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SEVENTH NATIONAL COMMUNICATION AND THIRD BIENNIAL REPORT UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

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EXECUTIVE SUMMARY

S.1. Introduction

The Republic of Poland has been a signatory to the United Nations Framework Convention on Climate Change since 1994, and to the Kyoto Protocol since 2002, thus contributing to the efforts undertaken by the international community to limit the effects of climate change.

Pursuant to Article 4.6 of the United Nations Framework Convention on Climate Change, Poland has recognized the desirability of flexible approach to the choice of base year for the evaluation of commitments arising under the Climate Convention, and adopted the year 1988 instead of 1990, which is obligatory for the Convention Member States, as reflected in paragraph 5 of Decision 9/CP.2.

One of the challenges faced by Poland, is to reconcile economic growth with care for the environment, including cut of emission of greenhouse gases and other pollutants. Poland succeeds in achieving these targets, as is evident from reduction in greenhouse gas emissions by about 29% compared to the base year, while increasing its GDP by about 220%. The last two decades have seen a steady growth of the Polish economy. Particularly important, in the context of the country's development, was the accession to the European Union in 2004, opening up new opportunities, markets and sources of funding for development. Poland's membership in the EU has contributed to modernization of the country's economy. At the same time, Poland's commitments in the field of environmental protection present a big challenge, especially for the Polish power industry.

The main objective of the 7th National Communication and the 3rd Biennial Report is to submit, to the Conference of the Parties under the Convention, an overview of the Polish government policies, which address ever-increasing effects of climate changes and adaptation to these changes as well as actions that aim at meeting commitments stemming from the Convention. The report covers the information pertaining to the years 2012–2015 and 2016, if any has been available during the preparation of the Reports. Legal and strategic documents describe national circumstances in force, in the period until mid-2017. It should be emphasized, that the information presented in the Reports is a continuation of the information submitted in the previous reports: 6th National Communication (2013) and 2nd Biennial Report
(2015).

S.2. National circumstances relevant to greenhouse gas emissions and removals in Poland

Poland is in a particular economic situation with respect to its considerable coal resources, which are the basic driver for national economy.

In terms of GDP, in 2014, Poland was ranked 23rd globally and 10th in Europe. In 2015, the GDP growth rate in EU-28 countries averaged at 102.2, while in Poland – 103.9 (Table S.1) [GUS Statistical Yearbook 2016].

Table S.1. GDP and GDP growth rate in Poland in the years 2012–2015

GDP in PLN	2012	2013	2014	2015
GDP [million PLN, at current prices]	1 615 894	1 656 341	1 719 704	1 798 302
GDP [per capita in PLN, at current prices]	41 934	43 020	44 686	46 764
GDP Dynamics [preceding year = 100]	101.6	101.3	103.3	103.9

Source: GUS Statistical Yearbook 2016, 2015, 2014

Data on the size and structure of primary energy consumption in Poland, by energy carriers, are shown in Table S.2.

Table S.2. Size and structure of primary energy consumption in national economy in the years 2012–2015, by energy carriers

Energy consumption	2012	2013	2014	2015
Total consumption of primary energy [TJ]	4 387 291	4 429 783	4 250 346	4 338 876
Share of individual sources [%]				
Coal	40.8	42.0	40.6	39.3
Lignite	12.1	12.4	12.2	11.9
Crude oil	24.4	23.2	24.1	25.6
Natural gas	13.1	13.0	13.2	13.3
Renewable energy, heat pumps	0.6	0.7	0.9	1.1
Other [1)]	9.1	8.6	8.9	8.9

[1)] Fuel wood, peat, waste fuels

Source: GUS Power and Fuel Economy

Consumption of hard coal and lignite as energy source has been in decline since many years to the advantage of petroleum fuels, although over the next few decades, coal will remain a strategic resource.

Achieving targets set in the climate and energy package by 2020 is foreseen based on the Local Low Carbon Economy Plans which will contribute to reducing greenhouse gas emissions, increasing the share of renewable energy, curbing final energy consumption, and improving air quality.

In the years 2011–2015, there was a steady growth in renewable energy generation while the total primary energy production had been broadly at the same level over this period. The share of renewable energy in the total primary energy increased from 10.9% in 2011 to 12.7% in 2015.

In Poland, solid biofuels dominate in the production and consumption of renewable energy. Their share in the production of energy from renewable sources accounted for over 72% of the renewable energy generated in 2015. In the period 2011–2015, there was an increase in the share of wind energy from 3.7% to 10.8%, liquid biofuels from 5.8% to 10.8%, biogas from 1.8% to 2.6%, solar energy from 0.2% to 0.5%, while the share of hydroenergy decreased from 2.7% to 1.8%.

Hard coal and lignite are the main sources of primary energy. Coal fuels remain the second most important type of consumable energy carriers with respect the final consumption, albeit their share declined from 21% in 2005 to 18% in 2015. In 2015, petroleum fuels were the most important energy sources, accounting for 32%, and this share was unchanged, as compared to 2005. Among other energy carriers, gas consumption declined from 15 to 14% and heat – from 12 to 9%. The

share of electricity grew by 2%, from 16 to 18%, and likewise that of other energy carriers (mainly from renewable energy sources) – from 7 to 10%.

Changes in the structure of final energy consumption by economy sectors occur compatibly with the development of individual branches. In the years 2005–2015, there was a decrease in energy consumption in industry, households and agriculture. On the other hand, there was an increase in energy consumption by transport and developing service industry.

The share of transport increased from 22 to 28%, being the largest change, and this could be attributed to the increasing role of road freight and passenger transport. Households remained the largest energy consumers, despite their declining share from 35 to 31%. The share of industry decreased from 26 to 24%, and that of agriculture – from 8 to 5%. The share of service sector increased from 12 to 13%.

Above 94% of energy consumed by transport sector in Poland in 2015 was used by road transport, less than 4% by air transport, less than 2% by rail transport, and trace quantities by inland and coastal water transport. Between 2005 and 2015, fuel consumption in road transport increased by 40% (annual growth rate of 3.4%), while in rail transport there was a 30% decrease (3.6% annually) in energy consumption over the same period. Overall, between 2006 and 2015, the average annual growth rate of fuel consumption in transport (excluding air transport) was 3.0% and was by 34% higher in 2015 than in 2005.

Between the years 2005–2015, the rate of improving energy intensity was significantly higher in Poland than in the European Union. In 2015, according to Eurostat data, the energy intensity values for the Polish and the EU economy were 227.3 kgoe/1000 euro and 120.4 kgoe/1000 euro, respectively.

There has been a noticeable decrease in the share of heating in the structure of energy consumption, owing to the installation of more efficient gas and electric appliances, thermal modernization and more restrictive building standards.

With respect to final energy consumption, consumption in the individual sectors of economy is driven by the following factors: activity, housing stock, lifestyle, structural changes, energy savings resulting from improved end-user performance, weather conditions, and other factors.

A significant problem in the power sector is the poor quality of transmission and distribution networks. Transmission and distribution networks, although ensuring the security of electricity supply to national customers, need modernization.

As of 1.01.2016, the farmland in Poland was estimated to be 18.6 million hectares, what constituted 59.6% of the country's area (GUS Statistical Yearbook of Agriculture 2016). According to information provided by the 2010 Agricultural Census, the area of farm holdings amounted to about 18 million hectares in 2010 and accounted for about 58% of the total area of the country.

In the beginning of 2016, the combined area of forests, woodland and shrubland in Poland was estimated to be 9715 thousand hectares, which accounted for almost 31% of the country's area. Between 1946 and 2016, the forest area grew up by more than 10% (from 20.8% in 1946), and the target forest area in Poland is expected to be 33–34%. In 2015, the forest cover rate, including only the forested land, varied between regions, ranging from 21.3% in central Poland to 49.2% in the Lubuskie Voivodeship in western Poland.

To the most important functions of forests belong the supporting (protective), productive (economic) and social functions. In 2015, the total area of protective forests accounted for 52.3% of the total forest area managed by the State Forests, and 41.2% of the total forested area, including the forest owned by various proprietors. Among the forest categories distinguished, the largest area is

taken by forests protecting water resources – 1541 thousand hectares, next to suburban forests – 628 thousand hectares, and forests damaged by industry – 466 thousand hectares.

The use of wood for energy purposes has remained almost constant in recent years. The firewood harvest in 2015 amounted to 5151 thousand m^3, which was less than 13% of the total volume of timber harvested. However, the level of harvest does not exceed the permissible use level, i.e. the level of the current increase in the stand volume.

In the period 2000–2015, the amount of waste generated in Poland was contained within the limits of 123-142 million tones. Industry is the largest waste producer, accounting for more than 90% of total waste generated. Over the last few years, the amount of industrial waste that has been recycled and disposed of has remained at a similar level. 17–22% of industrial waste is deposited in landfills.

According to recent estimates, the amount of collected municipal waste has been increasing year by year, what results from the tightening of the waste management system. In 2015, 10,863.5 thousand tonnes of municipal waste were collected (an increase by 5.2% compared to 2014). The average per capita municipal waste collected in 2015 was 283 kg.

S.3. Greenhouse gas inventory information

The National Centre for Emissions Management at the Institute of Environmental Protection – National Research Institute has the responsibility 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 of 2017, Item 286).

The National inventory of greenhouse gases for 1988–2015, presented in this report, has been prepared in accordance with the notification submitted to the Secretariat of the Climate Convention in 2017. The preparation of the inventory is consistent with the binding decision 24/CP.19, which contains Revision of the UNFCCC Reporting Guidelines on annual inventories for Parties included in Annex 1 to the Convention contained in the decision. Whereas, the guidelines used to calculate greenhouse gas emissions and removals are consistent with the methods recommended in the above decision, published by the Intergovernmental Panel on Climate Change (IPCC): 2006 IPCC Guidelines for National Greenhouse Gas Inventories. In line with the current IPCC guidelines, the national emission estimation methodology was used wherever possible to obtain a more accurate emission data.

In 2015, the aggregate emission of all estimated greenhouse gases was 385.8 million tonnes of CO_2 equivalent (excluding sector 4. Land use, land-use change and forestry). Balance of greenhouse gas emissions and removals in sector 4. was estimated to be 28.8 million tonnes of CO_2 equivalent – CO_2 sink (mainly by forest land) was 36.5 million tonnes CO_2, while emission amounted to 7.7 million tonnes of CO_2 equivalent. In 2015, the Energy sector made up the most (almost 84%) of the total greenhouse gas emission (expressed in CO_2 equivalent) in Poland, with fuel combustion as the dominant emission source. The share of major sectors in the national emission, according to the IPCC emission source categories, is shown in Figure S.1

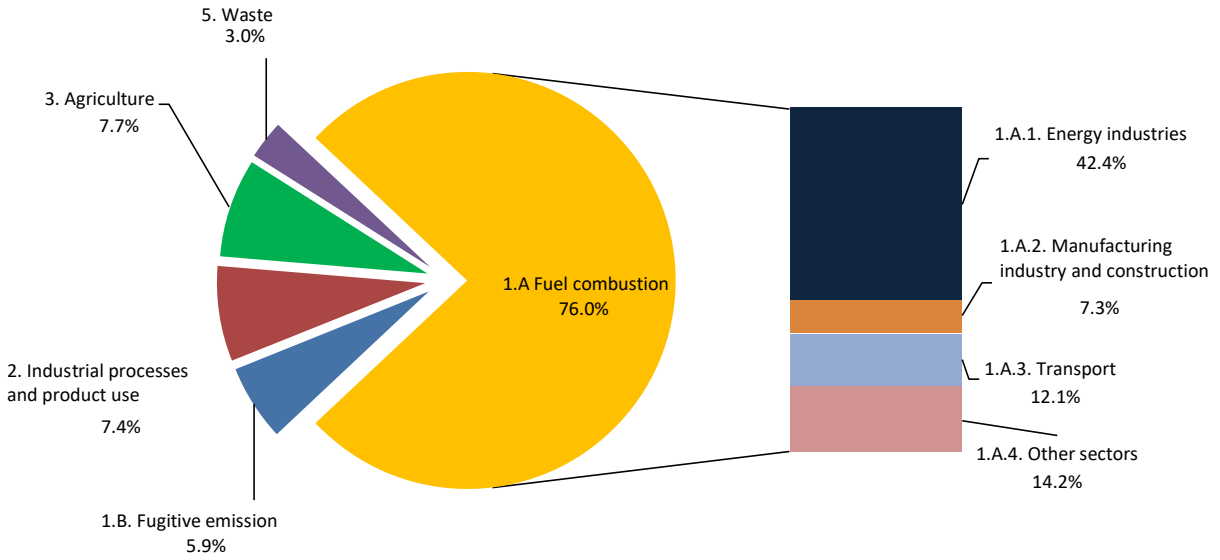


Fig. S.1. Structure of greenhouse gas emissions converted into CO_2 equivalent (without category 4) in 2015, by IPCC category, source: IOŚ–PIB, KOBiZE

The inventory results show that greenhouse gas emissions declined by 32.4% between the years 1988 and 2015, with carbon dioxide emissions down by 34.0%, methane – 32.6%, and nitrous oxide – 35.2%. Significant reductions in greenhouse gas emissions were noted in the years 1988-1990. This decrease was the result of considerable changes in the Polish economy, especially in the heavy industry. The changes accompanied the onset of political transformation in 1989, and the transition from a centrally controlled to a free market economy. The reduced emission value remained unchanged until 1993, after which it began to grow, reaching a local maximum in 1996, which was due to, among others, the development of heavy industry and an increased rate of economic growth. Over the subsequent years, the emission continued to decline, if slowly, until 2002, owing to programmes and actions aiming at the efficient use of energy. In 2002, there was noted a slight increase in emissions which continued to grow until 2007. Since 2008, emissions have been kept at a stable level, apart from a marked decline in 2009 caused by the global economic downturn. From the year 2012 onwards, the national emission does not exceed 400 Mt CO_2 eq. (Fig.S.2).

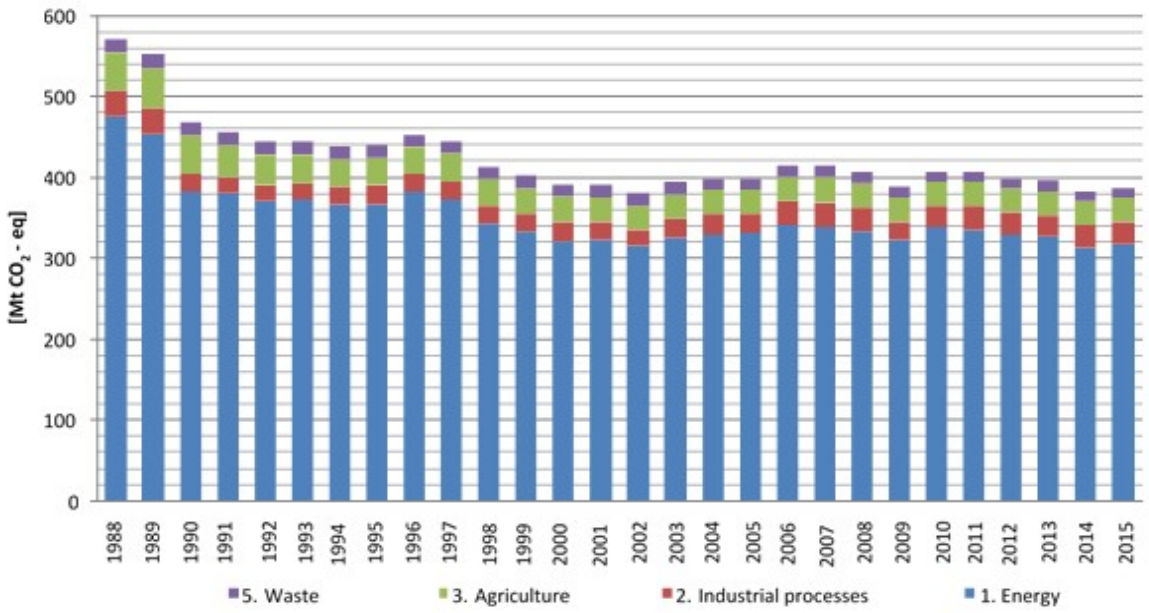


Fig. S.2. Trend of greenhouse gas emissions recalculated as CO_2 equivalent (without category 4) in the years 1988–2015, according to IPCC category, source: IOŚ–PIB, KOBiZE

The Polish registry of the Kyoto units was launched in July 2006 and, since 2008, has been linked to the International Transaction Log (ITL). Pursuant to national regulations, the Registry is managed by the National Centre for Emissions Management which operates within the framework of the Institute of Environmental Protection – the National Research Institute in Warsaw. The registry database holds information about entities covered by the system, installations, verified emissions, national holding accounts, installation accounts, aircraft operator accounts, personal holding accounts and working accounts.

The registry may be accessed by the participants in the emissions trading system and by the registry operator via a secure website at: https://ets-registry.webgate.ec.europa.eu/euregistry/PL/index.xhtml. The current information and changes in the national register are presented annually in the National Inventory Reports (NIRs) submitted to the UNFCCC Secretariat by 15 April.

S.4. Policies and measures

In the period 2008–2012, i.e. in the first period of commitments resulting from the ratification by Poland of the Kyoto Protocol, Poland has undertaken to reduce greenhouse gas emissions by 6% compared to the base year. Nonetheless, in the second commitment period set out by the Doha amendment, between the years 2013 and 2020, Poland, together with the other EU Member States and Iceland, has agreed on a common reduction target of 20% reduction compared to the base year.

Pursuant to the decisions taken within the framework of the energy and climate package, Poland is obliged to reduce its greenhouse gas emissions by 21% in the years 2013-2020, compared to 2005, and has the potential to increase by 14% emissions from the sectors not covered by the system. In addition, Poland has committed itself to increase, by up to 15%, the share of final energy production from renewable energy sources and, by up to 10%, the share of biofuels in the transport fuel market, as well as to improve the energy efficiency of the economy by 2016, to the level of 9% of the average national final energy consumption.

Recently, the Government has undertaken a number of initiatives towards strategic programming in Poland and designing a comprehensive development management system. The foundations for a new system of strategic documents have been worked out, defining the vision and directions of the country's development, both in the long-term perspective until 2030 (document the "Polish Long-term National Development Strategy by 2030. Third wave of modernity"), and over the recent decade (document: the "National development Strategy by 2020" together with 9 integrated strategies and the "Strategy for Responsible Development".

Between the years 1988 and 2015, greenhouse gas emission has significantly decreased (excluding sector 5. *Land use, land-use change and forestry*), attaining the value by about 30% lower than in the base year (Figure S.3). The change in emissions was a result of implementing a whole set of policies and actions designed primarily to improve energy efficiency and restructuring the consumption of fuel and energy carriers.

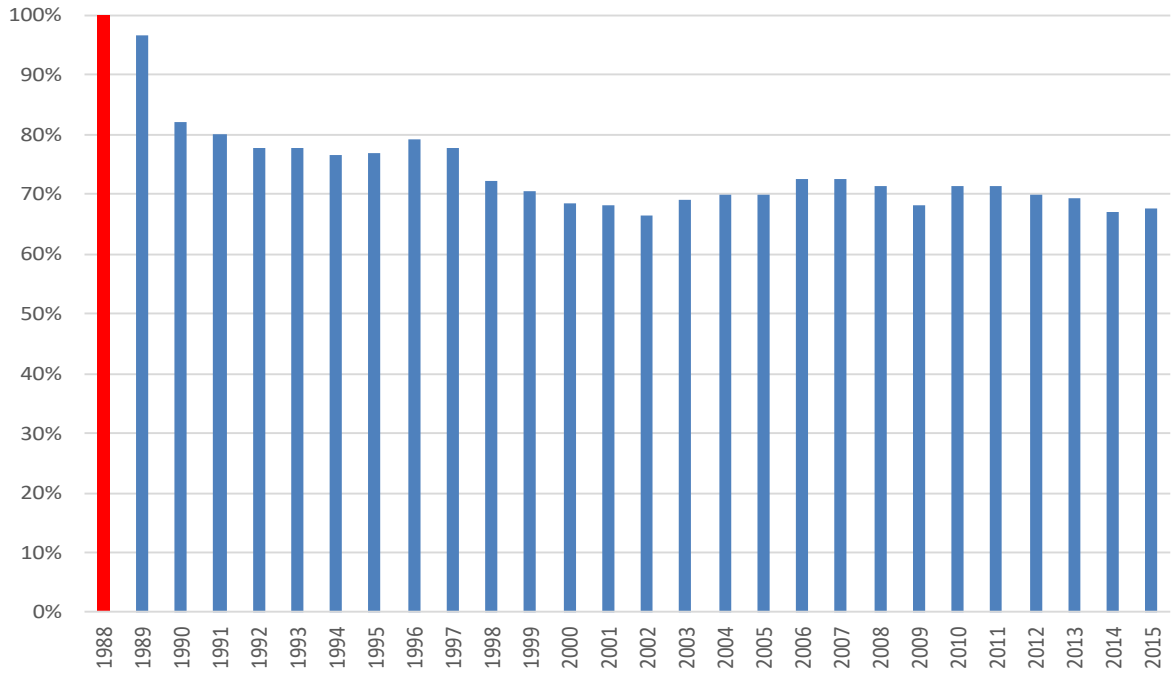


Fig. S.3. Changes in greenhouse gas emissions in Poland compared to 1988, source: IOŚ–PIB, KOBiZE

Supporting all activities which aim at reducing environmental pollution, Poland places particular emphasis on effective reduction of greenhouse gas emissions, implementing, above all, the national actions, alongside those driven by the mechanisms under the Kyoto Protocol.

