	105.2	105.7	104.6	105.1
Value added	105.0	105.4	104.4	104.9

Source: "Projection of the demand fuels and energy until 2030"(ARE, 2009);

Table 5.2. Final energy demand by sectors

Sector	Final energy demand by years [Mtoe]			
	2015	2020	2025	2030
Industry	19.0	20.9	23.0	24.0
Transport	16.5	18.7	21.2	23.3
Agriculture	4.9	5.0	4.5	4.2
Services	7.7	8.8	10.7	12.8
Households	19.1	19.4	19.9	20.1
TOTAL	**67.3**	**72.7**	**79.3**	**84.4**

Source: "Projection of the demand fuels and energy until 2030"(ARE, 2009);

Table 5.3. Final energy demand by carriers

Specification	Final energy demand by years [Mtoe]			
	2015	2020	2025	2030
Coal	10.1	10.3	10.4	10.5
Oil products	23.1	24.3	26.3	27.9
Natural gas	10.3	11.1	12.2	12.9
Renewable energy	5.0	5.9	6.2	6.7
Electricity	9.9	11.2	13.1	14.8
District heat	8.2	9.1	10.0	10.5
Other fuels	0.6	0.8	1.0	1.2
TOTAL	**67.3**	**72.7**	**79.3**	**84.4**

Source: "Projection of the demand fuels and energy until 2030"(ARE, 2009);

Table 5.4. Net electricity production by fuels

Specification	Net electricity production by years [TWh]			
	2015	2020	2025	2030
Hard coal	62.9	62.7	58.4	71.8
Lignite	51.1	40.0	48.4	42.3
Natural gas	5.0	8.4	11.4	13.4
Oil products	2.5	2.8	2.9	3.0
Nuclear fuel	0.00	10.5	21.1	31.6
Renewable energy	17.0	30.1	36.5	38.0
Pumped-storage hydro-power plants	1.00	1.00	1.00	1.00
Waste	0.6	0.6	0.7	0.7
TOTAL	**140.1**	**156.1**	**180.3**	**201.8**
Share of energy from RES [%]	12.2	19.3	20.2	18.8

Source: "Projection of the demand fuels and energy until 2030"(ARE, 2009);

Table 5.5. Input data for Sector 2. *Industrial Processes* [Gg]

2. Industrial Processes	Industrial production by years [Gg]			
	2015	2020	2025	2030
A. Mineral Products				
1. Clinker Cement Production	15,000	16,500	18,500	20,500
2. Lime Production	2,350	2,350	2,350	2,350
3. Limestone and Dolomite Use	*4,079*	*4,079*	*4,079*	*4,079*
4. Soda Ash- Use	1,275	1,400	1,400	1,415
B. Chemical Industry				
1. Ammonia Production	2,700	3,000	3,000	3,100
2. Nitric Acid Production	2,250	2,300	2,350	2,600
4. Carbide Production	0	0	0	0
5.Other				
5.a Methanol Production	0	0	0	0
5.b Carbon Black Production	60	60	60	60
5.c Styrene Production	130	130	300	300
5.e Ethylene Production	640	680	1200	1200
5.j Caprolactam	160	160	160	160
C. Metal Production				
1. Iron and Steel Production				
1.a Iron Ore Sinter Production	12,000	12,000	12,000	12,000
1.c Steel Cast Production	112	132	136	143
1.d Iron Cast Production	1,244	1,276	1,341	1,422
1.e Pig Iron Production in Blast Furnaces	6,200	6,200	6,200	6,200
1.f Basic Oxygen Furnace Steel Production	7,000	7,000	7,000	7,000
1.g Electric Furnace Steel Production	4,208	5,810	6,100	6,200
2. Ferroalloys Production	78	78	78	78
3. Aluminium Production (electrolytic method)	0	0	0	0
5. Other				
5.b Refined Lead Production	85	85	85	85
5.c Technically Pure Zinc Production	106	106	106	106

Source: Data from the Ministry of the Economy (2013); the values in italics were complemented on the basis of the average consumption of a given fuel in a given category in 2009-2011.

Table 5.6. Input data for Sector 4. *Agriculture*

4. Agriculture	Unit	Years			
		2015	2020	2025	2030
Area of farmland*	thousand ha	15,000	14,600	14,500	14,350
Total sown area*	thousand ha	10,450	10,400	10,350	10,300
Area of utilised soils*	thousand ha	14,500	14,150	14,050	14,000
Consumption of nitrogen fertilisers*	thousand ton	1,110	1,175	1,210	1,250
Mean annual milk yield per cow**	kg	5,200	5,650	6,200	6,850
Cattle population**	thousand heads	5,600	5,800	6,000	6,200
Including milk cows**	thousand heads	2,500	2,300	2,100	1,900
Sheep population**	thousand heads	250	250	300	300
Horse population**	thousand heads	250	230	210	200
Swine population**	thousand heads	11,000	11,500	12,500	13,000
Poultry population**	thousand heads	150,000	160,000	165,000	171,000
Cultivation area of papilionaceous plants (total)*	thousand ha	390	380	400	420
Cultivation area of other than papilionaceous plants*	thousand ha	10,060	10,020	9,950	9,880
Area of organic soils under cultivation*	thousand ha	680	675	670	665

*Sources: * Data from the Institute of Soil Science and Plant Cultivation (IUNG)*
*** Data from the Institute of Agricultural and Food Economics (IERiGŻ)*

Table 5.7. Input data for Sector 6. *Waste*

6. Waste	Unit	Years			
		2015	2020	2025	2030
Quantity of solid municipal waste generated in the country*	Gg	13,246	14,254	15,399	16,544
Quantity of solid municipal waste deposited at landfills	Gg	7,398	7,398	7,398	7,398
Quantity of solid municipal waste deposited at landfills complying with Directive 1999/31/EC	Gg	6,640	6,640	6,640	6,640
Quantity of landfilled industrial waste	Gg	83	83	83	83
Quantity of landfilled sewage sludge*	Gg	695	773	799	825
Quantity of discharged industrial wastewater	million m3	131.25	131.25	131.25	131.25
Quantity of discharged municipal wastewater	million m3	1,260.4	1,260.4	1,260.4	1,260.4
Urban population served by wastewater treatment plants	thousand	20,597.3	20,597.3	20,597.3	20,597.3
Rural population served by wastewater treatment plants	thousand	4,316.1	4,316.1	4,316.1	4,316.1
Quantity of treated wastewater	million m3	1,208.8	1,208.8	1,208.8	1,208.8
Animal protein consumption**	g/person/day	52.2	52.2	52.2	52.2
Vegetable protein consumption**	g/person/day	48.9	48.9	48.9	48.9
Country population***	million	38.02	37.83	37.44	36.80
Quantity of incinerated municipal waste	Gg	40.20	40.20	40.20	40.20
Quantity of incinerated industrial waste	Gg	116.31	116.31	116.31	116.31
Quantity of incinerated medical waste	Gg	29.39	29.39	29.39	29.39
Quantity of incinerated sewage sludge	Gg	34.94	34.94	34.94	34.94

*Source: * The National Waste Management Plan*
*** FAO Food and Agriculture Organization*
**** Central Statistical Office, the Information Release in the series "CSO Survey Results" entitled "The Population Projection for Poland for 2008-2035".*
The other data come from statistical yearbooks on Environmental Protection or were calculated by the Institute of Environmental Protection, KOBIZE..

Table 6(a).
Information on updated greenhouse gas projections under a 'with measures' scenario