The basic institutional and financial mechanism supporting the implementation of the Polish climate policy is the system of financing of environmental activity, based on funds provided by the National Fund for Environmental Protection and Water Management (NFOŚiGW), the Voivodeship Funds for Environmental Protection and Water Management (WFOŚiGW) and the European funds. The most commonly funded projects include:

- modernization and construction of district heating networks;
- modernization of boiler plants;
- thermo-modernization of public utility objects;
- reducing low emission;

- investments in installations using renewable energy sources;
- energy saving in urban heat supply systems (only within the framework of competition concerning energy saving in heating systems);
- use of biomass for energy purposes in the communal sector and industry;
- economic use of biogas from the agricultural sector, municipal landfills and sewage treatment plants;
- use of solar energy (photovoltaic panels and solar collectors under the subsidy system);
- use of shallow geothermal resources (heat pumps);
- promotion of fuel cell technology;
- use of energy derived from thermal conversion of waste.

Below, the directions for action have been presented to reduce national greenhouse gas emissions identified in the sectors covered by this report. The cross-sectoral policies and actions include:

- implementation of the European Union Emissions Trading System (EU ETS)
- the Effort Sharing Decision (ESD)
- Green Investment Scheme (GIS).

Whereas the sectoral policies and actions include:

In power industry:

- improving energy efficiency;
- increasing the security of fuel and energy supplies;
- diversification of the electricity production structure;
- increased use of renewable energy sources, including biofuels.

In industry:

- improving technical standards of installations and equipment;
- measures to reduce emissions of fluorinated greenhouse gases;
- implementation of best available techniques;
- reducing methane emissions from fuel production and distribution;
- promoting environmentally friendly and effective practices and technologies in industrial activities, and promoting the development of environmentally friendly and cost-effective greenhouse gas reduction methods;
- technological modernization in industrial plants.

In transport:

- reducing the environmental burden of road transport;
- increasing the share of alternative fuels in transport;
- modernization of railway infrastructure;
- purchase of modern and modernization of the existing mobile assets;
- providing support for technical solutions with enhanced energy efficiency on ships;
- introduction of organizational solutions conducive to reducing emissions in the air transport;
- improving public transport in cities;
- development of intermodal transport;
- promoting bicycle as a means of transport.

In construction and housing:

- introduction of requirements for energy standards in construction;

- assessment of the energy performance of buildings;
- promoting the use of renewable energy sources;
- thermo-modernization of buildings;
- increasing the awareness of building managers, owners and users in the scope of energy saving.

In agriculture:

- rationalizing the use of fertilizers, including nitrogen fertilizers;
- rationalization of energy management, including the production of biomass from waste, slurry and manure;
- afforestation of agricultural land and other lands;
- preferring crops with a high CO_2 uptake rate;
- conducting a rational economy on agricultural land;
- improvement of feeding techniques and fodder management;
- improvement of livestock maintenance systems, reduction of methane emissions from livestock manure;
- elimination of gaseous pollutants emitted from poultry buildings by the use of phytoremediation and solar ventilation.

In waste management:

- increase the recycling of municipal waste;
- using waste as energy source;
- reduction of waste, including biodegradable, deposited on landfills other than hazardous and inert (municipal) waste.

In forestry:

- counteracting changes in land use;
- rationalization of forest management, incentives and actions, supporting afforestation and protection of ecological sustainability of forests.

S.5. Emission projections and the total effects of policies and measures

The national projections cover the projected greenhouse gas emissions by 2040 (with the breakdown by the years 2020, 2025, 2030, 2035 and 2040), taking into account the effects of adopted and implemented policies and measures to reduce emission. These projections constitute the so-called scenario "with measures". The emission projections include all greenhouse gases and sectors covered by the national greenhouse gas inventory, submitted to the UNFCCC Secretariat in 2017.

The main assumptions for the projection of the emission are given in the document entitled: "Demand for fuel and energy by 2050", developed by the National Agency for Energy Conservation S.A in 2013, to the commission of the Ministry of Economy. The forecast assumes:

- improving energy efficiency,
- increasing the security of fuel and energy supply,
- diversification of fuel structure in power industry,
- development of the use of renewable energy sources,
- developing competitive fuel and energy markets,
- reducing the impact of energy sector on the environment.

The remaining input data for the emission projection were acquired, primarily, from the official prognostic documents concerning industrial activities and from sectors and branches providing information on industrial output, agricultural production, quantities of waste generated, etc., broken down by years and source types.

The projected greenhouse gas emissions in 2040 declined to about 327 million tonnes of CO_2 equivalent. Among the greenhouse gases, carbon dioxide will continue to maintain its position, albeit its share is projected to go down to less than 77% by 2040, as compared to over 82% in the base year 1988. In turn, the share of methane and nitrous oxide will rise respectively from around 12.3% and 5.1% to around 13.5% and 6.2%, respectively, by 2040. Approximately, 3% of the emissions will be industrial gases. So far, no NF_3 emissions have been reported in Poland, therefore the assumption concerning NF_3 emission has remained without change.

The value of the total projected greenhouse gases emission is largely affected by Sector 1. *Energy* (Table S.3), with the forecast that by 2035, the emissions in this sector will be gradually decreasing and then rise slightly in 2040. Emissions from industrial processes and product use show a slight upward trend. The projected greenhouse gas emissions in agriculture are slightly increasing until 2030 and then stabilizing, while emissions in the waste sector, after rise in 2020, will decrease systematically over the forecasted period.

Table S.3. Greenhouse gases emission projections for the years 2020–2040, as compared to emissions in the years 1988 and 2015

Source category	Emission by sectors [kt CO_2 eq.] in the years						
	1988	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
1. Energy	474 968.03	316 109.87	315 861.06	304 519.50	284 906.63	249 882.69	250 268.44
2. Industrial processes and product use	31 198.21	28 525.12	29 180.59	30 880.64	31 903.33	32 572.93	33 360.15
3. Agriculture	47 835.68	29 649.89	31 029.39	32 027.68	32 320.47	32 140.06	32 158.36
4. Land use, land-use change and forestry	-16 806.83	-28 844.99	-21 820.22	-18 446.49	-13 796.38	-11 804.84	-9 500.20
5. Waste	16 368.96	11 558.01	11 922.22	11 945.93	11 802.59	11 688.53	11 606.97
Total*	**570 370.88**	**385 842.89**	**387 993.26**	**379 373.75**	**360 933.03**	**326 284.21**	**327 393.91**
International fuel bunker jointly	**2 784.99**	**2 481.21**	**2 753.18**	**3 147.43**	**3 518.05**	**3 953.69**	**4 136.97**
Air transport	1 016.15	1 889.96	2 102.81	2 420.19	2 737.61	3 054.99	3 054.99
Marine transport	1 768.83	591.25	650.37	727.23	780.44	898.69	1 081.90

* Excluding emissions and removals from sector 4: *Land use, land-use change and forestry*

Source: IOŚ–PIB, KOBiZE

The projected 2020–2040 reduction in emissions as compared to the year 1988 was 32% in 2020, 36.7% in 2030 and 42.6% in 2040, respectively, from all sectors. The largest projected reduction occurred in the sectors of *Energy* (by 47% between the years 1988–2014) and *Agriculture* (by 33% between the years 1988 and 2040). On the other hand, the forecasted emissions from industrial processes are higher by about 7% in 2040 than in 1988.

S.6. Vulnerability assessment, climate change impacts and adaptation measures

Since the time when the 6th Governmental Report was elaborated, further progress has been made in preparing the country for the current and expected climate change. In the years 2011–2013,

the Government's position has provided the basis for launching KLIMADA project on "Developing and Implementing Strategic Adaptation Plan for Sectors and Areas Sensitive for Climate Change", implemented by the IOŚ–PIB (http://ios.edu.pl/pol/aktualnosci/15.01.14/adaptacja_wrazliwych_sekt_i_obsz_Polski_do_zmian_klimatu.pdf). The implementation of this project resulted in the adoption by the Government of the "Strategic Plan of Adaptation (SPA 2020) by 2020, with a vision to 2030". This strategy is part of the EU's policy framework for the adaptation to climate change, which aims to improve the resilience of the States, paying special attention to a better extreme climate and weather preparedness and reducing the socio-economic costs associated with it.

The last two decades of the 20th century and the first decade of the 21st century were the warmest in the history of instrumental observation carried out on the Polish territory. The warmest years in the last 30 years were the years 2015, 2014, 2012, 2007, 2000 and 1999.

Increases in air temperatures have been observed in all seasons of the year, more so in winter, than in summer. The decisive rise in extreme temperatures has taken place since the beginning of the eighties of the last century.

Comparing current trends with changes expected in the middle of this century, it is expected that changes will, in most cases, have the same tendency, but the process will be significantly intensified. This is especially true of warming in summer and winter. In summer, warmer periods with temperatures above 25 degrees will be extended. Temperature has been rising by an average of 0.4 °C over the entire period 1981–2090. Warming is accompanied by changes in the frequency of incidence of dangerous and disruptive weather phenomena, and in particular of: lack of snow cover in winter, frost and spring frost incidents, low water levels in rivers, soil drought, violent downpours and floods, heat waves, hurricanes and tornados. The observed temperature increases are conducive to prolonging the growing season in agriculture, while water deficit becomes a limiting factor for agricultural production.

Precipitation is changing less distinctly and shows a large spatial variability. The annual precipitation sums, in the period described, increased moderately from a dozen to a hundred tens of millimeters per decade. The increase in precipitation during the summer season amounted to 60 mm per a decade. The above trend was most significantly affected by the precipitation pattern over the last 30 years.

Over most of the Poland's territory there has been a change in the structure of precipitation consisting in a decisive increase in the number of days with heavy rainfall: e.g. a daily precipitation ≥ 30 mm increase by more than 3 days/decade; precipitation ≥ 50 mm – increase by 2 days/decade.

The observed climate change in Poland does not yet have any significant impact on the economy, but with further warming one should expect a growth in damage and, consequently, in the cost of loss compensation or actions to reduce negative effects. This applies in particular to water supply, especially in agriculture.

The main threats in Poland involve: changes in water balance, including increased variability of precipitation and evaporation, decrease in cereal and potato yields, increased frequency of extreme weather events including floods, droughts and hurricanes, increased forest fire risks, accelerated soil erosion, biodiversity loss as well as higher losses in forest stands as a result of more frequent extreme winds. Additional challenges will also be faced by the health system as a result of increased exposure to extreme weather events and diseases not yet occurring in our climate zone.

In the study made by the Institute of Environmental Protection – National Research Institute, the total value of losses caused by extreme events in the years 2012–2016 was estimated at about PLN 36.5 billion at prices in 2015. Every year, extreme events cause losses ranging from PLN 4

billion to PLN 7 billion. Once every few years, an over-average losses occur, as in 2015, when Poland was hit by severe drought. Long periods of drought have significant, destructive effects on many aspects of life: water supply, agriculture and forestry. The elements that have caused significant damage over the last five years include rain storms, which cause flooding in combination with strong winds that damage the infrastructure. Rain storms cause not only a material damage, but also endanger human life and health.

According to the Strategic Adaptation Plan for sectors and areas sensitive to climate change (SPA 2020), floods are one of the major catastrophic threats to Poland. With predicted climate change, the damage is expected to increase.

Extensive information on sector vulnerability has been provided in the 6th Governmental Report.

The main goal of adaptation policy is to ensure the sustainable development and effective functioning of the economy and society under conditions of changing climate. The climate change adaptation policy is coordinated by the Ministry of the Environment.

Issues related to adaptation to climate change were taken into account in the Strategy for Responsible Development adopted by the Council of Ministers on 14 February 2017 as well as in the "Strategic Adaptation Plan for Sectors and Areas Sensitive for Climate Change by 2020, with a vision to 2030". The need for action to adapt to climate change and the need for adaptation are addressed in the chapters on Environment, Small and Medium Enterprises and Territorial Sustainability.

The "Environmental Policy of the State" document (PEP) is also planned to include a direction of interventions with regard to climate change, which will address issues related to mitigation and adaptation. The information will be also provided on the research programs being implemented with respect to adaptation of actions undertaken at national and regional level.

S.7. Financial assistance and technology transfer in accordance with Art. 4.3, 4.4, 4.5 of the Climate Convention

The Republic of Poland does not belong to the Parties listed in Annex II to the Climate Convention, thus has no obligation to fulfill Articles 4.3, 4.4 and 4.5. of the Convention. However, Poland is carrying out a number of assistance tasks, recognizing and understanding the need to support sustainable development in developing countries and transition economies. As a member of the European Union, the majority of aid is allocated through contributions to the EU general budget.

Poland is pursuing a number of assistance tasks, recognizing and understanding the need to support sustainable development in developing countries and transition economies. With respect to the implementation of international aid commitments, the funds provided by Poland under Official Development Assistance (ODA) increased over the period 2012–2016, fluctuating from PLN 1,369 million to 2,610 million (USD 421–662 thousand). In 2012–2016, about 77% of Polish Official Development Aid was granted via a multilateral channel, mainly through contributions to the EU budget. Approximately 23% of the Polish aid was granted through bilateral assistance provided by the public finance sector institutions, Polish diplomatic missions and non-governmental organizations. Poland's contribution to climate change related activities, in the period covered by the Report, amounted to approximately PLN 63,684529.99 (EUR 14,727982.34) at current prices. The climate change related activities category covers contributions to international organizations tackling climate protection, environmental protection and energy. Some of the funds were donated to projects

in support of science and technology facilities in developing countries through the exchange of knowledge and the provision of specialized equipment for research purposes. Assistance was also provided for projects aimed at building resilience to natural disasters, dissemination of innovative energy efficient technologies and development of renewable energy sources.

Poland allocates funds to promote technological development in developing countries. In the years 2013–2016, 54 technological projects have been implemented under the GreenEvo Green Technologies Accelerator project, aiming to promote rational use of energy and renewable energy sources. Nearly 40% of the GreenEvo projects have been deployed to developing countries. Over the project duration period, companies had the opportunity to participate in meetings with potential partners in: China, Moldova, Serbia, Chile, Kazakhstan, Ukraine, Nigeria, Morocco, South Africa, Bosnia and Herzegovina, Costa Rica and Senegal.

S.8. Research and systematic observation

The issue of counteracting and adaptation to climate change in the National Programme for Research and Development Studies has been included in two of the five priority areas of research: energy and infrastructure, environment and agriculture.

Research and development in the field of climatology in Poland covers a wide range of topics. The leading fields of research include: physical climatology, climatology of areas under high human pressure, dynamic climatology, regional climatology, applied climatology and the study of climate change, its triggers, drivers and enhancing factors.

Climate change research can be divided into the following categories:

- climate change research in the past;
- modelling of climate processes;
- the impact of climate change on the environment, economy and society;
- human impact on the climate;
- social and political aspects of climate change.

The research work is carried out both within the framework of the abovementioned national programme as well as under numerous international programmes.

In Poland, observations and measurements within the global system of meteorological and climatic observations are conducted by the State Hydrological and Meteorological Service at the Institute of Meteorology and Water Management – State Research Institute (IMGW–PIB).

The observation and research tasks are carried out jointly by the IMGW–PIB, the Marine Fisheries Institute in Gdynia (MIR), the Institute of Oceanology of the Polish Academy of Sciences, the University of Gdańsk and the Maritime Institute in Gdańsk.

The Earth Observation System of Significant Climate Variables is integrated into the Global Terrestrial Network (GTN) and includes the following components:

- hydrology (GTN-H, GTN–Hydrology),
- flows (GTN-R, GTN–River Discharge)
- lakes (GTN-L, GTN–Lakes)
- glaciers (GTN-G, GTN–Glaciers),
- permafrost (GTN-P, GTN–Permafrost).

As part of the GTN-H component, the IMGW–PIB conducts measurements of water level at 863 locations in the country. The basic measuring range includes observations of water status, ice

phenomena, ice cover thickness, vegetation overgrowing the river beds and potentially, recording of daily water status and temperature (at over 210 locations).

Under the GTN-G component, the Polish scientific units conduct monitoring of inland glaciers at high geographical latitudes. Glaciers and permafrost are monitored in the Norwegian Arctic, in south-western Spitsbergen (Hornsund station). In Antarctica, ice surveys are conducted by the Polish Academy of Sciences in the vicinity of the Henryk Arctowski station (South Shetland Islands).

Research activities in the field of satellite observation systems focus on the use of satellite information for meteorology and hydrology in an operational mode. In addition, work is being done on the use of satellite data in climatology, oceanology, agriculture and environmental studies.

Greenhouse gases and other air pollutants are also monitored as part of the EMEP program, as well as tropospheric ozone and atmospheric concentration of carbon dioxide and methane.

In 2016 a multiannual programme was adopted for development cooperation for the years 2016–2020. Among priorities concerning the support for developing countries is environmental protection, with the specific objective of "Protecting natural resources and sustainable development and mitigating negative effects of climate change, including the prevention of natural disasters".

According to the programme, the projects that cover the above subject will be primarily implemented in African countries, including: Ethiopia, Tanzania, Kenya and Senegal.

S.9. Education, training and public awareness

Ecological education is a combination of education and the upbringing of society in a spirit of respect for the natural environment. Ecological education is also defined as a psychological and pedagogical process of influencing a human being in order to shape his/her ecological awareness.

Education is a process that can be implemented in an institutionalized form, as formal education at various levels of instruction, governed by relevant programming documents. It is supported by many forms of non-formal education conducted by scientific and social institutions outside the education system and by non-governmental and church organizations. An important role has the education gained through the media education programmes and inexperienced education through advertising, films, entertainment programs, etc. Every of the abovementioned categories of educational interventions should adequately cover all citizens in the lifelong learning process.

Various forms of education, promotion and information in the field of climate protection are offered by public administrations, scientific institutions and ecological NGOs. Much of this activity is carried out by the Ministry of the Environment or under the auspices of the Minister of the Environment, with the aim to raise awareness that every citizen may have impact on the reduction of greenhouse gas emissions.

Concluding, it is noteworthy to emphasize that in both formal and informal education programmes a lot of attention is dedicated to protecting the climate. However, the informal education offers much more in terms of information diversity and the way in which climate-friendly behaviour is promoted than the formal education, apart from the fact that the former is addressed to many social and professional groups. It is also noteworthy that business environments show ever growing interest in climate topics.

In the vast majority of educational programs and information campaigns, the main focus is on actions to reduce CO_2 emissions (through promoting both the energy-saving habits and renewable energy sources). However, proposals for climate change adaptation activities are only infrequently

taken into account in education. It is therefore important to include practical topics covering climate protection and climate change adaptation into education as priority topics, especially in urban areas, at the same time, extending the range of social groups addressed in the trainings as well as take into account their specificities.

CHAPTER 1. INTRODUCTION

This Seventh National Communication and the Third Biennial Report to the Conference of the Parties under the United Nations Framework Convention on Climate Change was prepared in accordance with Decision 9/CP.16 which specifies the deadline for submission of national communications and basing on UNFCCC/CP/1999/7, Part II: Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, which defines the content of the national communications.

The communication provides information on the period 2012–2015 in the following areas:

- National circumstances relevant to greenhouse gas emissions and removals;
- Greenhouse gas emissions inventory;
- Policies and measures;
- Projections and effects of policies and activities;
- Vulnerability assessment, climate change impact and adaptation measures;
- Development cooperation and transfer of technology;
- Research and systematic observation;
- Education, training and public awareness.

Due to the fact that the deadline and significant part of the biennial report coincides with the 7th national communication, this communication fulfills also the decision of the Conference of the Parties (Decision 2/CP.17) on the preparation of the third biennial report by developed countries. Therefore, this document also contains information required in biennial reports in the form of an attachment to the seventh communication. In addition, according to decision 19/CP18, the annexes to the third biennial report are tables generated from the Common Tabular Format (CTF) which were prepared in accordance with guidelines included in this decision.

Third biennial report is reduced to CTF tables containing information required by the decision in order to avoid repeating information from the Seventh national communication.

Additional information required under Article 7.2 of the Kyoto Protocol is presented in individual sections of the report. Table 1.1 presents a summary of additional information required under art. 7 paragraph 2 of the Protocol from Kyoto, with the indication of the relevant chapters in which this information is reported.

This report covers information on the period 2012–2015 and for 2016, if such data was available during the preparation of the communication. Legal and strategic documents describe national circumstances which were in force until mid-2017. The information contained in the report is a continuation of information contained in previous reports: 6th national communication (2013) and 2nd biennial report (2015).

Table 1.1. Summary of additional information reported under the Article 7 paragraph 2 of the Kyoto Protocol

Information reported under the Article 7 paragraph 2	Chapter of the national communication
The national inventory system	3.5
National register	3.6
Additional information connected with mechanisms under Articles 6, 12 and 17	4.3.2, 4.3.3, 5.5
Policies and actions under the Article 2	4.3.4
Programs and/or administrative procedures on national and regional level	4.2.5
Information required under the Article 10:	
Article 10, point a (measures undertaken to improve national inventory)	3.5
Article 10, point b (measures to mitigate climate change and measures to facilitate adaptation to climate change)	4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 6.4
Article 10, point c (actions related to transfer of technology)	7.6, 7.7
Article 10, point d (actions related to systematic observations)	8.2, 8.3
Article 10, point e (actions related to international education and training programmes and public awareness)	9.3, 9.7
Financial resources	7.2, 7.3, 7.4

CHAPTER 2. NATIONAL CIRCUMSTANCES RELEVANT TO GREENHOUSE GASES EMISSIONS AND REMOVALS IN POLAND

2.1. Organization of the State

2.1.1. The State governance

The Republic of Poland is a constitutional republic with a parliamentary-presidential system and a classic tripartite division of power into legislative, executive and judiciary branches.

The legislative power is exercised by a bicameral parliament, composed of the Sejm (the Chamber of Deputies) and the Senate (the Senate Chamber). The Sejm and the Senate in a joint session constitute the National Assembly.

The executive power belongs to both the President and the Council of Ministers. The Government consists of, among others, 18 ministries, including: Ministry of Digitization, Ministry of National Education, Ministry of Energy, Ministry of Finance, Ministry of Maritime Economy and Inland Waterways, Ministry of Infrastructure and Construction, Ministry of Culture and National Heritage, Ministry of Science and Higher Education, Ministry of National Defense, Ministry of Family, Labour and Social Policies, Ministry of Agriculture and Rural Development, Ministry of Development, Ministry of Sport and Tourism, Ministry of Interior and Administration, Ministry of Foreign Affairs, Ministry of Justice, Ministry of the Environment and Ministry of Health.

The Government executes its tasks supported by governmental organs and bodies at the national level: ministries, central offices and foreign services and, at the regional level: voivodes (province governors representing the Government in 16 voivodeships), voivodeship offices (subject to voivodes) as well as by territorial units of integrated governmental administration.

The territorial division of the State is three-tiered. It consists of municipalities, counties and voivodeships. Local self-government units are autonomous and their autonomy is subject to judicial protection. The local government basic unit is a municipality. As of December 31, 2015, there were 16 voivodeships in Poland, 314 counties, 66 cities with county status and 2 478 municipalities, including 304 urban municipalities, 1 563 rural and 611 urban-rural [Central Statistical Office (GUS) Statistical Yearbook 2016].

2.1.2. Organs and institutions involved in the implementation of climate policy

The Minister of the Environment in Poland conducts the tasks under the United Nations Framework Convention on Climate Change, done in New York on 9 May 1992 (Official Journal of the Laws of 1996, No. 53, Item 238), hereinafter referred to as the Climate Convention, and under the Kyoto Protocol to the United Nations Framework Convention on Climate Change, done at Kyoto on 11 December 1997 (Official Journal of the Laws of 2005, No. 203, Item 1684), hereinafter referred to as the Kyoto Protocol, in capacity of the Minister responsible for the implementation of the State ecological policies, including climate protection. The Minister of the Environment approves the Environmental Monitoring Program, which is coordinated by the Chief Inspector of Environmental Protection under the Act on the State Inspectorate of the Environment.

The Minister of the Environment commits the implementation of the Polish tasks under the Climate Convention and the Kyoto Protocol, to the research and development institutes which he/she oversees. These are primarily:

- Institute of Environmental Protection – National Research Institute (IOŚ–PIB), which operates the National Centre for Emissions Management, acting as the national coordinator for the Community GHG Emission Trading System and preparing reports on greenhouse gases and other pollutant emission to the atmosphere, also being responsible for the development of periodic reports to the Conference of the Parties to the Convention and to the European Union;
- Forest Research Institute (IBL) – conducts activities related to question of carbon dioxide sequestration in land use, land-use change and forestry (LULUCF);
- Institute of Meteorology and Water Management – National Research Institute (IMGW–PIB), which carries on systematic observations of climate change, and provides the framework for the activity of the National Focal Point for Intergovernmental Panel Climate Change;
- Polish Geological Institute – National Research Institute (PIG–PIB) – responsible for the statewide groundwater monitoring.

The responsibilities to execute the tasks under the Climate Convention at the central level, apart from the Minister of the Environment, are vested in the following Ministers responsible for the implementation to sector policies of the strategy for sustainable development, environmental policies and climate policy of the State. These are primarily:

- Minister of Energy, responsible for energy policy;
- Minister of Infrastructure and Construction, responsible for the development of the transport, construction, planning, spatial planning and housing sectors;
- Minister of Agriculture and Rural Development, responsible for implementing governmental policies in the scope of agriculture and rural development;
- Minister of Development, responsible for the implementation of the strategy for socio-economic development, economic policy and management of the European Funds implementation system;
- Minister of Foreign Affairs, responsible for bilateral aid policy for developing countries;
- Minister of Maritime Economy and Inland Waterways, responsible for the coastal zone, including selected adaptation measures;
- Minister of Finance, responsible for multilateral financial cooperation.

Another body essential for the implementation of the Climatic Convention and the Kyoto Protocol is the Central Statistical Office (GUS), which conducts surveys and disseminates results in the form of official statistics. The statistics include aggregated data on greenhouse gas and other air pollutant emission, statistics concerning energy, fuel production and consumption and many other statistics related to the Climate Convention, including data on the production and imports and exports of substances depleting the ozone layer.

2.2. Population profile

In 2015, the population of Poland amounted to about 38 437 thousand (as of 31.12.2015). The average population density is 123 persons per 1 km^2. The population density varies between regions. In the most urbanized region, in the Silesia province, the population density is 375 per 1 km^2, while in the least populated Podlaskie province – only 59 people per 1 km^2.

At present, the urban population accounts for about 60% of the country's population, and since 2005, the number and share of urban dwellers in the general population of Poland have been decreasing.

The population age structure is shown in Table 2.1. In recent years, the working-age population has declined, whereas the post-working age population shows an increasing trend.

Table 2.1. Population age structure in the years 2012–2015 and in the year 2005 [in thousand]

Population age	Years				
	2005	2012	2013	2014	2015
Pre- working	7 863.8	7 066.8	6 995.4	6 943.0	6 901.8
Working	24 405.1	24 605.6	24 422.1	24 230.2	24 002.2
Post-working	5 888.2	6 861.0	7 078.2	7 305.4	7 533.2
Total	38 157.1	38 533.3	38 495.7	38 478.6	38 437.2

Data: GUS Statistical Yearbook 2016, 2014

2.3. Geographical conditions

2.3.1. Geographical location

Poland is situated in the area of the Central European Lowlands, including the South Baltic Coastal Region and the Central Poland Lowlands. Within the Poland's borders there is also a strip of the Polish Highlands and a portion of the Czech Massif and Carpathian Mountains. In terms of physio-geography, Poland is located at the crossroads of Western and Eastern Europe. Such a location makes the area of Poland diverse with regard to climate, landscape and natural conditions.

2.3.2. Landscape diversity and ecosystems

Lowland is the predominant landscape type in Poland – about 25% of the country's area is situated below the altitude of 100 m above sea level, almost 50% at 100–200 m above sea level, and about 16% at altitudes between 200–300 m. The upland and mountain areas (over 300 m above sea level) occupy almost 9% of Poland, with high mountains taking only 0.2% of the country' area [GUS Statistical Yearbook 2016].

The Coastal Region creates a belt along the southern coast of the Baltic Sea with two bends of the coastline – the Pomeranian Bay with the Szczecin Lagoon and the Gulf of Gdańsk with the Vistula River Lagoon. The Vistula estuary encompasses the Żuławy depression with a well formed delta landscape, the lowest point of which is about 1.8 m below sea level. This area in the Vistula Delta belongs to the most sensitive to the changes in sea level across the entire Polish coastal zone.

The southern borders of Poland run through the ridge of the Sudety and the Carpathians mountain ranges. The largest rivers of Poland have both their sources at those ranges, the Vistula River in the Carpathians and the Odra River in the Sudety Mts. The Carpathians and the Sudety

mountain ranges support a great variety of natural resources embraced by various forms of legal protection.

The geographic location of Poland in the transition zone, with versatile influences of oceanic and continental air masses, diversified landscape and hydrographic layout, together with the variability of the soil substrate, contribute to the richness of natural resources of Poland.

The areas of special natural values in Poland are subject to legal protection. In 2015, these areas included: 23 national parks, 1,490 nature reserves, 122 landscape parks, 383 areas of protected landscape, 166 documentation sites, 7,130 sites of ecological importance and 339 complexes of natural and landscape values. They jointly account for 32.5% of the country's total area, of which 22.4% falls for areas of protected landscape and 8.1% for landscape parks [GUS Environmental Protection 2016].

The most valuable habitats of natural and seminatural character include extensive wetlands with peat bogs, extensive meadows and pastures in river valleys, as well as mountain and xerothermic grasslands rich in endemic species. Large compact forest tracts are among the most valuable ecosystems in Poland, since, albeit transformed and managed, they constitute the major refuges of flora and fauna.

2.3.3. Natural resources

The land relief in Poland is conducive to the economic use of land resources - the percentage of wasteland, including natural rough country, such as coastal dunes and bare rocks in the high mountain ranges, is inconsiderable (1.5%). Agriculture is a dominant form of land use (about 60% of the country) while forest, woodland and scrubland occupy about 31% of the country's area. Over the last 15 years, there has been a steady increase in the area of forested and woodland/shrubland (up by almost 7%). The structure of land use in Poland is given in Table 2.2.

Table 2.2. Area of Poland by land use form in the years 2012–2016 and in year 2005 (as of 1.01)

Land use forms	Years					
	2005	2012	2013	2014	2015	2016
Total area of the country in thousand hectares	31 269	31 268	31 268	31 268	31 268	31 268
Farmland	19 148	18 825	18 770	18 716	18 683	18 621
Forest land, wood- and shrub-land	9 338	9 600	9 634	9 658	9 674	9 715
Land under water	636	646	640	649	645	649
Built-up and urbanized land	1 476	1 590	1 613	1 635	1 652	1 678
Sites of ecological importance	25	35	36	36	37	38
Waste land	498	479	476	475	472	470
Other land	147	94	92	98	105	98

Source: GUS Environmental Protection 2016, 2015, 2014, 2013, 2012

Poland's natural resources involve mineral deposits, including: thermal waters, healing waters and brine. The main extracted geological materials are: hard coal and lignite, crude oil and natural gas, copper-, zinc- and lead ores, sulfur, rock salt and rock raw materials. The balance of selected stocks, as of 2015, is shown in Table 2.3.

Table 2.3. Resources of selected minerals (as of 31.12.2015)

Mineral reosurces	Anticipated economic resources of deposit beds [million tonnes]		Number of beds [units]	
	Total	Developed	Documented	Developed
Hard coal	56 220	21 107	156	51
Lignite	23 516	1 419	91	9
Crude oil	23	22	86	64
Natural gas	123	102	292	207
Copper and silver ores	1 976	1 389	15	5
Zinc and lead ores	84	14	20	3
Sulfur	505	20	19	5
Rock salt	85 378	15 113	19	6
Natural aggregates (sand and gravel)	18 640	5 470	9 704	3870

Source: GUS Statistical Yearbook 2016

Poland has also technically and economically viable resources of renewable energy, mainly the biomass and wind derived energy. The share of renewable energy in the total primary energy in Poland was 11.9% in 2014 (25.4% in the EU-28). In 2010, the average annual growth rate of this indicator was 4.0% for Poland and 6.0% for the EU-28. The renewable energy was mainly derived from solid biofuels (72.2%), wind energy and liquid biofuels (10.8% each), whereas the combined share of the remaining sources (biogas, hydro, solar, heat pumps, municipal waste and geothermal energy) is about 6.2% [GUS 2016 Renewable energy in 2015].

The total renewable water resources in Poland (the multi-annual average) are 63 100 million m^3 (the European average is 95 307 million m^3), ranking Poland twentieth among all European countries [GUS Environmental Protection 2016]. Water resources in Poland are among the poorest in Europe with about 1,600 m^3 per capita per year. For comparison, the European annual per capita is approximately 4,500 m^3, while the global one is around 7,300 m^3. The situation is aggravated by a high seasonal variability and significant spatial variability of hydrological resources, and, as a result, in many parts of the country there are periodic threats of deficit or excess of water. Retention reservoirs are able to retain only a small portion of the annual flow, and do not provide adequate protection against either drought or flood. Water extracted for the national economy in 2015 accounted for 83.5% of surface water resources, 16% of groundwater resources and about 0.5% of water resources from dewatering of mines [GUS Statistical Yearbook 2016].

2.4. Climate

The effect of climate types and seasonal variation of energy amount reaching the Earth, which depend on the geographical latitude, result in the climate zoning in Poland. The average air temperature ranges from about 8 °C in north-eastern Poland to about 11 °C in the south-western part of the country [GUS Environmental Protection 2016].

In Poland, as in many regions worldwide, climate change which has been observed in recent years is mainly due to: an increase in average annual air temperature, a change in the precipitation patterns and an increase in the number of extreme events. The growth of the average air temperatures has been noted across all parts of the country.

The annual precipitation totals fluctuated from about 250 mm in western Poland to 600 mm in northern Poland, and reached over 700 mm in the mountains, with prevailing summer precipitation.

In recent years, the frequency of occurrence of river water rises in Poland has increased (mainly in the montane, submontane and suburban areas as well as in the Vistula Delta). Water deficits in the lowlands and Lublin Uplands have already been regarded as permanent.

Apart from the risk of floods and droughts, the consequences of climate change in Poland include threats of increased forest fire risk and of lowering of groundwater levels followed by the disappearance of wetlands and habitat aridization.

For more information on climate conditions, see Chapter 6.

2.5. Socio-economic situation

2.5.1. Gross Domestic Product and trade

Gross domestic product

In 2014, Poland was ranked 23rd in the world and 10th in Europe in terms of GDP. In 2015, the average GDP growth was 102.2 in EU-28 countries and 103.9 in Poland (Table 2.4) [GUS Statistical Yearbook 2016].

Table 2.4. GDP in Poland in the years 2012–2015

Specification	Years			
	2012	2013	2014	2015
GDP [million PLN, at current prices]	1 615 894	1 656 341	1 719 704	1 798 302
GDP [PLN per capita, at current prices]	41 934	43 020	44 686	46 764
GDP growth [previous year = 100]	101.6	101.3	103.3	103.9

Source: GUS Statistical Yearbook 2016, 2015, 2014

Trade exchange

In foreign trade, the surplus of imports over exports has been observed. A moderate growth in exports from Poland results from a slowdown in the overall economic growth and the political uncertainty in the world. The export growth rate dynamics in the period 2011–2015 exceeded the dynamic of imports growth rate, only in 2014 the opposite was observed (Table 2.5).

Table 2.5. Import and export dynamics in the years 2011–2015 (fixed prices, previous year = 100)

Specification	Years				
	2011	2012	2013	2014	2015
Imports	106.2	98.5	102.9	110.4	105.3
Exports	108.1	103.4	106.5	106.7	107.7

Source: GUS Statistical Yearbook 2016, 2015

2.5.2. Power engineering

General characteristics

Raw materials for the power industry in Poland encompass:

- Hard coal – hard coal mining has been declining in recent years since the old and unprofitable mines were closed and there has been an increase in the use of energy-efficient technologies and equipment by energy consumers; hard coal occurs in the Upper Silesian, Lower Silesian and Lubelski Mining Basins.
- Lignite – extracted using the opencast mining method, the mining basins are located in the vicinity of the following towns: Konin, Turoszów and Bełchatów.
- Crude oil – oil production in Poland is negligible. Poland imports crude oil from Russia, Arab countries and the North Sea Basin.
- Natural gas – domestic production covers 40% of the Polish gas demand, the remaining part is covered by gas imports from Russia and Ukraine.
- The share of other energy sources, including renewable energy, shows an upward trend from year to year.

Data concerning the size and structure of primary energy consumption in Poland by energy carriers are given in Table 2.6.

Table 2.6. Size and structure of primary energy consumption in the national economy, by energy carrier, in the years 2012–2015

Energy consumption	Years			
	2012	2013	2014	2015
Total primary energy consumption [TJ]	4 387 291	4 429 783	4 250 346	4 338 876
Contribution of individual sources [%]				
Hard coal	40.8	42.0	40.6	39.3
Lignite	12.1	12.4	12.2	11.9
Crude oil	24.4	23.2	24.1	25.6
Natural gas	13.1	13.0	13.2	13.3
Renewable energy, heat pumps	0.6	0.7	0.9	1.1
Other 1)	9.1	8.6	8.9	8.9

1) Firewood, peat, waste fuels

Source: GUS Power and Fuel Economy

For many years, there has been a decrease in the consumption of hard coal and lignite as a source of energy to the advantage of petroleum derived fuels, though over the next few decades, coal will remain a strategic resource.

The local Low Carbon Economy Plans will contribute to accomplishing the targets set in the EU climate and energy package by 2020, including the reduction of greenhouse gases emission, increasing the share of renewable energy, reducing the final energy consumption and improving the air quality.

Primary energy generation

Data on the total primary energy generation in the years 2011–2015, including energy from renewable sources, are presented in Table 2.7. In the years 2011–2015, there was a systematic increase in the energy generation from renewable sources at a similar level of the total primary energy production. The share of renewable energy in the total energy increased from 10.9% in 2011 to 12.7% in 2015.

Table 2.7. Generation of total primary energy in 2011–2015, including energy from renewable sources

Energy generation	Years				
	2011	2012	2013	2014	2015
Acquisition of the total primary energy including that from renewable sources [TJ]	2 882 363 313 202	3 038 921 356 474	3 006 461 358 337	2 853 825 339 810	2 869 751 363 390
Share of renewable energy in total primary energy [%]	10.9	11.7	11.9	11.9	12.7

Source: GUS 2016, Energy from renewable sources in 2015

The dominant position in the generation and consumption of energy from renewable sources in Poland hold solid biofuels (Table 2.8). Their share in the acquisition of renewable energy in 2015 was more than 72% of the renewable energy generated (Fig. 2.1). In the period 2011–2015, the contribution of wind energy increased from 3.7% to 10.8%, that of liquid biofuels from 5.8% to 10.8%, biogas from 1.8% to 2.6% and solar energy from 0. 2% to 0.5%, while the share of hydroenergy decreased from 2.7% to 1.8%.