	GHG emissions and removals CO2 equivalent (Gg)							*GHG emission projections CO2 equivalent (Gg)*			
	1988	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**	**2025**	**2030**
Sector											
Energy	448 049,96	353 596,54	338 501,72	290 247,86	282 225,85	282 161,66	276 518,73	257 619,78	242 106,99	250 609,61	251 985,93
Transport	22 259,11	20 472,74	23 366,23	27 549,98	35 069,04	48 113,69	48 687,22	48 079,36	51 212,51	52 055,25	56 203,26
Industrial Processes	33 838,65	22 654,21	22 466,32	22 085,76	28 621,87	26 729,87	29 508,55	37 344,19	39 084,80	40 403,65	41 951,77
Agriculture	50 893,90	49 655,35	37 077,84	34 462,84	33 787,05	34 560,56	34 929,80	34 031,63	35 138,64	37 041,55	37 804,60
Forestry/LULUCF	-32 926,48	-16 329,24	-5 639,62	-8 297,52	-21 635,62	-25 022,21	-21 912,35	-21 166,23	-15 196,91	-11 457,42	-7 921,09
Waste	8 401,16	10 635,81	11 048,33	11 034,38	10 526,90	10 104,57	9 745,25	9 647,24	10 112,33	10 329,21	10 619,75
Gas											
CO_2 emissions including net CO_2 from LULUCF	436 209,10	353 746,11	350 447,29	305 018,53	294 146,08	305 309,21	306 138,93	293 987,43	289 033,40	303 065,92	313 476,46
CO_2 emissions excluding net CO_2 from LULUCF	469 143,82	372 288,35	358 302,29	315 539,64	318 019,54	332 573,75	330 309,43	317 413,47	306 518,06	316 826,60	323 722,53
CH_4 emissions including CH_4 from LULUCF	53 672,51	49 362,87	45 613,49	41 567,84	40 547,64	38 682,41	37 787,07	37 017,73	37 804,59	38 520,52	39 017,04
CH_4 emissions excluding CH_4 from LULUCF	53 665,03	47 166,41	43 410,47	39 361,03	38 325,61	36 448,45	35 537,91	34 757,92	35 516,85	36 217,26	36 692,06
N_2O emissions including N_2O from LULUCF	40 334,29	37 453,55	30 390,65	29 193,09	29 287,76	26 868,99	27 249,62	26 631,77	27 526,86	29 127,42	29 708,27
N_2O emissions excluding N_2O from LULUCF	40 333,53	37 437,00	30 378,30	29 176,30	29 271,96	26 860,62	27 240,63	26 631,77	27 526,86	29 127,42	29 708,27
HFCs	26,44		189,90	1 127,78	4 424,87	5 694,34	6 210,80	7 828,26	8 002,73	8 177,20	8 351,67
PFCs	250,18	122,88	148,96	151,88	160,65	56,13	49,88	49,88	49,88	49,88	49,88
SF_6	23,77		30,53	24,18	28,09	37,07	40,90	40,90	40,90	40,90	40,90
Total (including LULUCF)	**530 516,30**	**440 685,41**	**426 820,82**	**377 083,30**	**368 595,09**	**376 648,14**	**377 477,20**	**365 555,98**	**362 458,37**	**378 981,85**	**390 644,22**
Total (excluding LULUCF)	**563 442,77**	**457 014,65**	**432 460,44**	**385 380,81**	**390 230,71**	**401 670,35**	**399 389,55**	**386 722,20**	**377 655,28**	**390 439,27**	**398 565,31**

Table 7. Provision of public financial support: summary information in 2008-2011

Provision of public financial support: summary information in 2008										
Allocation channels	**PLN**					**USD**				
	Core/ general	Climate-specific				Core/ general	Climate-specific			
		Mitigation	Adaptation	Cross-cutting	Other		Mitigation	Adaptation	Cross-cutting	Other
Total contributions through multilateral channels:	0	0	0	0	0	0	0	0	0	0
Multilateral climate change funds	1 021 501	0	1 021 501	0	0	424 000	0	424 000	0	0
Other multilateral climate change funds	0	0	0	0	0	0	0	0	0	0
Multilateral financial institutions, including regional development banks	0	0	0	0	0	0	0	0	0	0
Specialized United Nations bodies	1 446 131	0	1 446 131	0	0	600 254	0	600 254	0	0
Total contributions through bilateral, regional and other channels	16 547 516	0	16 547 516	0	0	6 868 813	0	6 868 813	0	0
Total	**19 015 148**	**0**	**19 015 148**	**0**	**0**	**7 893 066**	**0**	**7 893 066**	**0**	**0**
Provision of public financial support: summary information in 2009										
Allocation channels	**PLN**					**USD**				
	Core/ general	Climate-specific				Core/ general	Climate-specific			
		Mitigation	Adaptation	Cross-cutting	Other		Mitigation	Adaptation	Cross-cutting	Other
Total contributions through multilateral channels:	0	0	0	0	0	0	0	0	0	0
Multilateral climate change funds	0	0	0	0	0	0	0	0	0	0
Other multilateral climate change funds	0	0	0	0	0	0	0	0	0	0
Multilateral financial institutions, including regional development banks	0	0	0	0	0	0	0	0	0	0
Specialized United Nations bodies	1 144 481	0	1 144 481	0	0	367 268	0	367 268	0	0
Total contributions through bilateral, regional and other channels	18 958 762	0	18 958 762	0	0	6 083 936	0	6 083 936	0	0
Total	**20 103 243**	**0**	**20 103 243**	**0**	**0**	**6 451 204**	**0**	**6 451 204**	**0**	**0**
Provision of public financial support: summary information in 2010										
Allocation channels	**PLN**					**USD**				
	Core/ general	Climate-specific				Core/ general	Climate-specific			
		Mitigation	Adaptation	Cross-cutting	Other		Mitigation	Adaptation	Cross-cutting	Other
Total contributions through multilateral channels:	0	0	0	0	0	0	0	0	0	0

Multilateral climate change funds	0	0	0	0	0	0	0	0	0	0
Other multilateral climate change funds	0	0	0	0	0	0	0	0	0	0
Multilateral financial institutions, including regional development banks	0	0	0	0	0	0	0	0	0	0
Specialized United Nations bodies	3 706 724	0	3 706 724	0	0	1 229 142	0	1 229 142	0	0
Total contributions through bilateral, regional and other channels	22 095 920	0	22 095 920	0	0	7 326 962	0	7 326 962	0	0
Total	**25 802 644**	**0**	**25 802 644**	**0**	**0**	**8 556 104**	**0**	**8 556 104**	**0**	**0**
Provision of public financial support: summary information in 2011										
Allocation channels	**PLN**					**USD**				
	Core/ general	Climate-specific				Core/ general	Climate-specific			
		Mitigation	Adaptation	Cross-cutting	Other		Mitigation	Adaptation	Cross-cutting	Other
Total contributions through multilateral channels:	0	0	0	0	0	0	0	0	0	0
Multilateral climate change funds	594 700	0	594 700	0	0	200 682	0	200 682	0	0
Other multilateral climate change funds	0	0	0	0	0	0	0	0	0	0
Multilateral financial institutions, including regional development banks	0	0	0	0	0	0	0	0	0	0
Specialized United Nations bodies	3 357 643	0	3 357 643	0	0	1 133 037	0	1 133 037	0	0
Total contributions through bilateral, regional and other channels	34 647 002	0	34 647 002	0	0	11 692 000	0	11 692 000	0	0
Total	**38 599 345**	**0**	**38 599 345**	**0**	**0**	**13 025 719**	**0**	**13 025 719**	**0**	**0**

Table 7(a). Provision of public financial support: contribution through multilateral channels in 2008-2011

Provision of public financial support: contribution through multilateral channels in 2008 1 USD=2.4092 PLN									
Donor Funding	Total amount				Status	Fundung source	Finanacial instrument	Type of support	Sector
	Core/general		Climate specific		Provided Committed Pledged	ODA OOF Other	Grant Concessional loan Non concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Water and Sanitation Cross-cutting Other Not applicable
	PLN	USD	PLN	USD					
Multilateral Climate Change Funds									
Global Environmental Facility									
Least Developed Countries Fund									
Special Climate Change Fund									
Adaptation Fund									
Green Climate Fund									
UNFCCC Trust Fund for supplementary Activities									
Other multilateral climate change funds: Multilateral Fund for the Implementationof the Montral Protocol	1 021 501	424 000	1 021 501	424 000	Provided	ODA	Grant		
Subtotal	1 021 501	424 000	1 021 501	424 000					
Multilateral financial institutions, including regional development banks									
World Bank									
International Finance Corporation									
European Bank for Reconstruction and Development									
Other									
Subtotal	0	0	0	0					
Specialized United Nations bodies									
United Nations Development Programme									
United Nations Environment Programme	465 930	193 396	465 930	193 396	Provided	ODA	Grant		
Subtotal	465 930	193 396	465 930	193 396					
Other:									
UNFCCC	95 645	39 700	95 645	39 700	Provided	ODA	Grant		
WMO	638 877	265 182	638 877	265 182	Provided	ODA	Grant		
UNCCCD	122 598	50 887	122 598	50 887	Provided	ODA	Grant		
ITTO	123 081	51 088	123 081	51 088	Provided	ODA	Grant		
IRENA									
ESP									
Subtotal	980 201	406 857	980 201	406 857					
Total	**2 467 632**	**1 024 254**	**2 467 632**	**1 024 254**					

Provision of public financial support: contribution through multilateral channels in 2009 1 USD = 3.1162 PLN									
Donor Funding	Total amount				Status	Fundung source	Finanacial instrument	Type of support	Sector
	Core/general		Climate specific		Provided Committed	ODA OOF	Grant Concessional loan	Mitigation Adaptation	Energy Transport
	PLN	USD	PLN	USD					