Table. 2.8. Share of renewable energy carriers in energy generation from renewable sources in 2011–2015 [%]

Energy carriers	Years				
	2011	2012	2013	2014	2015
Solid biofuels	84.89	82.07	79.88	76.14	72.22
Solar energy	0.17	0.17	0.29	0.43	0.52
Hydroenergy	2.68	2.06	2.45	2.31	1.82
Wind energy	3.68	4.79	6.03	8.13	10.76
Biogas	1.83	1.97	2.12	2.56	2.64
Liquid biofuels	5.76	7.96	8.18	9.18	10.78
Geothermal energy	0.17	0.19	0.22	0.25	0.25
Municipal waste	0.43	0.38	0.39	0.45	0.46
Heat pumps	0.39	0.41	0.44	0.55	0.56

Source: GUS 2016, Energy from renewable sources in 2015

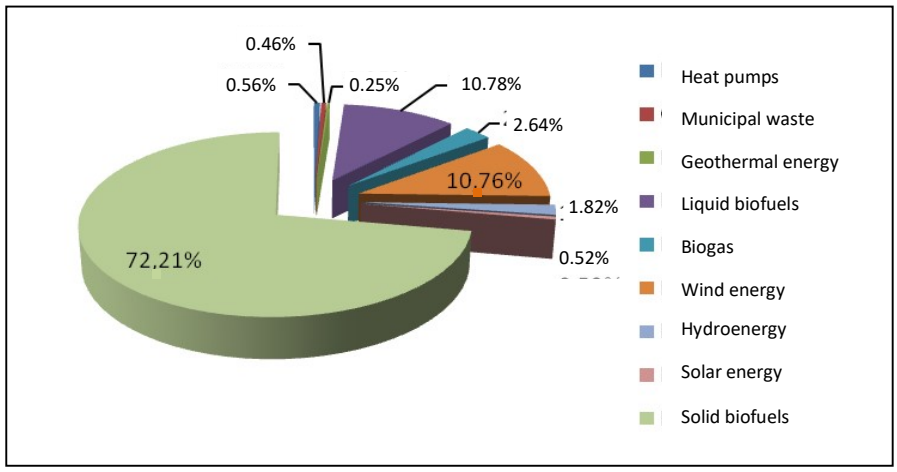


Fig. 2.1. Structure of renewable energy sources by energy carrier in 2015

Data on the production and consumption of renewable energy in Poland, by generation sources, in tonnes of oil equivalent (Toe) are presented in Table 2.9. The share of renewable energy in both the energy generation and the total energy consumption has been steadily increasing.

Table 2.9. Production and consumption of renewable energy in the years 2012–2015, by generation source

Energy sources	Years			
	2012	2013	2014	2015
TOTAL [Toe], including:	8 514	8 559	8 116	8 679
geothermal	16	19	20	22
biomass	6 988	6 837	6 180	6 268
wind energy	408	516	660	934
hydroenergy	175	210	188	158
Share in total energy production [%]	11.7	11.9	11.9	12.7
Share in total energy consumption [%]	10.89	11.36	11.48	11.77

Source: GUS 2016, Energy from renewable sources in 2015

Primary energy consumption

The consumption of fuels and energy carriers in 2015 was as follows:

- hard coal – 72.3 million tonnes, including 59% of consumption falling for energy sector, nearly 25% for industry and construction and 13% for households;
- natural gas – 554.0 PJ, including about 50% falling for industry and construction. almost 11% for energy sector, slightly more than 3% for transport and about 36% for small customers;
- heat – 442.0 PJ, including falling for 55% industry and construction and 37% for households;
- electricity – 150.3 TWh, including 41% falling for industry, about 3% for transport and 47% for other customers;
- liquid gas – 0.9 million tonnes;
- light fuel oil – 0.7 million tonnes;
- heavy fuel oil – 1.1 million tonnes [GUS 2016, Fuel and Energy Consumption in 2015].

Between 2005 and 2015, the total primary energy consumption increased from 92 Mtoe to 95 Mtoe, what constitutes an increase by 0.3% annually. The consumption tended to increase until 2011 and peaked in that year (the only decline was recorded in 2009), reaching the highest value of about 101.5 Mtoe (Figure 2.2). In the subsequent years, the primary energy consumption had shown a downward trend only to rise in 2015 [GUS 2017, Efficiency of energy consumption in the years 2005-2015].

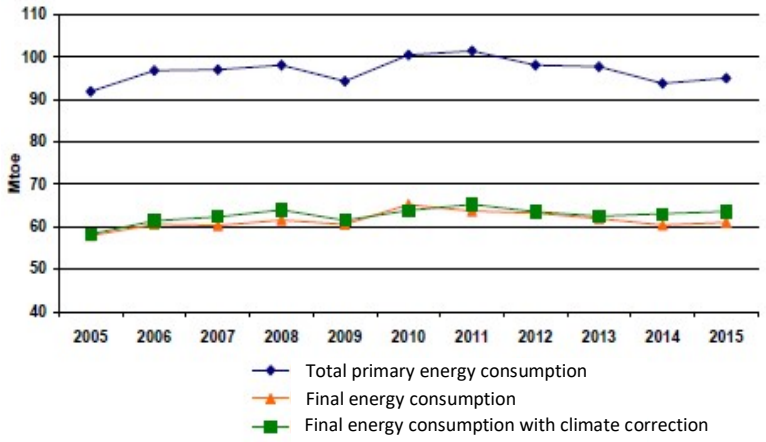


Fig. 2.2. Total primary energy consumption and final energy consumption in the period 2005–2015. Source GUS 2017, Efficiency of energy consumption in the years 2005–2015

The final energy consumption increased from 58 Mtoe to 61 Mtoe between 2005 and 2015, which represents an average annual growth rate by 0.5%, while a decrease in the consumption was registered in the years 2007, 2009 and 2011–2014 (Figure 2.2). Taking into account the varied weather conditions, that is, in the case of final consumption of energy with climate change correction, the consumption growth rate was 0.9% in the years 2006–2015. The energy consumption with climate correction determines the theoretical value of consumption for a given year, if it were characterized by the weather conditions described by the long-term average number of degrees. The final consumption thus calculated amounted to nearly 64 Mtoe in 2015.

The increase in the primary energy consumption was mainly due to: an increased final energy consumption and a wider distribution of electric power. The reduction in the primary energy demand was driven by the improvements in the efficiency of thermal power plants (a decrease by 1.6 Mtoe) and an increase in the use of renewable energy (a drop of 1.4 Mtoe).

The main sources of primary energy are hard coal and lignite. Considering the final energy consumption, coal fuels are the second most important type of consumable energy carriers, the share of which fell from 21% in 2005 to 18% in 2015. The most significant energy carriers in 2015 were petroleum derived fuels, which accounted for 32% of the total and did not change, compared to 2005. Among other carriers, the decline was noted in gas consumption (from 15% to 14%) and heat (from 12 to 9%),while there was an increase in the contribution of electricity – from 16% to 18%, and in that of other energy carriers (mainly from renewable energy sources) – from 7% to 10% (Figure 2.3).

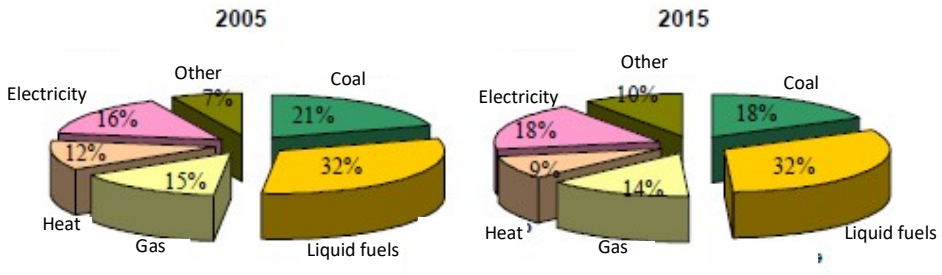


Fig. 2.3. Structure of final energy consumption in Poland in 2005 and 2015, by energy carrier. Source: GUS 2017, Efficiency of energy consumption in the years 2005–2015

In the individual sectors of economy, changes in the structure of the final energy consumption occur correspondingly to the development of individual branches. In the years 2005–2015, a reduction in energy consumption was noted in industry, households and in agriculture. On the other hand, energy consumption increased in transport and developing services.

The share of transport increased from 22 to 28%, which was the largest change, and the reason was the increasing role of road freight and passenger transport. Households remained the largest energy consumer, despite a decline in their share from 35 to 31%. The share of industry decreased from 26 to 24%, and that of agriculture – from 8 to 5%. The share of services increased from 12 to 13% (Figure 2.4).

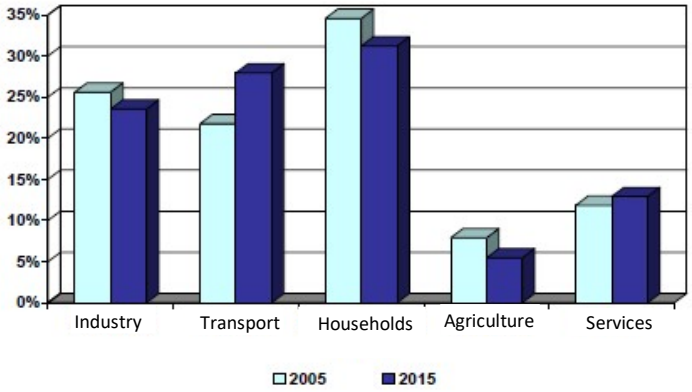


Fig. 2.4. Structure of final energy consumption in Poland in 2005 and 2015, by sector. Source: GUS 2017, Efficiency of Energy Consumption in the years 2005–2015

The final energy consumption in industry peaked in 2007 (15 Mtoe), and was lowest (13 Mtoe) in 2009 (Figure 2.5). In the years 2010–2011, the consumption increased, showing slight fluctuations at a level close to 14 Mtoe. The largest drop in energy consumption was for liquid fuels (down by 56%). The consumption of heat (by 42%) and coal (by 23%) also decreased. On the contrary, there was an increase in the consumption of gas (by 6%), electricity (by 21%) and other carriers by 114%.

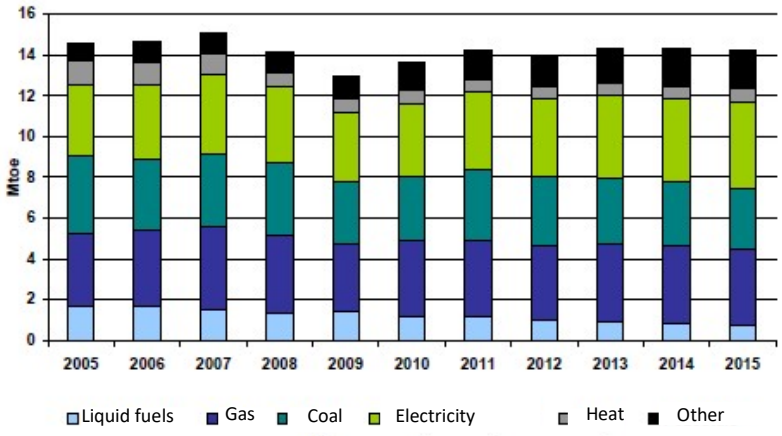


Fig. 2.5. Final energy consumption in industry, in the period 2005–2015, by energy carrier. Source: GUS 2017, Efficiency of Energy Consumption in the years 2005–2015

In the structure of energy consumption in the processing industry there dominate the three energy intensive industries: metallurgical, chemical and mineral, whose total combined share in the energy consumption was 54% in 2015 (58% in 2005). The food and paper industries also reached a significant 10% share.

The share of food, textile, metallurgical, chemical and transport industries decreased, while that of wood, paper, mineral, machine and other industries increased (Figure 2.6). In relative terms, the textile industry (56%) recorded the largest decline while the paper industry noted the highest growth (35%).

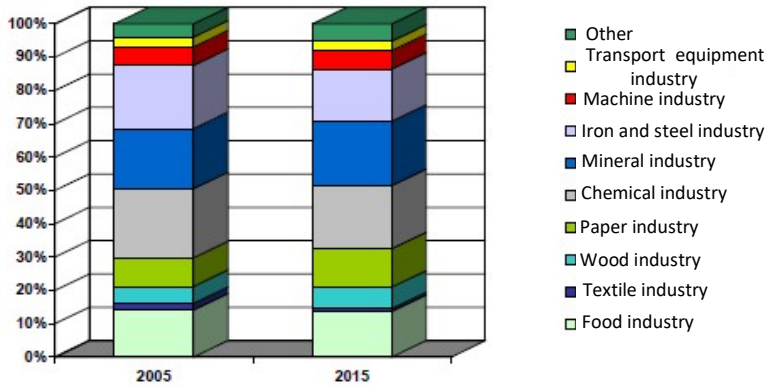


Fig. 2.6. Division structure of final energy consumption in the manufacturing industry in 2005 and 2015. Source: GUS 2017, Efficiency of Energy Consumption in the years 2005–2015

Figs. 2.7 and 2.8 show changes in the indices of energy intensity of industrial activities in the years 2005-2015. The greatest dynamics of energy efficiency improvement was noted for metallurgical, textile, machine and transport industries. The improvement was slowest in the food industry and in the remaining branches.

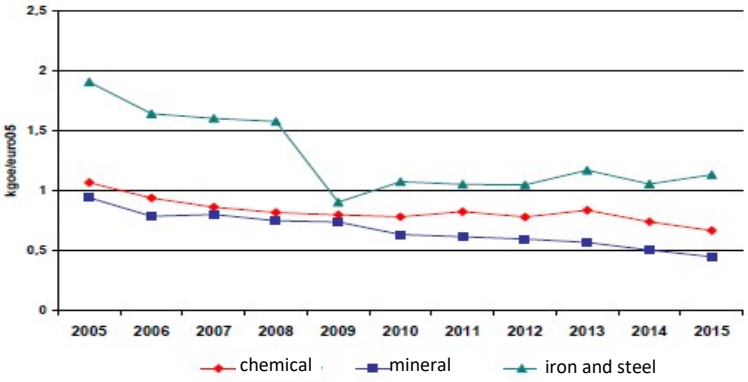


Fig. 2.7. Energy consumption in energy-intensive industries in the period 2005–2015. Source: GUS 2017, Efficiency of Energy Consumption in the years 2005–2015

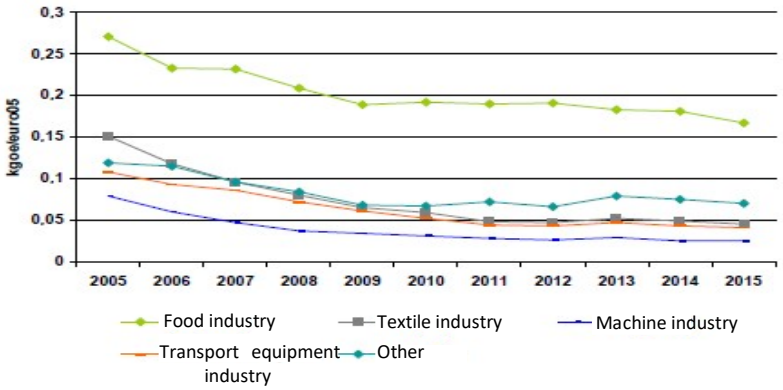


Fig. 2.8. Energy intensity index in the low energy-intensity industries in the period 2005–2015. Source: GUS 2017, Efficiency of Energy Consumption in the years 2005–2015

Overall, the rate of energy intensity improvement in the processing industry was high in the years 2006-2009 (Table 2.10), and averaged at 12.1% per year. At that time, the energy intensity in the processing industry at the fixed structure, after eliminating the impact of the changing contributions of particular branches in the total share of processing industry, had decreased by 10.8% annually. The situation changed significantly in the years 2010–2015, when the rate of decline in energy intensity decreased to 4.5% annually, while the effect of structural changes was 1.7% per year, and the rate of energy intensity improvement, at the fixed structure, decreased to 2.8% per year.

Table 2.10. Dynamics of changes in the energy intensity of processing industry and the effect of structural changes [% annually]

Energy intensity changes	**Years**	
	2006–2009	**2010–2015**
Energy intensity	-12.09	-4.52
Energy intensity at a fixed structure	-10.75	-2.83
Effect of structural changes	-1.50	-1.74

Source: GUS 2017, Efficiency of Energy Consumption in the years 2005–2015

The rate of energy intensity improvement in Poland, in the period 2005–2015, was significantly higher than that in the European Union (Figure 2.9). According to Eurostat, the 2015 data on energy intensity of the Polish and EU economies, respectively, were as follows: 227.3 Kgoe /1000euro and 120.4 Kgoe /1000euro [GUS Energy Intensity of the Economy].

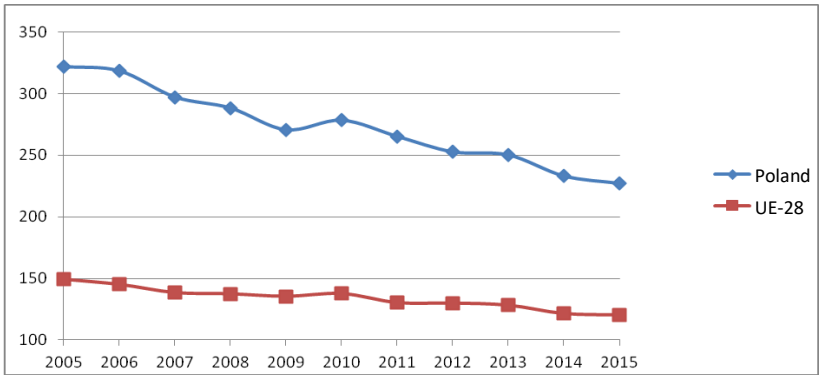


Fig. 2.9. Energy intensity of the economy in Poland and EU-28, in the years 2005–2015

The share of the household energy consumption in the final energy consumption was 31% in 2015. Energy consumption by energy carriers is shown in Figure 2.10. The most frequently consumed media were carbon fuels, whose share increased from 32% in 2005 to 33% in 2015. Heat was next commonly used energy carrier, and its share in 2015 was 21%, down from 23% in 2005. In 2015, the share of natural gas in the household energy consumption was 17%, while that of electricity and other media was 13% each, and that of liquid fuels – 3%.

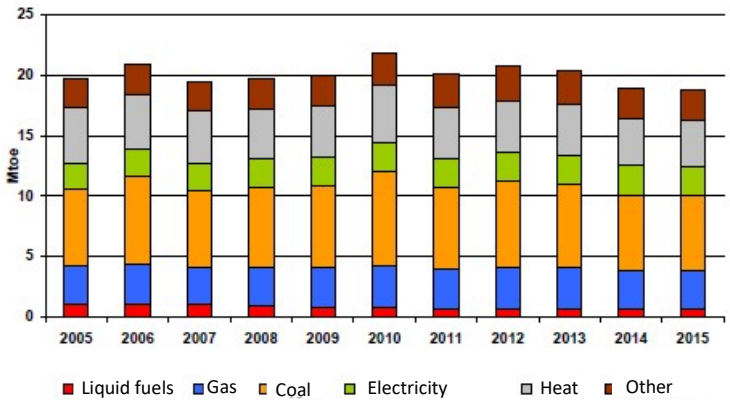


Fig. 2.10. Final consumption of energy in households in the period 2005–2015, by energy carrier. Source: GUS 2017, Efficiency of Energy Consumption in the years 2005–2015

There has been a noticeable decrease in the share of heating in the structure of energy consumption, owing to the installation of more efficient gas and electric appliances, thermal modernization and more restrictive building standards. The increased availability of electric appliances and changes in the user behavior (e.g. changes in the intensity of use of washing machines, dishwashers, TV sets and computers) resulted in a significant increase in the share of energy consumption by electrical appliances between the years 1993 and 2015 (Table 2.11).

Table 2.11. Structure of the household energy consumption by major energy use [%]

Major energy uses	Years				
	1993	2002	2009	2012	2015
Total	100.0	100.0	100.0	100.0	100.0
Space heating	73.1	71.3	70.2	68.8	65.5
Water heating	14.9	15.0	14.4	14.8	16.2
Cooking	7.1	7.1	8.2	8.3	8.5
Lighting	1.6	2.3	1.8	1.5	9.8*)
Electrical appliances	3.3	4.3	5.4	6.6	

*) Including lighting and electrical appliances

Source: GUS 2017, Efficiency of Energy Consumption in the years 2005–2015

In Poland, over 94% of energy consumed in transport in 2015 was used in road transport, less than 4% in air transport, less than 2% in rail transport, and traces in inland and coastal water transport. Fuel consumption by road transport increased by 40% (the annual growth rate by 3.4%) between 2005 and 2015, while there was a simultaneous clear decrease (by 30% and 3.6% per year) in energy consumption by rail transport. Overall, the average annual growth rate of fuel consumption in transport (excluding air transport) was 3.0% between the years 2006–2015, and was by 34% higher in 2015 than in 2005 [GUS 2017, Efficiency of Energy Consumption in the years 2005–2015].

The agricultural sector significantly reduced energy consumption to 1,500 GWh in 2005 from more than 4,100 GWh in 2004. In the subsequent years, fluctuations were observed, and following an increase in energy consumption to more than 1, 600 GWh, in the years 2008–2010, a successive reduction has been noted (Figure 2.11).