					Pledged	Other	Non concessional loan Equity Other	Cross-cutting Other	Industry Agriculture Forestry Water and Sanitation Cross-cutting Other Not applicable
Multilateral Climate Change Funds									
Global Environmental Facility									
Least Developed Countries Fund									
Special Climate Change Fund									
Adaptation Fund									
Green Climate Fund									
UNFCCC Trust Fund for supplementary Activities									
Other multilateral climate change funds: Multilateral Fund for the Implementationof the Montral Protocol									
Subtotal	0	0	0	0					
Multilateral financial institutions, including regional development banks									
World Bank									
International Finance Corporation									
European Bank for Reconstruction and Development									
Other									
Subtotal	0	0	0	0					
Specialized United Nations bodies									
United Nations Development Programme									
United Nations Environment Programme	489 855	157 196	489 855	157 196	Provided	ODA	Grant		
Subtotal	489 855	157 196	489 855	157 196					
Other:									
UNFCCC	550 009	176 500	550 009	176 500	Provided	ODA	Grant		
WMO	104 617	33 572	104 617	33 572	Provided	ODA	Grant		
UNCCCD									
ITTO									
IRENA									
ESP									
Subtotal	654 626	210 072	654 626	210 072					
Total	**1 144 481**	**367 268**	**1 144 481**	**367 268**					

Provision of public financial support: contribution through multilateral channels in 2010 1 USD = 3.0157 PLN

Donor Funding	Total amount				Status	Fundung source	Finanacial instrument	Type of support	Sector
	Core/general		Climate specific						
	PLN	USD	PLN	USD	Provided Committed Pledged	ODA OOF Other	Grant Concessional loan Non concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Water and Sanitation

									Cross-cutting Other Not applicable
Multilateral Climate Change Funds									
Global Environmental Facility									
Least Developed Countries Fund									
Special Climate Change Fund									
Adaptation Fund									
Green Climate Fund									
UNFCCC Trust Fund for supplementary Activities									
Other multilateral climate change funds: Multilateral Fund for the Implementationof the Montral Protocol									
Subtotal	0	0	0	0					
Multilateral financial institutions, including regional development banks									
World Bank									
International Finance Corporation									
European Bank for Reconstruction and Development									
Other									
Subtotal	0	0	0	0					
Specialized United Nations bodies									
United Nations Development Programme									
United Nations Environment Programme	454 285	150 640	454 285	150 640	Provided	ODA	Grant		
Subtotal	454 285	150 640	454 285	150 640					
Other:									
UNFCCC	1 306 791	433 329	1 306 791	433 329	Provided	ODA	Grant		
WMO	836 526	277 390	836 526	277 390	Provided	ODA	Grant		
UNCCCD	292 122	96 867	292 122	96 867	Provided	ODA	Grant		
ITTO									
IRENA	52 000	17 243	52 000	17 243	Provided	ODA	Grant		
ESP	765 000	253 672	765 000	253 672					
Subtotal	3 252 439	1 078 502	3 252 439	1 078 502					
Total	**3 706 724**	**1 229 142**	**3 706 724**	**1 229 142**					

Provision of public financial support: contribution through multilateral channels in 2011 1 USD =2.9634 PLN

Donor Funding	Total amount				Status	Fundung source	Finanacial instrument	Type of support	Sector
	Core/general		Climate specific						
	PLN	USD	PLN	USD	Provided Committed Pledged	ODA OOF Other	Grant Concessional loan Non concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Water and Sanitation Cross-cutting Other Not applicable
Multilateral Climate Change Funds									

Global Environmental Facility									
Least Developed Countries Fund									
Special Climate Change Fund									
Adaptation Fund									
Green Climate Fund									
UNFCCC Trust Fund for supplementary Activities									
Other multilateral climate change funds: Multilateral Fund for the Implementationof the Montral Protocol	594 700	200682	594 700	200682	Provided	ODA	Grant		
Subtotal	594 700	200 682	594 700	200 682					
Multilateral financial institutions, including regional development banks									
World Bank									
International Finance Corporation									
European Bank for Reconstruction and Development									
Other									
Subtotal	0	0	0	0					
Specialized United Nations bodies									
United Nations Development Programme									
United Nations Environment Programme	435 570	146 983	435 570	146 983	Provided	ODA	Grant		
Subtotal	435 570	146 983	435 570	146 983					
Other:									
UNFCCC	797 100	268 982	797 100	268 982	Provided	ODA	Grant		
WMO	1 604 173	541 329	1 604 173	541 329	Provided	ODA	Grant		
UNCCCD	397 700	134 204	397 700	134 204	Provided	ODA	Grant		
ITTO	123 100	41 540	123 100	41 540	Provided	ODA	Grant		
IRENA									
ESP									
Subtotal	2 922 073	986 054	2 922 073	986 054					
Total	**3 952 343**	**1 333 719**	**3 952 343**	**1 333 719**					