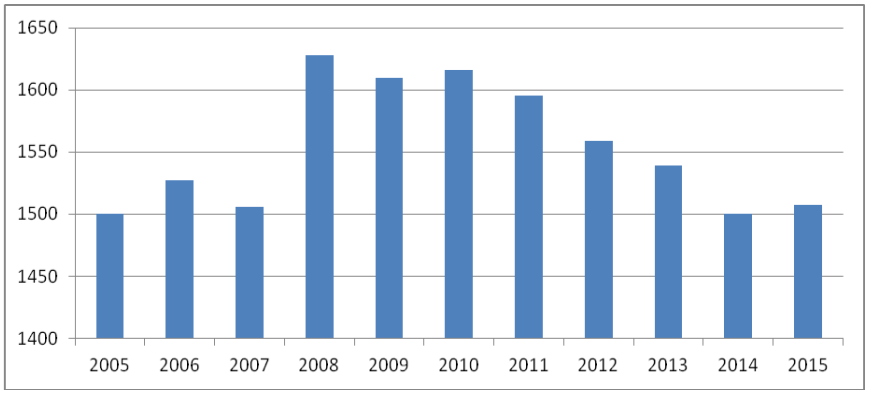


Fig. 2.11. Electricity consumption in GWh in the agricultural sector, in the years 2005–2015, Source: Local Data Bank

Energy saving

Figure 2.12 shows the energy savings achieved by the manufacturing industry, households and transport sectors after 2000, calculated using the ODEX indices, every time assuming each previous year as the baseline year. Energy savings have been achieved in all sectors in all years, with the exception of the transport sector in 2015. The sum of the savings was generally oscillating around 1 Mtoe, with a slightly decreasing trend.

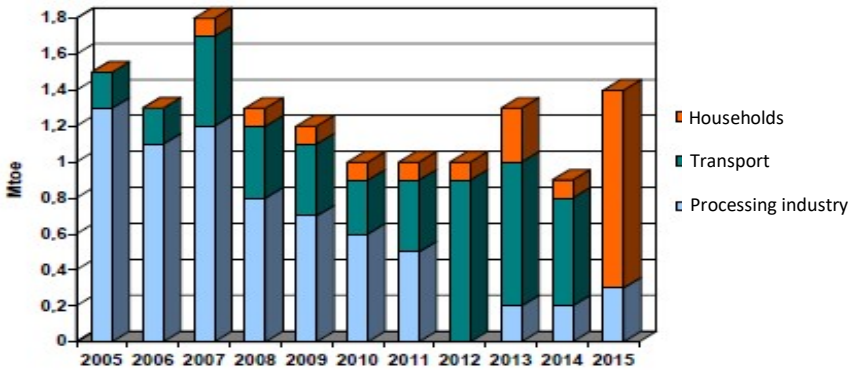


Fig. 2.12. Energy savings in the period 2005–2015 by sector. Source: GUS 2017, Efficiency of Energy Consumption in the years 2005–2015

The cumulative energy savings since 2000, calculated on the assumption, that the baseline value of the ODEX index in 2000 equals to 100, showing how much energy consumption would, in a given year, exceed the baseline value, if energy efficiency improvements were not implemented after 2000, amounted to 27.0 Mtoe in 2015 (Figure 2.13). This result includes savings by sectors covered by the European Emissions Trading Scheme (ETS). Energy savings, in the long run, are better indicators of the value of cumulative savings [GUS 2017, Efficiency of Energy Consumption in the years 2005–2015].

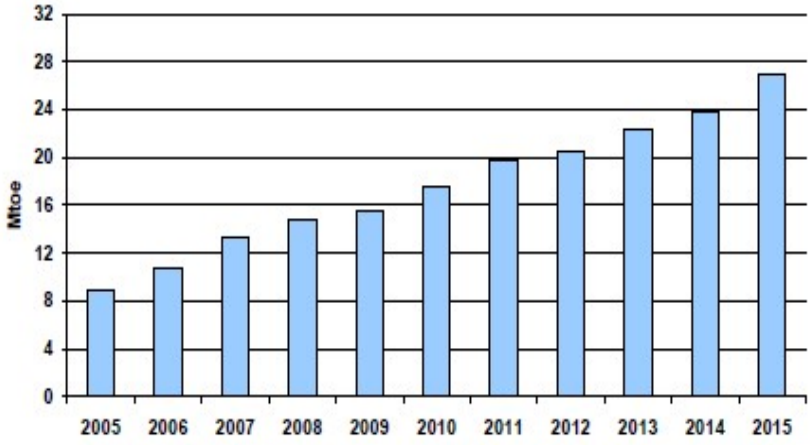


Fig. 2.13. Cumulative energy savings in the period 2005–2015. Source: GUS 2017, Efficiency of Energy Consumption in the years 2005-2015

Factors influencing the amount of energy consumption

As regards the final energy consumption, the Bevmajor drivers affecting consumption in particular sectors include: activity, housing stock, lifestyles, structural changes, energy savings resulting from the improved end-user performance, weather conditions and the remaining factors. The summarized results by sector illustrate the effect on final consumption, as shown in Figure 2.14.

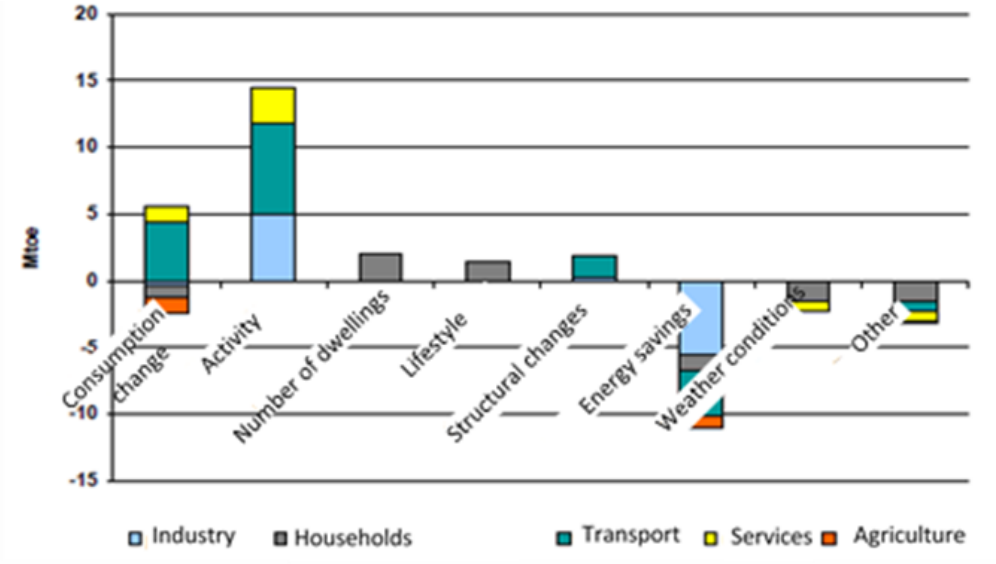


Fig. 2.14. Effect of selected factors on final energy consumption in the years 2005–2015. Source: GUS 2017, Efficiency of Energy Consumption in the years 2005–2015

Energy consumption in industry decreased slightly between 2005 and 2015. The increase in industrial activity was equivalent to an increase in the final energy demand by 5 Mtoe; however, the extent of consumption has been reduced by a rapidly improving energy efficiency (a decrease by 5.5 Mtoe). Structural changes that affected the increase in consumption and other factors (mainly the difference between the increase in activity measured by added value or the production index) that contributed to the decrease, have had much lower impact [GUS 2017, Efficiency of Energy Consumption in the years 2005–2015].

The energy consumption in households decreased by 0.8 Mtoe between 2005 and 2015. The increase in the number of dwellings and lifestyle changes (larger dwellings) contributed to increased consumption by 2.1 and 1.4 Mtoe, respectively. Weather conditions have reduced the energy consumption by 1.6 Mtoe. Moreover, the reduction in consumption was influenced by the improved energy efficiency (1.2 Mtoe) and other factors (1.5 Mtoe). The largest increase in energy consumption was in the transport sector (4.5 Mtoe). This was mainly attributable to an increase in activity and structural changes (an increase in the share of road transport). Energy savings have reduced the consumption by 3.4 Mtoe.

In the service sector, the increase in consumption was 1.0 Mtoe. The development of activity increased the consumption by 2.6 Mtoe. No improvement in energy efficiency was observed [GUS 2017, Efficiency of Energy Consumption in the years 2005–2015].

A poor quality of transmission and distribution networks constitutes an important problem in the power sector. Transmission and distribution networks, although ensuring the security of electricity supply to customers in the country, need modernization. Cross-border mergers, despite recent investments, are insufficient, and do not ensure effective functioning of the electricity market.

2.5.3. Industry

Industry remains a dominant factor in Poland's economic growth. The trends in the dynamics of industrial production in Poland are consistent with the trends in economically developed countries. The fastest growth shows the manufacturing industry, which determines the dynamics of

the whole national industry. Fluctuation of production dynamics are mostly inconsiderable, albeit in 2015, an increase in all manufacturing branches was recorded.

A faster increase in the production of those branches and groups, which are recognized as carriers of technical progress than in the remaining industrial branches represents a positive phenomenon. Another significant trend has been observed in the structure of sectors, consisting in the growth of importance of private sector which was manufacturing more than 90% of the total value of industrial output sold in 2015, as compared to 82% in 2005.

The transformations of both the ownership structure of the industry and the branch structure of production are accompanied by organizational and technical and technological changes in the manufacturing processes, what contributes to the improvement in energy efficiency, and thus to the reduction of energy intensity of industrial production and greenhouse gas emissions. Data depicting trends in the industry are given in Tables 2.12 and 2.13.

Table 2.12. Industrial output sold in Poland in the years 2012–2015 and in 2005

Specification	Years				
	2005	2012	2013	2014	2015
Total industrial output sold (milion PLN, at current prices)	687 810	1 178 304	1 182 964	1 210 039	1 255 516
Output sold per capita (PLN)	18 024	30 578	30 724	31 443	32 649
Public sector (%)	18.0	12.6	11.5	10.9	9.9
Private sector (%)	82.0	87.4	88.5	89.1	90.1

Source: GUS Statistical Yearbook 2016, 2015, 2014

Table 2.13. Dynamics of industrial output sold in 2012–2015 (fixed prices)

Sections and branches	Years			
	2012	2013	2014	2015
Total	100.5	101.8	104.1	106.0
Mining and extraction	99.3	103.3	92.7	102.5
Industrial processing:	100.7	101.9	105.5	106.9
Food products manufacturing	106.5	101.3	101.1	104.1
Beverage manufacturing	103.7	98.4	98.4	103.6
Textile manufacturing	100.8	110.3	112.3	107.1
Clothing manufacturing	100.0	99.2	101.7	111.2
Manufacturing of wood, cork, straw and wicker products	102.5	103.4	109.7	105.4
Production of coke and refined petroleum products	98.5	98.0	99.4	101.2
Manufacturing of chemicals and chemical products	104.1	97.0	100.3	106.8
Manufacturing of rubber and plastic products	99.5	105.5	108.8	106.1
Metal manufacturing	97.4	96.2	105.8	101.4
Manufacturing of metal products	103.8	101.0	110.0	108.7
Manufacturing of machinery and equipment	106.3	93.7	108.1	107.6
Manufacturing of motor vehicles, trailers and semi-trailers	93.1	106.7	104.6	111.0
Furniture manufacturing	93.6	110.4	112.9	110.8
Generation and supply of electric power, gas, steam and hot water	100.4	99.1	96.5	98.3

Source: GUS 2015 and GUS 2016, 2014

2.5.4. Transport

The most visible change in the structure of transport categories in 2005–2015 is the increasing importance of road transport, in particular of freight transport. By contrast, the passenger road transport showed a downward trend in recent years, whereas there was an increase in the share of rail and air transport of passengers.

The share of freight rail transport, amounting to nearly 19% in 2005, decreased to about 12% in 2015. In turn, the share of passenger rail transport increased from around 25% in 2005 to more than 39% in 2015.

Passenger air traffic is the fastest growing branch of transport in Poland, what shall largely be attributed to the accession of Poland to the European Union. Due to the rapid increase in the demand for air transport, the needs for investment in infrastructure have become high. This concerns both the development of airports and the provision of fast and efficient road and rail access to airports.

The share of maritime and inland waterway transport in the carriage of goods and passengers is less than 1% of the total transport structure. The Polish shipping is confronted with many problems, and most serious include the decapitalization of fixed assets and the lack of good access to sea ports, especially from the mainland. The main barrier to the development of water transport in Poland is the state of waterway infrastructure.

Details on the size and structure of cargo and passenger transport in Poland are presented in Tables 2.14 and 2.15.

Table 2.14. Size and structure of cargo transport in Poland in the years 2012–2015 and in 2005

Transport type	Years						
	2005	2012	2013	2014	2015	2005	2015
	thousand tonnes					%	
Total	1 422 576	1 789 345	1 848 348	1 839 961	1 803 818	100.0	100.0
Railway transport	269 553	230 878	232 596	227 820	224 320	18.9	12.4
Car transport	1 079 761	1 493 386	1 553 050	1 547 883	1 505 719	75.9	83.5
Pipeline transport	54 259	52 985	50 656	49 810	54 850	3.8	3.0
Maritime transport	9 362	7 476	6 965	6 781	6 963	0.7	0.4
Inland waterway transport	9 607	4 579	5 044	7 629	11 928	0.7	0.7
Air transport	34	41	37	38	38	0.0	0.0

Source: GUS Statistical Yearbook 2016, 2014

Table 2.15. Size and structure of passenger transport in Poland in the years 2012–2015 and in 2005 (without public transport)

Transport type	Years						
	2005	2012	2013	2014	2015	2005	2015
	thousand persons					%	
Total	1 046 930	779 797	739 556	709 698	703 742	100.0	100.0
Railway transport	258 110	273 182	269 815	268 204	277 321	24.7	39.4
Car transport a)	782 025	497 288	459 947	431 516	416 774	74.7	59.2
Maritime transport	714	642	606	611	597	0.1	0.1
Inland waterway transport b)	1 444	1 515	1 540	1 579	1 762	0.1	0.3
Air transport c)	4 637	7 170	7 648	7 788	7 288	0.4	1.0

a) Without transportation carried out by entities employing up to 9 persons; b) Including coastal transport; c) With time table and without time table
Source: GUS Statistical Yearbook 2016, 2014

An increase in both fuel consumption and number of vehicles was noted in road transport. Over the period 2005–2015, the total number of registered vehicles increased by almost 63%, including passenger cars – by almost 68%, and motorcycles – by almost 69% (Table 2.16).

Table 2.16. Vehicles registered in Poland in the years 2012–2015 and in 2005 [in thousand units]

Vehicles	Years				
	2005	2012	2013	2014	2015
Overall. including:	16 816	24 876	25 684	26 472	27 409
Passenger cars	12 339	18 744	19 389	20 004	20 723
Coaches	80	100	103	106	110
Trucks and tractors	2 305	3 178	3 242	3 341	3 428
Motorcycles	754	1 107	1 153	1 190	1 272
Agricultural and ballast tractors	1 243	1 596	1 633	1 669	1 703

Source: GUS Statistical Yearbook 2016, 2014

Changes in energy efficiency in transport in Poland in the years 2000–2014, in the form of the ODEX index, are illustrated in Figure 2.15.

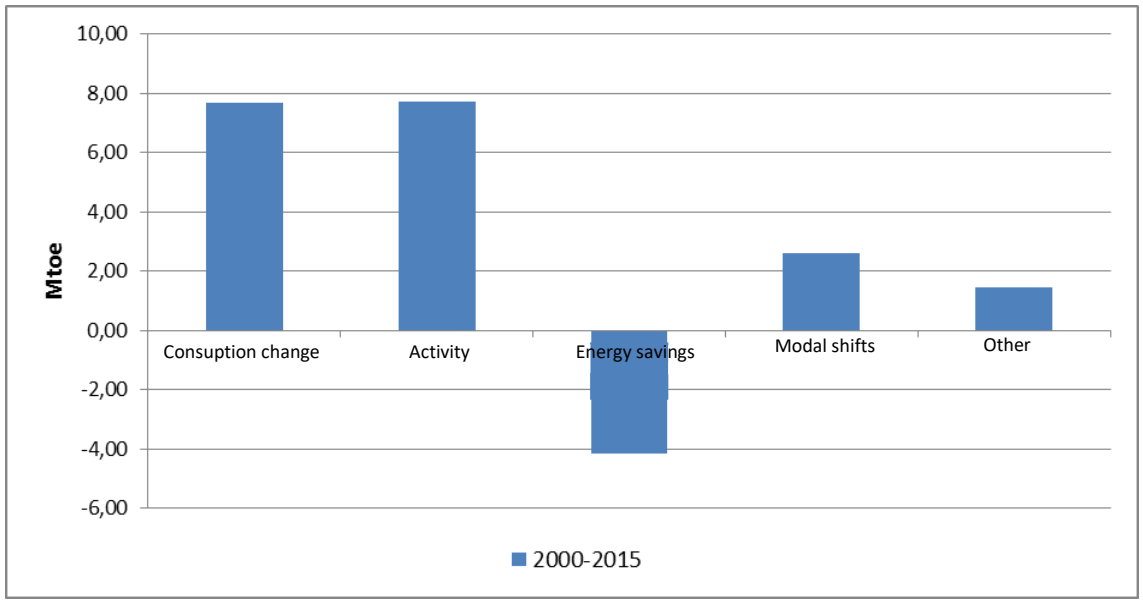


Fig. 2.15. ODEX index of energy efficiency changes in transport in Poland in the years 2000–2015, source: ODYSSEE–MURE

2.5.5. Construction and housing

The increased dynamics of investment activity owing to, among others, the influx of aid from the European Union, resulted in growing trend and increased dynamics of gross expenses on fixed assets.

Table 2.17. Gross value added in million PLN (at current prices) in the years 2012–2015 and in 2005

Gross value added	Years				
	2005	2012	2013	2014	2015
Total. including:	870 349	1 431 872	1 470 844	1 524 940	1 595 276
Industry	219 103	361 296	366 052	386 652	419 646
Construction	66 404	109 112	108 567	119 680	125 025
Transport and materials management	49 017	87 369	88 357	94 765	100 627

Source: GUS Statistical Yearbook 2016, 2015, 2014

The contribution of construction sector to national GDP has increased since 2005. The gross value added in the construction sector has increased by over 88% in 2015, as compared to 2005, while in the industry by 92%, and in the transport and material economy – by over 105% (Table 2.17). Data on buildings put into use in the years 2012–2015 are presented in Table 2.18.

Table 2.18. Buildings put into use in the years 2012–2015 and in 2005

Specification	Years				
	2005	2012	2013	2014	2015
New buildings put into use (units)	80 118	99 908	99 606	96 345	100 492
Urban areas	37 105	35 314	33 683	32 657	33 732
Rural areas	43 013	64 594	65 923	63 688	66 760
Cubic capacity of buildings (dam3)	119 532	164 626	155 207	169 381	180 210
Urban areas	72 657	90 713	82 850	88 947	96 756
Rural areas	46 875	73 913	72 357	80 434	83 454
Residential buildings (units)	59 700	77 279	77 575	73 072	76 663
Non-residential buildings (units)	20 418	22 629	22 031	23 273	23 829

Source: GUS Statistical Yearbook 2016, 2014

The number of dwellings per thousand inhabitants in Poland in 2016 was 366, compared to the European average of 460, which puts Poland at one of the last places in Europe.

The dwelling installations have been systematically improved (Table 2.19). Most of the dwellings are equipped with water supply (96.7%), and, to a lesser extent, with flushed toilet and bathroom (93.6% and 91.2%, respectively). In 2015, 55.7% of dwellings were equipped with gas installation, and 81.6% of dwellings - with the central heating installation. Rural dwellings are less well equipped than those in urban areas, but the improvement in the dwelling equipment is more pronounced in rural- than in urban areas. Since 2005, a decreasing trend in the number of gas installations in urban dwellings has been observed, which is a consequence of abandoning gas installations to the advantage of electric instllation and central heating network in new multi-family buildings.

Table 2.19. Equipment installation in dwellings in the years 2012–2015 and in 2005

% of apartments – equipped with	Years				
	2005	2012	2013	2014	2015
Total					
water mains	95.1	96.6	96.7	96.7	96.7
toilet	87.5	93.3	93.4	93.5	93.6
bathroom	86.4	90.9	91.0	91.1	91.2
network gas	55.5	56.2	56.1	55.8	55.7
central heating	77.4	81.2	81.4	81.6	81.6
Urban areas					
water mains	98.5	99.0	99.0	99.0	99.0
toilet	94.3	97.1	97.1	97.1	97.2
bathroom	92.0	95.3	95.3	95.4	95.4
network gas	74.0	73.2	73.1	72.5	72.3
central heating	84.1	86.6	86.8	86.9	87.1
Rural areas					
water mains	88.2	91.7	91.8	91.9	92.0
toilet	73.5	85.6	85.7	85.9	86.1
bathroom	74.9	81.8	82.0	82.2	82.4
network gas	17.6	20.8	20.9	21.2	21.3
central heating	65.3	70.0	70.3	70.6	70.9

Source: GUS Statistical Yearbook 2016, 2014

In recent years, there has been a decrease in the unit energy consumption in dwellings what shall be related to the implementation of a programme for improving the thermal efficiency of buildings, reduction of losses in heating systems and improvement of energy efficiency of the newly installed appliances. In households (which are one of the largest consumers of energy nationally, with 31% of total final energy consumption in 2015), about 65% of the energy consumed is used for space heating and about 16% for water heating (Table 2.11). About 18% of the energy consumed is used for lighting, cooking and supplying electrical appliances.

2.5.6. Agriculture

Agriculture in Poland is characterized by a vast land resources, with a large share of poor and acidified soils, great fragmentation of farm holdings and traditional farming methods still maintained.

As of 1.01.2016, the farmland in Poland took 18.6 million hectares and accounted for 59.6% of the country's area [GUS Statistical Yearbook of Agriculture 2016]. According to the information provided by the 2010 Agricultural Census, the area of farm holdings in 2010 reached about 18 million hectares and accounted for about 58% of the total country area.

Private sector dominates in the structure of user groups, accounting for 99.7% of the farmland area in 2015. In total, there were 1,409.6 thousand farm holdings in 2015, including 1,405.5 thousand of individual farms (Table 2.20). Small holdings, with an area of up to 5 ha, prevail among the individual farms, accounting for about 51% of the total number of individual farms. Farms over 15 hectares, including the largest farms, account for about 14.7% of the farmland. In recent years, a trend has been observed of increasing the area of the largest farms and decreasing the area of the smallest farms.

Table 2.20. Farm holdings in Poland in the years 2012–2015

Farm holdings	Years			
	2012	2013	2014	2015
No of farm holdings in thousand	1 477.9	1 429.0	1 413.0	1 409.6
including individual farms	1 474.3	1 425.4	1 408.9	1 405.5
Individual farms with an area over 1 ha of arable land – as percent				
Farm size	1 452.9	1 391.1	1 377.6	1 377.9
1–2 ha	19.7	19.9	19.0	18.4
2–5 ha	32.5	32.8	33.2	32.9
5–10 ha	24.0	22.6	22.4	23.4
10–15 ha	9.9	10.2	10.7	10.6
15–20 ha	5.1	5.0	5.1	5.1
20–50 ha	7.0	7.4	7.4	7.4
over 50 ha	1.8	2.1	2.2	2.2

Source: GUS Statistical Yearbook 2016, 2014

Apart from the fragmentation of agricultural holdings, the model of traditional agriculture in Poland is characterized by a still modest (comparing to Western European countries) level of mineral fertilization and use of chemical plant protection products. The consumption of mineral and chemical fertilizers is fluctuating and, in 2014/2015, it amounted to a total of 1,792.2 thousand tonnes. About 123.2 kg of fertilizers were applied per one ha of arable land. The consumption of calcium fertilizers is distinctly lower than that of mineral fertilizers (Table 2.21). The sale of plant protection products, as calculated per active substance, reached about 16 thousand tonnes in 2005, and about 24 thousand tonnes in 2015 [GUS Statistical Yearbook of Agriculture 2016].

Table 2.21. Consumption of mineral and calcium fertilizers (calculated as pure ingredient) in Poland, in selected years

Fertilizer	Years				
	2004/2005	2011/2012	2012/2013	2013/2014	2014/2015
In thousand tonnes					
Mineral fertilizers (NPK), including:	1 628.4	1 883.8	1 943.4	1 935.3	1 792.2
Nitrogen (N)	895.3	1 094.7	1 179.1	1 098.4	1 003.6
Phosphorus (P2O5)	324.3	370.8	374.1	341.1	303.6
Potassium (K2O)	408.8	418.3	390.2	495.8	485.0
Calcium fertilizers (CaO)	1 455.6	507.8	634.7	697.2	567.6
Per 1 ha of agricultural land, in kg					
Mineral fertilizers (NPK). including:	102.4	125.8	133.0	132.9	123.2
Nitrogen (N)	56.3	73.1	80.7	75.5	69.0
Phosphorus	20.4	24.8	25.6	23.4	20.9
Potassium	25.7	27.9	26.7	34.1	33.3
Calcium fertilizers (CaO)	91.5	33.9	43.4	47.9	39.0

Source: GUS Environmental Protection 2016, 2014

In the Polish agriculture, both plant and livestock production are balanced. In 2015, the shares of plant and animal production in the global value of agricultural production were almost the same, while the value of commodity production was dominated by animal production, accounting for 58.5% (Table 2.22)

Table 2.22. Global and commodity agricultural production (at current prices) in Poland in the years 2012–2015 and 2005

Specification	Years				
	2005	2010	2013	2014	2015
Global output (PLN m)	63 337	84 484	107 504	105 345	98 638
Crop production (%)	48.6	53.2	53.7	51.1	50.1
Animal production (%)	51.4	46.8	46.3	48.9	49.9
Commodity production (PLN m)	42 907	59 357	79 997	76 701	74 203
Crop production (%)	38.7	44.0	44.9	40.7	41.5
Animal production (%)	61.3	56.0	55.1	59.3	58.5
Share of total commodity production in total agricultural production, in total (%)	67.7	70.3	74.4	72.8	75.2
Agricultural production per 1 ha of arable land					
Global output (PLN)	3 982	5 686	7 359	7 236	6 782
Commodity production (PLN)	2 698	3 995	5 476	5 269	5 102

Source: GUS Agriculture 2016

In the animal production, the most important categories are slaughter livestock (pig and poultry) and cow's milk. The structure of crop production is dominated by cereals, followed by industrial plants and fruit and vegetables. Growing of non-food crops, including energy crops, has recently been gaining an increasing importance.

2.5.7. Forestry

In the beginning of 2016, the combined area of forested, wooded and shrub land in Poland reached 9.715 thousand hectares, which accounted for almost 31% of the country's area (Table 2.23). Between 1946 and 2016, the forest cover rate increased by more than 10% (from 20.8% in 1946). According to the National Forest Policy of 1997 and the National Programme for the Augmentation of Forest Cover (1995), it was planned to increase the forest cover to 30% by 2010, and to 33% by the middle of the 21st century. The level of forest cover planned for 2020 has already been reached.

The forest cover rate, taking into account only forested land, varied between regions and oscillated from in 21.3% in the Łódź Voivodeship in central Poland to 49.2% in the Lubuskie Vivodeship in western Poland [GUS Environmental Protection 2016].

Table 2.23. Area of forest land in Poland in the years 2012–2015 and in 2005

Specification	Years				
	2005	2012	2013	2014	2015
Total in thousand hectares	9 200.4	9 370.0	9 383.0	9 403.1	9 420.1
Forests	9 000.5	9 163.8	9 177.2	9 197.9	9 214.9
Public	7 410.7	7 439.4	7 439.7	7 447.1	7 449.8
Managed by the State Forests	7 042.5	7 079.4	7 085.4	7 094.7	7 099.6
National parks	182.6	184.8	185.0	185.2	185.3
Private	1 589.8	1 724.4	1 737.5	1 750.8	1 765.1
Land under forest management	199.9	206.2	205.8	205.2	205.2
Forest cover rate in%	28.8	29.3	29.4	29.4	29.5
Share of forest land in the country's land area in %	30.0	30.6	30.6	30.7	30.8

Source: GUS Statistical Yearbook 2016, 2014

The increase in forested land results from both afforestation of formerly arable land or waste land, using artificial afforestation and from re-qualifying grounds covered by forest vegetation (natural succession) as the forested land. In the years 2014–2015, a total of 115.4 thousand hectares were afforested (Table 2.24). The balance of forested land is to a limited extent only affected by the exclusion of forest land for non-agricultural and non-forest purposes. In the years 2014–2015, about 1.51 thousand hectares were excluded.

Table 2.24. Amount of renewal and afforestation as well as exclusions of forest land for non-forest purposes in 2012–2015 and in 2005

Specification	Years				
	2005	2012	2013	2014	2015
Forest regenration and afforestation in thousand hectares	62.0	57.7	55.5	56.7	58.7
Exclusion in hectares	472	494	497	774	738

Source: GUS Statistical Yearbook 2016, 2014, GUS Environmental Protection 2016, 2014

The timber growing stock has been estimated at 2 491.5 hm^3, including that in public forests – estimated at 2 082.3 hm^3, and in private forests – at 409.2 hm^3 [GUS Statistical Yearbook 2016]. Timber harvesting has been systematically increasing (Table 2.25).

Table 2.25. Wood harvesting a) in the years 2012–2015 and in 2005 [dam^3]

Timber type	Years				
	2005	2012	2013	2014	2015
Total	31 945	37 045	37 946	39 742	40 247
Large timber	29 725	34 978	35 796	37 661	38 327
Coniferous large timber	21 919	26 042	26 792	28 533	29 078
Deciduous large timber	7 806	8 936	9 004	9 128	9 249

a) Excluding large timber harvested in woodland

Source: GUS Statistical Yearbook 2016, 2014

The share of deciduous trees in the total forest area has been growing for 50 years now, and between the years 1945–2015, the area of deciduous stands increased from 13% to almost 28%. Afforestation activities, appropriately targeted, owing to the application of administrative and financial instruments as well as methods of forests management, lead to a gradual rebuilding of forest stands, with the aim to make them compatible with natural site conditions.

In 2015, the sites of special natural values were protected in 23 national parks, 1 490 nature reserves, 122 landscape parks, 383 areas of protected landscape, 166 documentation sites, 7 130 sites of ecological importance and 339 complexes of natural and landscape values.

To the most important functions of forests belong the supporting (protective), productive (economic) and social functions. In 2015, the total area of protective forests accounted for 52.3% of the total forest area managed by the State Forests, and 41.2% of the total forested area, including the forest owned by various proprietors. Among the classified forest categories, the largest area is taken by forests protecting water resources – 1541 thousand hectares, next to suburban forests – 628 thousand hectares and forests damaged by industry – 466 thousand hectares [State Forests in numbers, 2016].

Another important function of forests and forestry is mitigating the effects of climate change. In line with the assumptions of the National Forest Policy, it is envisaged that carbon dioxide

sequestration and accumulation increases by about 10% in 2020 and by 20% by the second half of the 21st century, i.e. by 4.5 and 9 million tonnes, respectively. The undertakings of the State Forests over the last decades (especially after 1991) have significantly contributed to the increase in carbon capture and storage. This applies to afforestations, increase in wood stock and in the share of deciduous species, changes in forest management and many more.

The use of wood for energy purposes has remained almost constant in recent years. The firewood harvest in 2015 amounted to 5 151 thousand m^3, which was less than 13% of the total volume of timber harvested. However, the level of harvest does not exceed the permissible use level, i.e. the level of the current increase in the stand volume.

2.5.8. Waste and sewage management

The amount of waste generated in Poland, in the period 2000–2015, was contained within the limits of 123–142 million tonnes, (Table 2.26).

Table 2.26. Waste generated in the years 2012–2015 and in 2005 [tonnes]

Waste generation	Years				
	2005	2012	2013	2014	2015
Total	133 956	135 209	141 888	141 586	141 848
including:					
waste (excluding municipal waste)	124 602	123 124	130 593	131 256	130 985
municipal waste a)	12 169	12 085	11 295	10 330	10 863

a) estimates for the years 2000–2013; Since 2014 waste has been collected from all property owners

Source: GUS Environmental Protection 2016, 2014

Industry is the largest waste producer, accounting for more than 90% of total waste generated. Over the last few years, the amount of industrial waste that has been recycled and disposed of has remained at a similar level. 17-22% of industrial waste is deposited in landfills. Treatment of waste other than municipal waste in 2015 is illustrated in Table 2.27.

Table 2.27. Waste (a) produced in 2015 [thousand tonnes]

Waste type	2015
Generated, including:	130 985
recycled	28 636
disposed of, including:	26 471
thermally	342
stored	22 025
transferred to other recipients	74 056
temporarily stored	1 822

a) excluding municipal waste

Source: GUS Environmental Protection 2016

As a result of the changes in the municipal waste management system introduced in 2013, it is difficult to analyze changes over the last decade. As a result of the amendment of the provisions of the Act on Waste, from 1st July 2013 onwards, the municipalities taking over the commitment to manage municipal waste arising on their territory, have been obliged to include all the property owners to the system. It is assumed that the amount of waste collected from the inhabitants is equal to the amount of waste generated.

Municipal waste, i.e. the household waste, excluding end-of-life vehicles, and the non hazardous waste from other generators, which by its character or composition is similar to household waste, account for 8–10% of the total waste generated. More than 80% of municipal waste is generated in households (Figure 2.16).

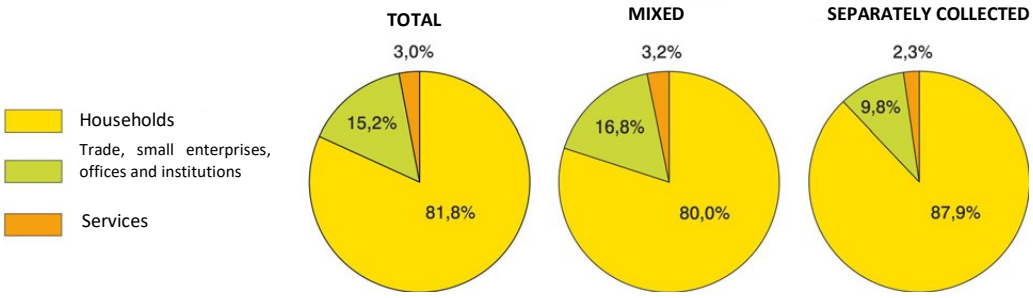


Fig. 2.16. Sources of origin of municipal waste collected in 2015. Source: GUS 2016 Municipal Infrastructure in 2015

According to estimations, the amount of collected municipal waste has been increasing from year to year, what results from tightening of the waste management system. In 2015, 10,863.5 thousand tonnes of municipal waste were collected (an increase by 5.2% as compared to 2014). The per capita waste generation in Poland was 283 kg in 2015 (Table 2.28).

Table 2.28. Management of municipal waste in the years 2012–2015 and in 2005

Waste management	Years				
	2005	2012	2013	2014	2015
Municipal waste collected in thousand tonnes	9 352	9 581	9 474	10 330	10 864
including from households	6 493	6 821	7 139	8 240	8 889
Municipal waste collected per capita in kg	245	249	246	268	283
ton Municipal waste collected selectively in thousand tonnes	295	1 005	1 275	2 049	2 537
Waste for recovery and disposal, including: recycling,	367	1 244	1 499	2 180	2 867
composting or fermenting	318	1 128	1 231	1 154	1 750
thermal transformation	44	51	766	1 560	1 439
Storage	8 623	7 158	5 979	5 437	4 808

Source: GUS Environmental Protection 2016. 2014. GUS Statistical Yearbook 2016, 2014

The share of selectively collected waste in the total amount of municipal waste collected increased from 19.8% in 2014 to 23.4% in 2015. In 2015, the per capita amount of municipal waste collected selectively was approximately 66 kg (preceding year – 53 kg), including: glass – 11.0 kg, plastic – 7.9 kg, paper and cardboard – approximately 6.3 kg, large size waste – 6.8 kg and biodegradable waste – 17.1 kg [GUS 2016 Municipal Infrastructure in 2015].

In 2015, 10,864 thousand tonnes of municipal waste were collected, out of which 5,934 thousand tonnes were allocated for recovery (about 55% of the total collected municipal waste). Approximately 2,867 thousand tones were spend on recycling (26.4% of municipal waste collected). These were both municipal waste collected selectively and the raw material waste sorted from mixed municipal waste.

Approximately 1,750 thousand tonnes of municipal waste were aimed to biological treatment (composting or fermentation). These were mainly green waste from gardens, parks and cemeteries, waste from market places, biodegradable kitchen waste and waste from catering. This constituted an increase by 16.1% in the share of waste designed to biological treatment in the total amount of municipal waste collected, as compared to the preceding year.

Almost 1,318 thousand tonnes of municipal waste (approximately 12.1%) were allocated to thermal transformation with energy recovery. A total of 4,929 thousand tones was allocated to disposal, out of which 4,808 thousand tonnes (44.3% of the total waste collected) were destined for storage and 121 thousand tonnes (1.1% of total waste collected) for incineration without energy recovery [GUS 2016 Municipal Infrastructure in 2015].

Dynamic changes have been observed in the municipal waste management system (Table 2.28). The selectively collected municipal waste was only 3% of the waste collected in 2005, while in 2015 – it was over 23%. Increasingly larger amounts of waste are being recycled and disposed of, i.e. the amount of waste intended for recycling has been systematically increasing (there was eight–fold increase over the last 10 years), the amount of waste composted and fermented (more than five-fold increase) and that of the thermally transformed waste (nearly 33-fold increase). In contrast, the amount of waste directed to landfills is reduced, since in 2005 – over 92% of waste collected was deposited, while in 2015 – about 44%.

Due to the need of adapting municipal landfills to the technical and organizational requirements resulting from the provisions of law, the number of operating landfill sites has been systematically decreasing for several years. At the end of 2015, there were 347 landfill sites receiving municipal waste. These sites occupy a total area of 1,860 ha. In 2015, 77 landfill sites of this type, with an area of about 246 hectares, were closed [GUS 2016 Municipal Infrastructure in 2015].

Table 2.29. Data on municipal landfills in the years 2012–2015 and in 2005

Year	Municipal waste landfills						
	Number of landfills with degassing plant				Total number of landfills		
	Total	In relation to the operating [%]	Including with gas disposed of by incineration				
			No energy recovery	With energy recovery	Open	Closed (completed operation)	Wild dumping sites
2005	233	23	8	38	1025	57	2583
2012	430	82	144	71	527	61	2334
2013	363	84	139	74	431	119	2791
2014	342	87	141	78	394	66	2371
2015	303	87	137	88	347	74	1978

Source: GUS Environmental Protection 2016, 2015, 2014, 2013. Local Data Bank

The number of operating landfills of municipal waste has been decreasing, whereas the number of landfills with degassing installations is increasing. 23% of operating landfills were equipped with a degassing plant in 2005 and 87% in 2015 (Table 2.29). In 2015, 1978 wild dumping sites were localized.

In 2005, the amount of the treated municipal sewage discharged through the sewerage network accounted for 89.5% of the total municipal wastewater volume, while in 2015 – it accounted for almost 100% of the total (Table 2.30).

Table 2.30. Data on municipal sewage management discharged in the sewerage network in the years 2012–2015 and in 2005

Specification	Years									
	2005		2012		2013		2014		2015	
	Million m^3	%	Million m^3	%	Milion m^3	%	Million m^3	%	Million m^3	%
Total	1 273.6	100.0	1 248.8	100.0	1 246.6	100.0	1 238.1	100.0	1 258.4	100.0
Treated, including:	1 140.0	89.5	1 220.8	97.8	1 244.3	99.8	1 236.5	99.9	1 254.2	99.7
mechanically	49.8	4.3	1.9	0.2	1.5	0.1	0.4	0.0	0.4	0.1
biologically	367.2	32.2	195.8	16.0	201.7	16.2	187.8	15.2	189.9	15.1
with elevated biogen removal (EBR)	723.0	63.4	1 023.1	83.8	1 041.1	83.7	1 048.3	84.8	1 063.9	84.8
Untreated	133.6	10.5	28.0	2.2	2.3	0.2	1.5	0.1	4.1	0.3

Source: GUS Statistical Yearbook 2016, 2015, 2014

Waste water is treated in the mechanical, mechanical-biological treatment plants as well as in those with elevated biogen removal. The amount of the mechanically treated sewage is negligible (about 0.1%). Almost 100% of municipal waste water is treated in the course of biological processes, and, in this volume, the amount of wastewater treated with elevated biogen removal (EBR) has risen, accounting for almost 85% of the total waste water treated in 2015.

Over the past few years, there has been a marked decrease in the amount of sludge produced in industrial sewage treatment plants, and an increase in the amount of sludge from municipal sewage treatment plants (Table 2.31). The total amount of sludge generated was about 15% lower in 2015 than in 2005.