UNFCCC	UN Framework Convention on Climate Change
WMO	World Meteorological Organization
UNCCCD	UN Convention to Combat Desertification
ITTO	International Tropical Timber Organization
IRENA	International Renewable Energy Agency
ESP	Eastern Europe Energy Efficiency and Environmental Partnership

Table 7(b). Provision of public financial support: contribution through bilateral, regional and other channels in 2008-2011 (incl. capacity building)

Provision of public financial support: contribution through bilateral, regional and other channels in 2008 1 USD = 2.4092 PLN								
Recipient country/ region/project/programme	Total amount		Status	Funding source	Financial instrument	Type of support	Sector	Additional Information
	Climate-specific		Provided, Committed, Pledged	ODA OOF Othe	Grant Concessional loan Non-concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Water and sanitation Cross-cutting Other	
	Mio PLN	Mio USD						
Share in EU ODA	8,229	3,416	Provided	ODA	Grant			
Afghanistan	0,172	0,071	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Afghanistan	0,055	0,023	Provided	ODA	Grant	Adaptation	Energy	
Afghanistan	0,013	0,005	Provided	ODA	Grant	Adaptation	Energy	
Afghanistan	0,493	0,205	Provided	ODA	Grant	Adaptation	Agriculture and water	
Albania (10%), Angola (10%), BELARUS (10%), CROATIA (10%), GEORGIA (10%), KYRGYSTAN (10%), MOLDOVA (10%), TAJIKISTAN (10%), UKRAINE(20%)	0,308	0,128	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
ALGERIA (5%), Antigua and Barbuda (5%), SAUDI ARABIA (5%), ARGENTINA (5%), Barbados (5%), Benin (5%), BRAZIL (5%), CHINA (5%), DOMINIKAN REPUBLIC (5%), Philippines (5%), Ghana (5%), Grenada (5%), INDIA (5%), INDONESIA (5%), Iran (5%), COSTA RICA (5%), Maledives (5%), Republic of South Africa (5%), Tanzania (5%), Tuvalu (5%)	0,447	0,186	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Angola	0,096	0,040	Provided	ODA	Grant	Adaptation	Agriculture and water	
Australia	0,035	0,015	Provided	ODA	Grant	Adaptation	Agriculture and water	
Azerbaijan	0,187	0,078	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Belarus	0,121	0,050	Provided	ODA	Grant	Adaptation	Agriculture and water	
Brazil	0,066	0,027	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Cameroon	0,040	0,016	Provided	ODA	Grant	Adaptation	Agriculture and water	
Democratic Republic of Congo	0,017	0,007	Provided	ODA	Grant	Adaptation	Agriculture and water	
Ethiopia	0,494	0,205	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Ethiopia	0,001	0,001	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Georgia	0,036	0,015	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Georgia	0,272	0,113	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Georgia	0,040	0,017	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Georgia	0,192	0,080	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Georgia	0,102	0,042	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	

Georgia	0,026	0,011	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Kazakhstan	0,163	0,067	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Kenya	0,015	0,006	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Kenya	0,286	0,119	Provided	ODA	Grant	Adaptation	Agriculture and water	
Kirgistan	0,179	0,074	Provided	ODA	Grant	Adaptation	Agriculture and water	
Mexico	0,068	0,028	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Mexico	0,028	0,012	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Moldova	0,336	0,140	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Moldova	0,389	0,162	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Moldova	0,027	0,011	Provided	ODA	Grant	Adaptation	Agriculture and water	
Moldova	0,083	0,034	Provided	ODA	Grant	Adaptation	Agriculture and water	
Moldova	0,104	0,043	Provided	ODA	Grant	Adaptation	Agriculture and water	
Moldova	0,331	0,137	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Palestine	0,610	0,253	Provided	ODA	Grant	Adaptation	Agriculture and water	
Palestine	0,610	0,253	Provided	ODA	Grant	Adaptation	Agriculture and water	
Senegal	0,033	0,014	Provided	ODA	Grant	Adaptation	Agriculture and water	
Serbia	0,035	0,015	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Sudan	0,764	0,317	Provided	ODA	Grant	Adaptation	Agriculture and water	
Tajikistan	0,066	0,027	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Ukraine	0,400	0,166	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Ukraine	0,112	0,046	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Ukraine	0,233	0,097	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Ukraine	0,013	0,005	Provided	ODA	Grant	Adaptation	Agriculture and water	
Ukraine	0,221	0,092	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
TOTAL	**16,548**	**6,869**						