Table 2.31. Amount of sewage sludge [in thousand tonnes dry mass] generated and managed in respective years

Sludge generation and management	Years				
	2005	2012	2013	2014	2015
Sludge generated in industrial wastewater treatment plants	638.2	418.6	392.5	411.4	383.5
Sludge generated in municipal sewage treatment plants, including:	486.1	533.3	540.3	556.0	568.0
applied in agriculture	66.0	115.0	105.4	107.2	107.5
applied for land reclamation, including on land designed for agricultural purposes	120.6	50.3	29.4	22.0	19.2
used for growing plants intended for compost production	27.4	33.3	32.6	46.3	47.1
thermally transformed	6.2	56.6	72.9	84.2	79.3
Składowane Stored	150.7	46.8	31.4	31.5	40.5
Combined sludge from industrial and municipal treatment plants	1 124.4	951.9	932.8	967.4	951.5

Source: GUS Environmental Protection 2016

The amounts of both the municipal sewage sludge applied in agriculture and that disposed of in thermal processes have been increasing, while the amounts of sludge used for land reclamation and deposited in landfills has been decreasing.

Poland's socio-economic situation in 2015, compared to the average for the EU countries, is illustrated in Table 2.32.

Table 2.32. Poland and the European Union in 2015

Specification	UE-28	Poland
Dynamics of industrial production (at fixed prices) – 2014 = 100, including:	102.2	104.5
mining and excavation	98.1	100.3
industrial processing	102.3	105.4
generation and supply of electricity, gas, steam and hot water	102.3	97.5
Production dynamics in construction (at fixed prices) – 2014 = 100	100.8	99.7
Acquisition of primary energy (expressed in oil equivalent)		
Million tonnes (Toe)	770.7	66.9
Per 1 capita in kg (kgoe)	1 518	1 759
Final energy consumption (expressed in oil equivalent)		
Million tonnes (Toe)	1 061.7	61.6
Per 1 capita in kg (kgoe)	2 091	1 621
GDP growth (at fixed prices) – 2014 = 100	102.2	103.9
Gross value added (at current prices) by activity type in %:	1.5	2.6
agriculture, forestry, hunting and fishing, industry, construction	24.6	34.1
service sector	73.9	63.3

Source: GUS Statistical Yearbook 2016

2.5.9. State of the environment

After economic transformations in Poland, of foremost importance are the processes of economic restructuring and modernization which aim at reducing the human impact on the environment. The State Environmental Policy1, currently implemented in Poland, brings effects in the form of gradual improvement of the state of individual elements of the environment as well as in the rise in the public ecological awareness. Finally, another important factors supporting sustainable use of the environment and catching up on environmental protection, are the legal, administrative and financial institutions operating in Poland.

The expenditures for environmental protection (for fixed assets intended for environmental protection) increased between the years 2005–2015; in 2005 they were around PLN 6.0 billion, in 2010 – PLN 10.9 billion, and in 2015 – PLN 15.2 billion, including the following expenditures for the protection of atmospheric air and climate: PLN 1.1 billion, PLN 2.2 billion and PLN 4.2 billion, respectively. The share of expenditure on environmental protection in the national economy investment expenditures has remained at the level of about 5% in recent years, while in the gross domestic product – at about 0.8% [GUS Environmental Protection 2016].

[1] In 2003, the Sejm of the Republic of Poland adopted the document "The State Environmental Policy for the years 2003–2006 taking into account the perspective for the years 2007–2010". Since 2008, Poland has implemented the "State Environmental Policy" covering the period 2009–2012 with a perspective until 2016.

2.6. Special circumstances for fulfilling commitments by Poland

Pursuant to Article 4.6 of the United Nations Framework Convention on Climate Change, Poland has recognized the desirability of a flexible approach to the choice of base year for the assessment of commitments arising under the Climate Convention, and adopted the year 1988 instead of 1990, which is obligatory for the Convention member states, as reflected in paragraph 5 of Decision 9/CP.2.

The reason for assuming the base year 1988 instead of 1990 was that 1990 had been the first year following the major changes of political and economic situation, and consequently, also of the state system, which clearly undermined the stability of the Polish economy[2]. In 1990, there occurred a temporary collapse of the economy. Therefore, the amount of greenhouse gas emissions in 1990 does not correspond to either the normal emission level resulting from the needs for the country's development or to the real economic potential of Poland. Thus this year (1990) cannot be taken as a reliable base to assess the potential and condition of the Polish economy.

[2] Detailed justification for the adoption of 1988 as the base year by Poland was included in the First Report of the Government to the Conference of Parties to the Convention (1994)

CHAPTER 3. GREENHOUSE GAS INVENTORY INFORMATION

3.1. Inventory information

The national inventory of greenhouse gases for the years 1988–2015, presented in this report, conforms with the submission uploaded to the Secretariat of the Climate Convention in 2017. It was prepared in agreement with the Decision 24/CP.19, currently in force, containing revised guidelines for annual reporting of inventories by countries listed in Annex I to the Convention (Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention contained in the decision). While, the guidelines used to calculate greenhouse gas emissions and removals are consistent with the methodology recommended in the abovementioned decision, which was published by the Intergovernmental Panel on Climate Change (IPCC): 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The most important features of the inventory preparation process can be summarized as follows:

- activity data covering emission sources is derived from statistical publications of the Central Statistical Office (GUS), the Eurostat database and, in the case of categories for which there are no official statistics, from the committed expert elaborations and assessments;
- emission factors for major sources have been developed on the basis of national surveys and, in the absence of national factors or their high uncertainty, the default IPCC factors have been adopted (e.g. CH_4 and N_2O emissions from combustion in stationary sources);
- all data referring to the activity of emission sources, emission factors and results of emission inventory have been archived in the KOBiZE.

3.2. Inventory results for 2015 and emission trends

The aggregate emission of all estimated greenhouse gases in 2015 was 385.8 million tonnes of CO_2 equivalent (excluding sector 4. *Land use, land-use change and forestry).* The balance of greenhouse gas emissions and carbon sequestration in sector 4 was estimated to be 28.8 million tonnes of CO_2 equivalent, with CO_2 removals (mainly forest land) at the level of 36.5 million tonnes CO_2, while emissions amounting to 7.7 million tonnes of CO_2 equivalent.

Contributions of individual sectors and of respective gases to the total aggregate emission, provided in this chapter, do not take into account the greenhouse gas balance in sector 4. *Land use, land-use change and forestry.*

In 2015, the energy sector was mainly (almost 84%) responsible for Poland's total greenhouse gas emission (expressed in CO_2 equivalent), with fuel combustion being the dominant emission source. Shares of major sectors in the total national emission, by the IPCC emission source categories, are shown in Figure 3.1:

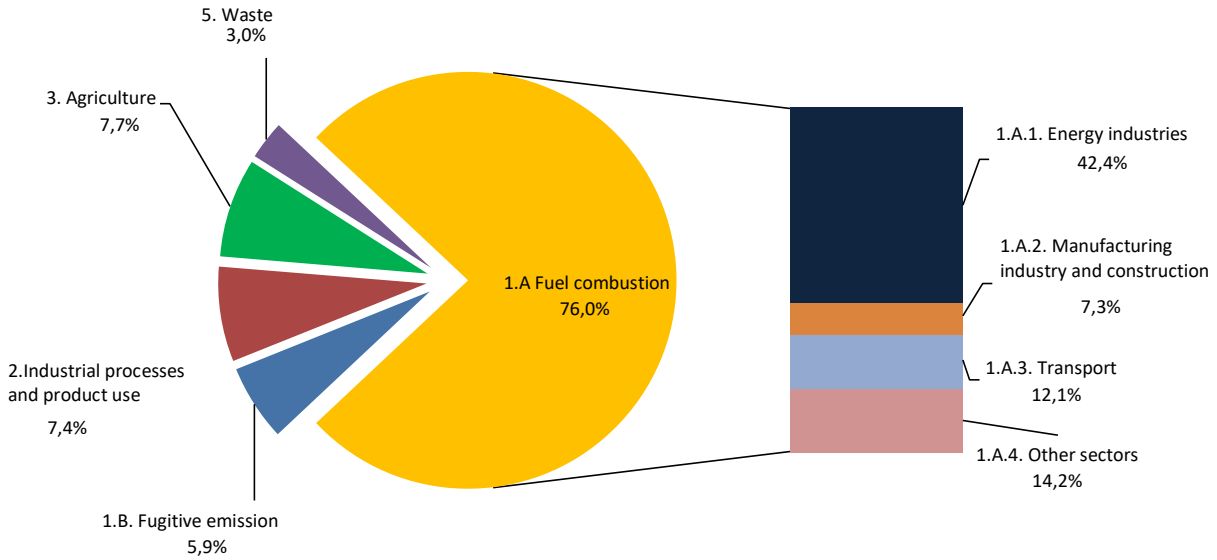


Fig. 3.1. Structure of greenhouse gas emissions recalculated to CO_2 equivalent (excluding category 4) in 2015, by IPCC category, source: IOŚ–PIB, KOBiZE

The inventory results indicate that, between 1988 and 2015, greenhouse gas emissions declined by 32.4%, while carbon dioxide emission fell by 34.0%, methane emission by 32.6%, and that of nitrous oxide by 35.2%. A particularly sharp drop in greenhouse gas emissions was noted between 1988 and 1990, which was driven by significant changes in the Polish economy, especially in heavy industry. The economic changes resulted from political transformation and transition from a centrally controlled to a free market economy. The reduced emission level had been maintained until 1993, after which it began to grow, reaching a local peak in 1996, as a result of, among others, modernization of heavy industry as well as a dynamic economic growth. Over the subsequent years, there was a slow reduction in emission until 2002, due to the adoption of programmes and actions aiming at the efficient use of energy. After 2002, a slight increase in emission level was registered, which was maintained until 2007. Since 2010, the emissions reached a stable level, with the exception for 2009 when a distinct decline was noted, caused by the world economic slowdown. From 2012 onwards, the national emission has not exceeded 400 Mt CO_2 equiv. (Fig. 3.2, Tab. 3.1).

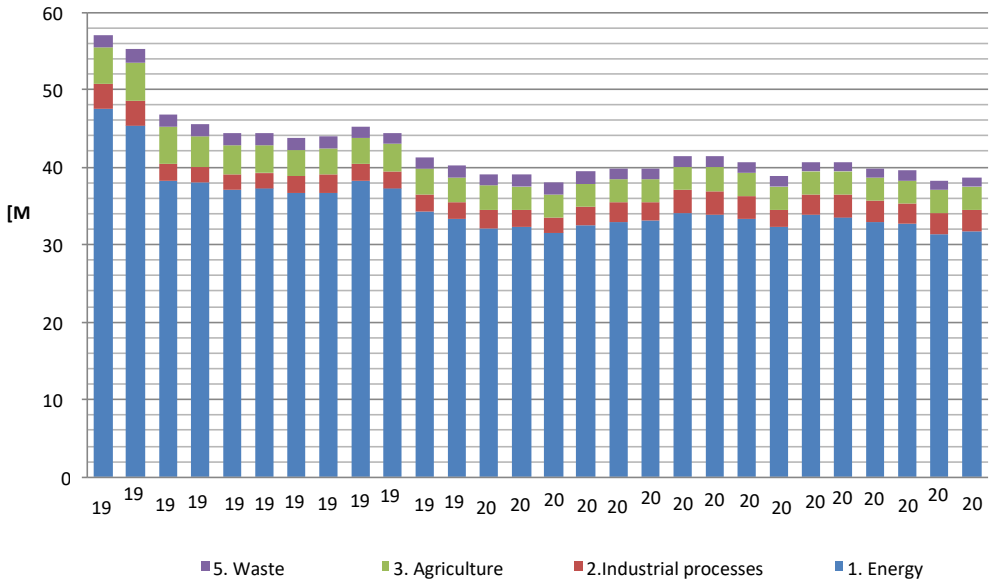


Fig. 3.2. Trend of greenhouse gas emissions recalculated to CO_2 equivalent (without category 4) in 1988–2015, according to IPCC category, source: IOŚ–PIB, KOBiZE

Table 3.1. Emission of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3) in the years 1988–2015, expressed in carbon dioxide equivalent

Greenhouse gas	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2 (including category 4.)	453 865.18	429 875.70	350 082.31	355 155.04	367 565.97	361 674.83	355 728.68	346 298.38	341 718.38	332 955.46	297 143.34	280 751.08	285 220.31	290 956.07
CO_2 (excluding category 4.)	470 886.43	451 253.19	376 039.78	373 379.31	363 720.14	364 128.74	359 612.30	361 305.16	375 306.19	366 571.50	337 342.94	327 653.71	317 098.60	313 546.99
CH_4 (including category 4.)	70 059.30	69 720.40	64 430.84	59 755.03	57 987.27	56 575.37	55 626.58	54 225.29	53 535.15	53 397.50	51 640.46	50 724.26	49 420.23	51 242.53
CH_4 (excluding category 4.)	70 015.17	69 676.37	64 386.78	59 710.04	57 942.76	56 533.16	55 585.64	54 179.39	53 498.76	53 359.57	51 606.13	50 687.16	49 387.68	51 209.95
N_2O (including category 4.)	29 492.30	30 765.16	27 495.61	23 047.68	21 545.27	22 797.25	22 458.10	23 468.69	23 584.50	23 485.77	23 259.85	22 547.34	22 916.01	23 104.16
N_2O (excluding category 4.)	29 322.01	30 553.70	27 312.65	22 842.50	21 285.45	22 210.73	22 143.19	23 121.04	23 247.81	23 151.41	22 895.52	22 174.03	22 533.39	22 690.55
HFC	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	134.69	335.49	481.02	569.32	780.47	1 378.08	1 937.55
PFC	147.26	147.51	141.87	141.31	134.63	144.86	152.78	171.97	161.07	173.36	174.86	168.71	176.68	197.34
Unspecified mix of HFC and PFC	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
SF_6	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	13.27	29.12	23.80	22.91	23.94	23.50	23.07	22.86
NF_3	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
Total emission (including category 4)	**553 564.04**	**530 508.77**	**442 150.63**	**438 099.06**	**447 233.14**	**441 192.30**	**433 979.40**	**424 328.15**	**419 358.40**	**410 516.02**	**372 811.76**	**354 995.37**	**359 134.37**	**367 460.52**
Total emission (excluding category 4)	**570 370.88**	**551 630.77**	**467 881.09**	**456 073.16**	**443 082.97**	**443 017.48**	**437 507.17**	**438 941.37**	**452 573.12**	**443 759.77**	**412 612.70**	**401 487.58**	**390 597.49**	**389 605.24**

Greenhouse gas	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
CO_2 (including category 4.)	273 599.28	282 970.33	275 712.79	275 525.14	293 989.64	299 067.88	293 009.73	281 590.63	300 746.11	293 121.48	285 772.55	278 690.55	274 312.69	280 665.84
CO_2 (excluding category 4.)	305 731.84	318 416.96	322 540.32	321 670.63	334 625.08	334 367.83	327 450.53	314 146.67	332 132.43	331 703.81	324 225.51	319 921.73	307 601.95	310 638.59
CH_4 (including category 4.)	49 635.78	49 972.17	49 571.92	50 026.26	50 231.36	49 573.53	49 337.99	48 186.63	48 209.94	47 116.39	46 828.08	47 104.83	46 629.82	47 210.15
CH_4 (excluding category 4.)	49 601.07	49 935.26	49 537.66	49 992.78	50 192.29	49 543.83	49 303.35	48 156.79	48 178.30	47 085.31	46 796.31	47 067.85	46 594.56	47 176.03
N_2O (including category 4.)	21 992.06	22 220.36	22 743.52	22 927.11	23 442.99	24 270.34	23 720.85	20 603.28	20 338.17	20 684.94	20 834.75	20 945.77	20 875.54	20 082.82
N_2O (excluding category 4.)	21 581.12	21 795.56	22 299.95	22 476.06	22 974.44	23 746.84	23 179.29	20 025.09	19 707.86	20 039.26	20 116.82	20 202.33	19 790.29	18 989.19
HFC	2 524.04	3 104.97	3 760.17	4 588.89	5 269.92	5 885.98	6 222.43	6 181.23	6 902.13	7 536.17	7 875.88	8 278.26	8 915.81	8 948.85
PFC	207.33	201.08	205.07	187.41	193.58	184.63	163.12	17.97	17.07	16.22	15.41	14.64	13.90	13.21
Unspecified mix of HFC and PFC	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
SF_6	23.29	20.72	22.36	26.80	33.20	31.16	32.87	37.60	35.37	39.02	41.92	47.54	52.79	77.03
NF_3	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
Total emission (including category 4)	**347 981.78**	**358 489.62**	**352 015.83**	**353 281.62**	**373 160.69**	**379 013.52**	**372 486.99**	**356 617.34**	**376 248.79**	**368 514.22**	**361 368.59**	**355 081.59**	**350 800.55**	**356 997.90**
Total emission (excluding category 4)	**379 668.68**	**393 474.53**	**398 365.54**	**398 942.56**	**413 288.50**	**413 760.27**	**406 351.60**	**388 565.35**	**406 973.16**	**406 419.78**	**399 071.85**	**395 532.34**	**382 969.30**	**385 842.89**

Source: IOŚ–PIB, KOBiZE

Detailed inventory of greenhouse gas emissions and removals in the years 1988–2015, by IPCC sectors, is provided in Annex 1.

Carbon dioxide

Carbon dioxide is the dominant greenhouse gas emitted in Poland, its share in total emissions was 80.5% in 2015. In 2015, the most important source of carbon dioxide emissions was fuel combustion in sector 1. *Energy*, responsible for 92.5% of CO_2 emissions including subsectors: *Energy industries* (1.A.1) – 52.4%, *Manufacturing industries and construction* (1.A.2.) – 9.0%, *Transport* (1.A.3.) – 14.8% and *Other sectors* (1.A.4.) – 16.3%. Sector 2. *Industrial processes and product use* is responsible for 6.0% of CO_2 emissions (Figure 3.1). In 2015, the balance of carbon dioxide emissions and removals in sector 4.was estimated to be around 30.0 million tonnes (Figure 3.3).

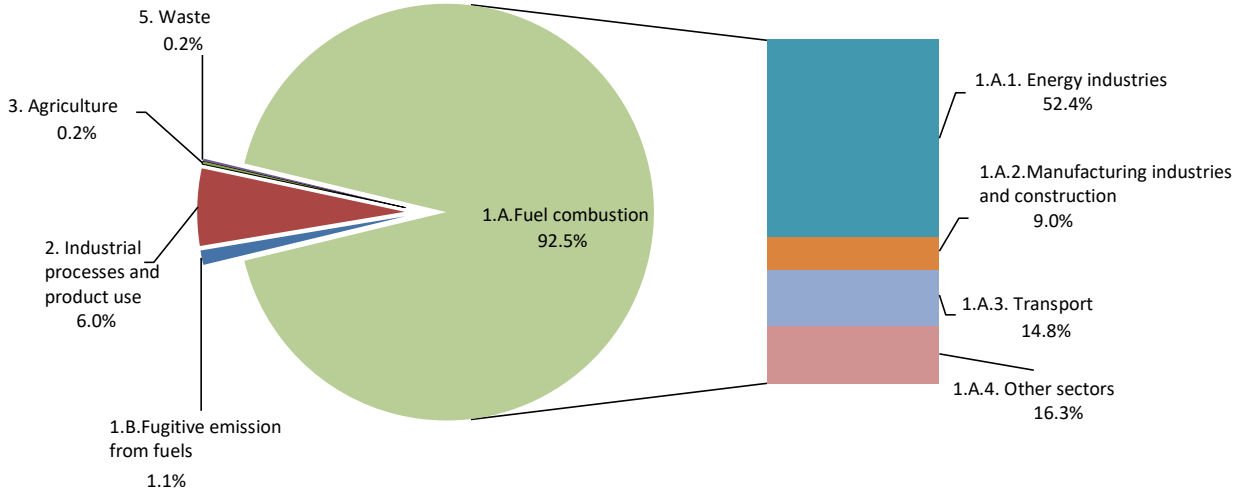


Fig. 3.3. Structure of carbon dioxide emissions (excluding category 4) in 2015, by IPCC category, source: IOŚ–PIB, KOBiZE

Between the years 1988–2015, CO_2 emissions (excluding sector 4) decreased by approximately 34.0% in relation to the base year. The largest decrease, exceeding 20%, occurred in 1988–1990. Between these years, the following changes took place in the structure of fuel consumption:

- the share of solid fuels decreased from 80.1 (1988) to 54.7% (2015),
- the share of liquid fuels increased from 11.7 (1988) to 23.0% (2015),
- the share of gaseous fuels increased from 6.2 (1988) to 12.7% (2015).