Provision of public financial support: contribution through bilateral, regional and other channels in 2009 1 USD = 3.1162 PLN

Recipient country/ region/project/programme	Total amount		Status	Funding source	Financial instrument	Type of support	Sector	Additional Information
	Climate-specific		Provided, Committed, Pledged	ODA OOF Other	Grant Concessional loan Non-concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Water and sanitation Cross-cutting Other	
	Mio PLN	Mio USD						
Share in EU ODA	10,083	3,236	Provided,	ODA	Grant			

Afghanistan	0,055	0,018	Provided,	ODA	Grant	Adaptation	Agriculture and water	
Afghanistan	0,561	0,180	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Afghanistan	1,356	0,435	Provided,	ODA	Grant	Adaptation	Adaptation investment project	
Armenia	0,066	0,021	Provided,	ODA	Grant	Adaptation	Agriculture and water	
Azerbaijan	0,177	0,057	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Azerbaijan	0,147	0,047	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Brazil	0,057	0,018	Provided,	ODA	Grant	Adaptation	Agriculture and water	
Ethiopia	0,404	0,130	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Ethiopia	0,189	0,061	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Georgia	0,102	0,033	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Georgia	0,120	0,039	Provided,	ODA	Grant	Adaptation	Adaptation investment project	
Georgia	0,246	0,079	Provided,	ODA	Grant	Adaptation	Agriculture and water	
Georgia	0,199	0,064	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Ghana	0,174	0,056	Provided,	ODA	Grant	Adaptation	Agriculture and water	
India	0,201	0,065	Provided,	ODA	Grant	Adaptation	Agriculture and water	
Kyrgyzstan	0,139	0,045	Provided,	ODA	Grant	Adaptation	Agriculture and water	
Moldova	0,239	0,077	Provided,	ODA	Grant	Adaptation	Agriculture and water	
Moldova	0,028	0,009	Provided,	ODA	Grant	Adaptation	Agriculture and water	
Moldova	0,229	0,074	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Moldova	0,250	0,080	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Moldova	0,149	0,048	Provided,	ODA	Grant	Adaptation	Adaptation investment project	
Moldova	0,241	0,077	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Maroko	0,135	0,043	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
North Korea	0,040	0,013	Provided,	ODA	Grant	Adaptation	Agriculture and water	
North Korea	0,056	0,018	Provided,	ODA	Grant	Adaptation	Agriculture and water	
Rep. of South Africa	0,053	0,017	Provided,	ODA	Grant	Adaptation	Agriculture and water	
Serbia	0,120	0,039	Provided,	ODA	Grant	Adaptation	Agriculture and water	
Tanzania	0,090	0,029	Provided,	ODA	Grant	Adaptation	Agriculture and water	
Tanzania	0,380	0,122	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Ukraine	0,210	0,067	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Ukraine	0,139	0,045	Provided,	ODA	Grant	Adaptation	Agriculture and water	

Ukraine	0,140	0,045	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Ukraine	0,346	0,111	Provided,	ODA	Grant	Adaptation	Adaptation investment project	
Ukraine	0,158	0,051	Provided,	ODA	Grant	Adaptation	Adaptation investment project	
Ukraine	0,292	0,094	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Ukraine	0,166	0,053	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Ukraine	0,084	0,027	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Ukraine	0,114	0,037	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Ukraine	0,458	0,147	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Ukraine	0,345	0,111	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
Ukraine	0,223	0,071	Provided,	ODA	Grant	Adaptation	Capacity building for adaptation	
TOTAL	**18,959**	**6,084**						

Provision of public financial support: contribution through bilateral, regional and other channels in 2010 1 USD = 3.0157 PLN

Recipient country/ region/project/programme	Total amount		Status	Funding source	Financial instrument	Type of support	Sector	Additional Information
	Climate-specific		Provided, Committed, Pledged	ODA OOF Othe	Grant Concessional loan Non-concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Water and sanitation Cross-cutting Other	
	Mio PLN	Mio USD						
Share in EU ODA	9,307	3,086	Provided	ODA	Grant			
China	8,344	2,767	Provided	ODA	Loan	Adaptation	Other	
Afghanistan	2,259	0,749	Provided	ODA	Grant	Adaptation	Water and sanitation	
Ukraine	0,475	0,158	Provided	ODA	Grant	Adaptation		
Ukraine	0,464	0,154	Provided	ODA	Grant	Adaptation		
Ukraine	0,173	0,057	Provided	ODA	Grant	Adaptation		
Ukraine	0,368	0,122	Provided	ODA	Grant	Adaptation		
Georgia	0,209	0,069	Provided	ODA	Grant	Adaptation	Forestry	
Georgia	0,151	0,050	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Georgia	0,245	0,081	Provided	ODA	Grant	Adaptation	Capacity building for adaptation	
Belarus	0,101	0,034	Provided	ODA	Grant	Adaptation	Other	
TOTAL	**22,096**	**7,327**						

Provision of public financial support: contribution through bilateral, regional and other channels in 2011 1 USD = 2.9634 PLN

Recipient country/ region/project/programmeb	Total amount		Status	Funding source	Financial instrument	Type of support	Sector	Additional Information
	Climate-specific		Provided, Committed, Pledged	ODA OOF Othe	Grant Concessional loan Non-concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Energy Transport Industry Agriculture Forestry Water and	
	Mio PLN	Mio USD						

							sanitation Cross-cutting Other	
Share in EU ODA	27,603	9,315	Provided	ODA	Grant			
China	6,881	2,322	Provided	ODA	Loan	Adaptation	Other	
Developing Countries (educational program)	0,163	0,055	Provided	ODA	Grant	Adaptation	Other	
TOTAL	**34,647**	**11,692**						

Table 8. Provision of technology development and transfer support

Recipient country and/or region	Targeted area	Measures and activities related to technology transfer	Sector	Source of the funding for technology transfer	Activities undertaken by	Status	Status of implementation
Azerbaijan	Mitigation	CHEMADEX ® - high-load wastewater treatment technology	Water and wastewater management	Private and public	Private	Planned	Preparatory work for developing and implementing a project to build an industrial wastewater treatment plant with biogas recovery capacity at the end of the treatment process
Egypt	Mitigation	PROM@R – a system to monitor the rational use of energy carriers	Energy saving	Private and public	Private	Planned	Agreements on cooperation in the implementation of the technology with local companies in Egypt
Libya	Mitigation	PROM@R - a system to monitor the rational use of energy carriers	Energy saving	Private and public	Private	Planned	Agreements on cooperation in the implementation of the technology with local companies in Libya
Moldova	Mitigation	BIOMASSER® mobile briquetting machines producing environment-friendly fuel from straw and hay	RES	Private and public	Private	Implemented	The commissioning of five Biomasser technological lines for partners in the Riscani District
Thailand	Mitigation	T-Technology – a system producing liquid fuels from waste plastics	Waste management	Private and public	Private	Implemented	The delivery of technology and licence to the company Polimer Energy LLC for an installation to process municipal waste plastics from Bangkok. The final product will be synthetic oil.
Tanzania	Mitigation	BIOMASSER® mobile briquetting machines producing environment-friendly fuel from straw and hay	RES	Private and public	Private	Implemented	Biomasser briquetting machines have already been successfully used in Tanzania within the framework of the Keep Mwanga Green Project for briquetting grass. The briquettes serve local communities as fuel for preparing meals. Its aim is to limit the clear-cutting of trees to be used as fuel.
Tunisia	Mitigation	PROM@R - a system to monitor the rational use of energy carriers	Energy saving	Private and public	Private	Planned	Agreements on cooperation in the implementation of the technology with local companies in Tunisia
Vietnam	Mitigation	BIOMASSER® mobile briquetting machines producing environment-friendly fuel from straw and hay	RES	Private and public	Private	Implemented	The technology has been modified to make it suitable for briquetting wet rice straw (with moisture content of as much as 15-30%) to produce environment-friendly heating fuel