Methane

In 2015, the share of methane in the total national greenhouse gases emissions was 12.2%. Methane emissions are generated mainly by the three sectors, including: *Fugitive emission from fuels* (1.B.), *Agriculture* (3.) and *Waste* (5.), whose shares in the national total in 2015 were as follows: 41.0%, 29.8% and 21.5%, respectively (Figure 3.2). The emissions from the first of the above sectors embrace emission from the *Underground mines* (1.B.1) – about 35.8% of the total CH_4 emissions as well as emissions from the *Oil and natural gas system* (1.B.2) which jointly constitute approximately 5.1% of the emissions. In sector *Agriculture,* the dominant emission source was sub-sector *Enteric fermentation* (3.A.), with approximate 26.3% of the total methane emissions

in 2015. Emissions from sub-sector *Solid waste disposal* (5.A) amounted to close to 21.4% of national methane emissions (Figure 3.4).

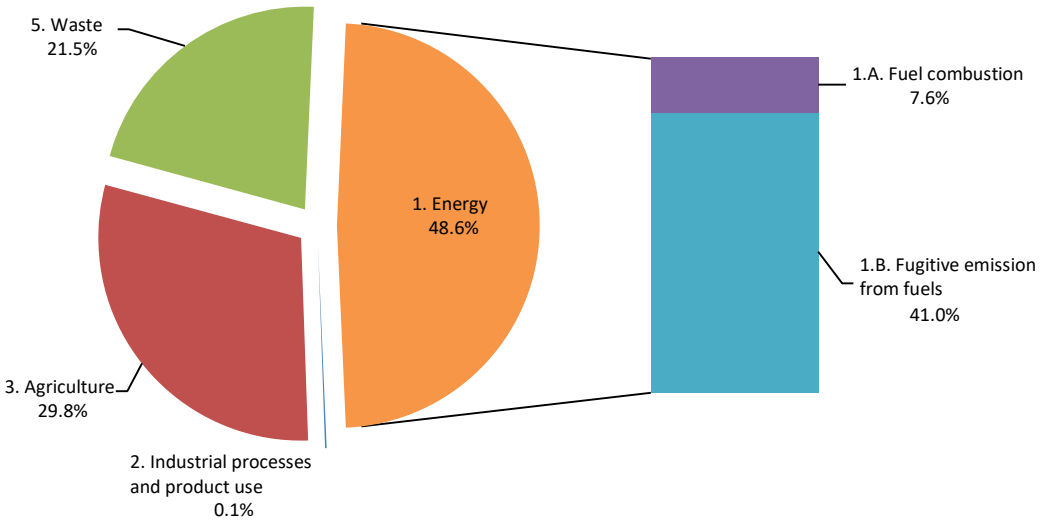


Fig. 3.4. Structure of methane emissions (excluding category 4) in 2015, by IPCC category, source: IOŚ–PIB, KOBiZE

In 2015, methane emissions (excluding category 4) were about 32.6% lower than in the base year. This was mainly due to the reduction by 43.4% of emissions from sub-sector *Enteric fermentation* due to a significant decrease in farm livestock (sector 3. *Agriculture)*, and to the reduction by 22.5% of emissions from the sub-sector *Fugitive emission from fuels,* as a result of restructuring of mining and applying quotas on coal mining (sector 1. *Energy*). The reduction by 32.2% of methane emissions from sector 5. *Waste* resulted from a change in inventory methodology, account was taken in the inventory of waste outside the system ("wild" landfill, etc.).

Nitrous oxide

The share of nitrous oxide emissions in the total greenhouse gas emissions in 2015 was 4.9%. The key sources for total N_2O emissions in 2015 were: *Agricultural soils* (3.D.) – 67.0%, *Manure management* (3.B) – 11.0%, *Chemical industry* (2.B) – 3,9% and *Fuel combustion* (1.A) – 12.3% (Figure 3.5).

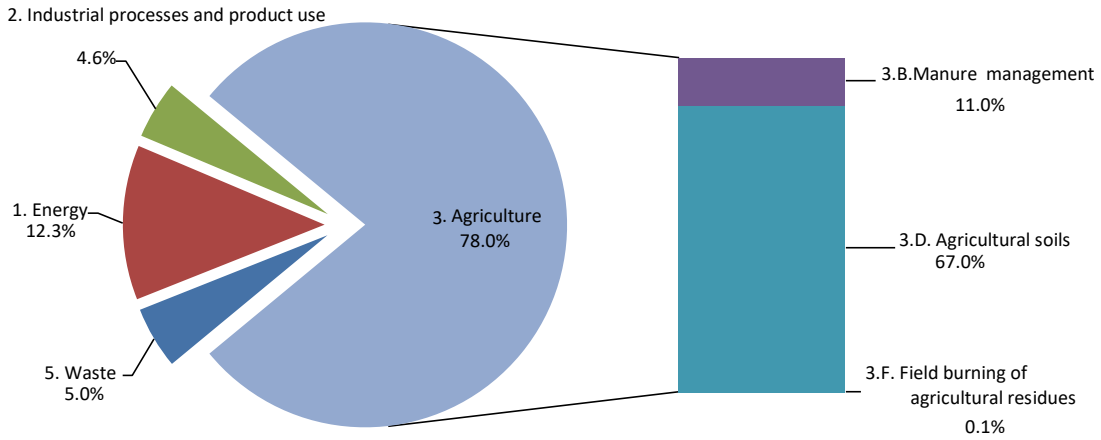


Fig. 3.5. Structure of nitrous oxide emissions (excluding category 4) in 2015, by IPCC category, source: IOŚ–PIB, KOBiZE

In 2015, the N_2O emission (excluding category 4) was about 35.2% lower than in the base year. In the total N_2O emission, the share of emissions from subsector *Manure management* (3.B) increased from 10.7% in 1988 to 11.0% in 2015, those from subsector *Agricultural soils* (3.D) – increased from 61.1% in 1988 to 67.0% in 2015, while in subsector *Chemical industry* (2.B) this share decreased from 16.4% in 1988 to 3.9% in 2015.

Industrial gases

HFCs emissions significantly increased in 2015, as compared to the level of mid-1990s and accounted for 2 592% of the emissions from 1995. The above significant growth in emission in this group of gases is due to the increasing use of refrigerating and air-conditioning equipments. PFCs emission was 92.3% lower in 2015 than in the base year (1995). The value of this emission depends on both the level of aluminum production (the main source of PFCs), and the use of C_4F_{10} in fire extinguishers. The SF_6 emissions were 164.5% higher in 2015 than in 1995. The main source of SF_6 emissions is leaks from electrical equipment during its use, production and, recently, also decommissioning. No activity has been identified that could cause NF_3 emissions. Such a significant increase in industrial gases emission, as compared to the base year level, does not significantly affect the trend of national emissions, since the total share of industrial gases in the total national emissions was about 2.3% in 2015.

3.3. Uncertainty assessment of data on greenhouse gas emissions

An uncertainty analysis for estimates of greenhouse gas emissions was carried out in line with the current guidelines of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories at the level of accuracy 1 (Approach 1). After analyzing the input data and simulating the error propagation for 2015, the following uncertainties for the total emissions (excluding category 4) were obtained:

CO_2 – 1.8%	CH_4 – 22.9%	N_2O – 47.9%
HFC – 8.2%	PFC – 15.8%	SF_6 – 4.5%

Analyzing the results obtained, it can be concluded that they are in line with those obtained in other countries, where the uncertainty for CO_2 emissions is in the range between 0.23% and 10%, for CH_4 – between 5 and 50% and for N_2O between 5 and 300%.

The relatively small value of uncertainty for estimates of total CO_2 emissions (1.8%) is due to the fact that a significant part of uncertainty comes from sector 1.A, which is characterized by a relatively high accuracy of activity data (2–5%) and emission factors (1–5%). A greater uncertainty for estimates of total CH_4 emissions (22.9%) is due to the fact that a significant part of it comes from *Agriculture* (3.A and 3.B.), for which the uncertainty of emission estimates is relatively high (about 50%). In Poland, as in other reporting countries, the relatively high uncertainty was found for estimates of N_2O emission (47.9%). This is driven by the high uncertainty of emission factors in the dominant subcategories, including, among others: manure management in agriculture – 3.B.11 and 3.B.12 (150%).

The high uncertainty of emission factors is, among others, related to the uncertainty of measurements and analyses undertaken for their determination, or to a limited knowledge of the processes underlying the emission. The uncertainty as to the activity data is often due to the lack of appropriate analyses and statistical methods applied in the framework of the national public statistics. The uncertainty of inventory data may be reduced by commissioning detailed studies on emission factors, firstly by selecting factors with greatest uncertainty, assigned to key sources.

3.4. Key categories of greenhouse gas emissions

The analysis of key categories of greenhouse gas emissions (excluding sector 4) has indicated 25 categories as the largest source of emissions in 2015 (Table 3.2). The most important categories include:

- 1.A.1 *Fuel combustion – Energy industries – Solid fuels*,
- 1.A.3.b *Road transport*,
- 1.A.4 *Other sectors – Solid fuels*.

Greenhouse gas emissions from these sources amounted to 59.0% of the national total emissions, expressed in CO_2 equivalent.

Table 3.2. Key category analysis of greenhouse gas emissions (excluding Sector 4.) in 2015.

Lp.	Source category (IPCC)	Greenhouse gas	Emission [CO_2 eq.]	Level asessment	Total
1	1.A.1 Fuel combustion - Energy industries - Solid fuels	CO_2	151906.09	0.394	0.394
2	1.A.3.b Road transport	CO_2	44830.88	0.116	0.510
3	1.A.4 Other sectors - Solid fuels	CO_2	30799.19	0.080	0.590
4	1.B.1 Fugitive emission from solid fuels	CH_4	16896.26	0.044	0.634
5	1.A.2 Fuel combustion - Manufacturing and construction - Solid fuels	CO_2	15771.45	0.041	0.674
6	3.A Enteric fermentation	CH_4	12419.47	0.032	0.707
7	1.A.4 Other sectors – Gaseous fuels	CO_2	11509.98	0.030	0.736
8	3.D.1 Direct N_2O emissions from soil	N_2O	10232.11	0.027	0.763
9	5.A Solid waste disposal	CH_4	9111.69	0.024	0.787
10	2.F.1 Refrigeration air-conditioning equipment	F-gases	8442.94	0.022	0.808
11	1.A.4 Other sectors - Liquid fuels	CO_2	8420.59	0.022	0.830
12	1.A.2 Fuel combustion - Manufacturing and construction - Gaseous fuels	CO_2	7586.07	0.020	0.850
13	2.A.1 Cement production	CO_2	6341.81	0.016	0.866
14	1.A.1 Fuel combustion - Energy industries - Gaseous fuels	CO_2	6197.48	0.016	0.882
15	1.A.1 Fuel combustion - Energy industries - Liquid fuels	CO_2	4407.85	0.011	0.894
16	2.B.1 Ammonia production	CO_2	3870.48	0.010	0.904
17	1.A.2 Fuel combustion - Manufacturing and construction - Other fossil fuels	CO_2	2678.26	0.007	0.911
18	3.D.2 Indirect N_2O emissions from soils	N_2O	2486.35	0.006	0.917
19	1.A.4 Other sectors - Solid fuels	CH_4	2247.54	0.006	0.923
20	3.B Manure management	N_2O	2087.62	0.005	0.928
21	2.C.1 Iron and steel production	CO_2	2032.65	0.005	0.934
22	2.A.4 Other process uses of carbonates	CO_2	1817.12	0.005	0.938
23	1.A.2 Fuel combustion - Manufacturing and construction - Liquid fuels	CO_2	1791.59	0.005	0.943
24	1.B.2.Fugitive emission from fuels - Other	CO_2	1789.16	0.005	0.948
25	1.B.1 Fugitive emission from solid fuels	CO_2	1678.68	0.004	0.952

Source: IOŚ–PIB, KOBiZE

3.5. National system for greenhouse gases inventories

The unit responsible for carrying out the inventory of greenhouse gases is the National Centre for Emissions Management at the Institute of Environmental Protection – National Research Institute. The Centre was established by the Act of July 17 2009 on the System to Manage the Emissions of Greenhouse Gases and Other Substances (Official Journal of the Laws of 2017, Item 286) at the Institute of Environmental Protection – National Research Institute (IOŚ–PIB) in Warsaw.

The Act of 17 July 2009 on the System to Manage the Emissions of Greenhouse Gases and Other Substances sets forth the legal grounds for managing the national emission ceilings of greenhouse gases or other substances in a way that secures the Republic of Poland's compliance with the international and Community commitments and provides for cost optimization in reducing the emission of air pollutants. The scope of tasks defined by the Act covers, among others:

- work associated with the operation of the national emission balancing and forecasting system, including the maintenance of the National database on emission of greenhouse gases and other substances;
- develop methodology for estimating values of emission from respective types of installations or activities, as well as methodology for determining emission factors;
- prepare reports and projections for air pollutant emissions;
- operate the National Register of Kyoto Units;

- keep a register of joint implementation projects within the territory of the Republic of Poland, which are backed by supporting letters or letters of approval;
- manage the greenhouse gas emission allowance trading system (ETS).

Pursuant to Article 11 of the abovementioned Act, the National Centre is responsible for elaborating and submitting to the Minister responsible for the environment, of annual greenhouse gas inventories, required by the EU laws or international environmental agreements, prepared in accordance with guidelines under the climate convention, as well as inventories of substances specified in the UNECE CLRTAP Convention on Long-Range Transboundary Air Pollution, no later than 30 days before deadlines. The tasks of the National Centre also include the compilation of information, including the emission data, for the purpose of public statistics (Art. 3, Par. 3, Item 3).

Inventories of greenhouse gases emissions, including calculation of emission values, selection and development of methodology, selection of activities - sources of emission and determination of emission factors are made by the Emission Inventory and Reporting Unit (ZIiRE), set up at the National Centre for Emissions Management (KOBiZE). Both individual experts and institutions, such as: the Central Statistical Office (GUS), the Energy Market Agency (ARE SA), the Institute of Transport Engineering (ITS) and the Office of Forest Management and Forest Economy (BULiGL) cooperate in the inventory preparation. These institutions are primarily involved in providing activity data. The KOBiZE experts have also access to the data submitted by companies participating in the EU Emissions Trading Scheme (EU ETS). These verified data are used in the inventory of greenhouse gas emissions, in certain sectors (e.g. in subcategories of industrial processes).

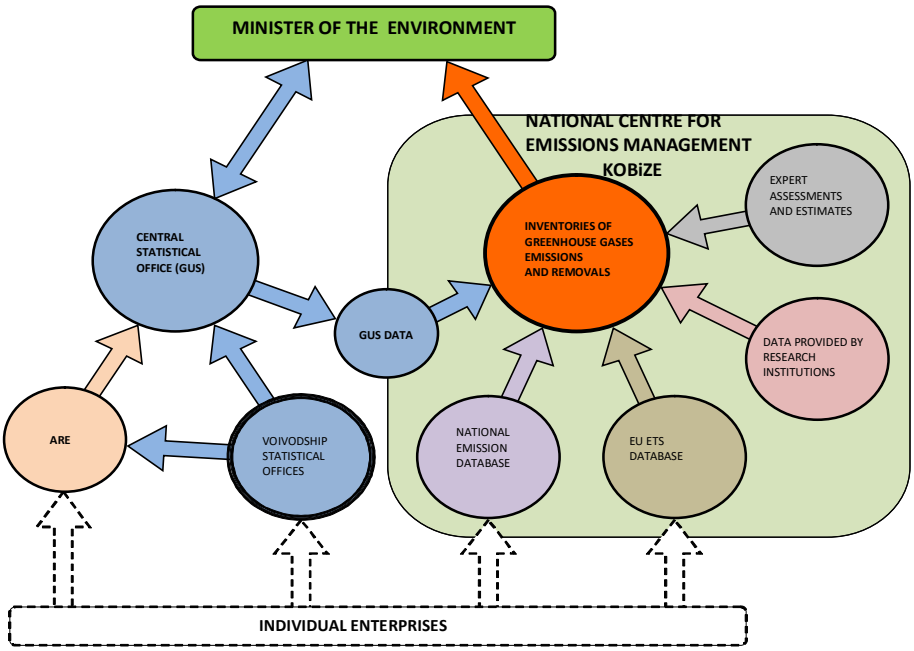


Fig. 3.6. Scheme of national greenhouse gas inventory system; source: IOŚ–PIB, KOBiZE

The tasks performed by KOBiZE are supervised by the minister competent for the environment (Figure 3.6). Prior to official submission, the national inventory is subject to internal approval. The body responsible for approving the inventory results is the Minister of the Environment.

3.6. National Registry

The Polish Registry was launched in July 2006 and, since 2008, has been linked to the International Transaction Log (ITL). According to national regulations, the Registry is managed by the National Centre for Emissions Management at the Institute of Environmental Protection – National Research Institute in Warsaw. The Registry database collects information on the entities covered by the system, installations, verified emission data, national holding accounts, installation accounts, aircraft operator accounts, personal holding accounts and working accounts.

At present, the Polish Registry of units is maintained together with Registries of other EU Member States. The amended EU regulations, in particular, the EU Directive 2009/29/EC, which was adopted in 2009, paved the way for centralizing the EU Emissions Trading Scheme (EU ETS) in one EU Registry, and to including the aviation sector into the trade system since the beginning of the year 2012. At the same time, in order to increase the operational efficiency of the national registries, 28 Member States of the European Union (also Parties to the Kyoto Protocol) as well as Iceland, Liechtenstein and Norway decided to merge national registries into one consolidated registry, in accordance with decisions providing for establishing national registries and, in particular, Decision 13/CMP.1 and Decision/CP.8. Consequently, in June 2012, the national registries of the European Union countries were consolidated. As a result of the merger, both the physical location of the Polish Registry and the relevant software were updated, and all technical procedures applied up to date were changed. The software and infrastructure for the common Registry is provided and technically operated by the European Commission. The Registry is connected by a teleinformatic network with the International Transaction Journal (ITL) managed by the Secretariat of the United Nations Framework Convention on Climate Change and with the European Union Transaction Log (EUTL) serving as an additional transaction log.

Participants in the emissions trading system as well as the manager have access to the Registry via a secure website at: https://ets-registry.webgate.ec.europa.eu/ euregistry/PL/ index.xhtml.

The consolidated Registry has been established based on the following assumptions.

1. In countries (also in Poland), there are still organizations functioning as administrators of national registries, responsible for fulfilling all obligations of the parties with respect to the common Registry;
2. Each Kyoto unit issued in the Polish part of the EU Registry is marked with a unique serial number containing the identifier of origin;
3. Within the EU Registry, Poland, as a Party to the Kyoto Protocol, has its own national accounts. Each of these accounts was assigned a unique number, consisting of the site identifier ("PL"), and a unique number in this part of the EU Registry;
4. Transactions performed using Kyoto units are transferred and verified by the International Transaction Log (ITL), which is responsible for verifying transaction correctness and validity;
5. Comparisons of data between the different parts of the new register and the International Journal of Transactions have been still continuing to ensure consistency of data and enable the ITL's automatic controls;

6. All parts of the EU Registry are kept on the consolidated IT platform, sharing the same infrastructure technology, however, the system architecture selected ensures the security, uniqueness, and possibility of unambiguous identification of a given part of the Registry.

The implementation of the above is based on the following guidelines:

- with respect to data exchange, each part of the EU Registry, administered by a Party to the Kyoto Protocol, has a direct, separate and secure communication link via a unified communications channel (VPN tunnel);
- ITL is responsible for authenticating the national registries and ultimately registers all transactions made with the use of Kyoto units, as well as verifies other administrative processes in such a way that the completed operations cannot be challenged and rejected;
- with respect to data storage, the consolidated platform guarantees their confidentiality and protection against unauthorized access;
- the data storage architecture provides for the distinction and unambiguous identification of data relating to the Polish part of the EU Registry in relation to data associated with the remaining parts of the consolidated registry;
- each part of the EU Registry conducts a separate URL, with separate rules for authorization and configuration.

Following the successful launch of the CSEUR (Consolidated System of European Union Registries), 28 national registries have been accredited (UNFCCC certification). The consolidated registry certification process included connection testing, reliability testing, isolation and interoperability testing to demonstrate compliance with the Data Interchange Standard (DES). All tests were successful and led to the completion of the certification process on June 1, 2012.

In connection with the establishment of a new registration system, a technical support team (EU ETS Service Desk) has been set up to provide administrators of individual EU Member States with technical assistance on the functioning of the EU Registry. This constitutes a second level of support, after local teams were established in the Member States. The EU ETS Service Desk also plays a key role in communicating with the ITL (ITL Service Desk), especially with regard to the connection problems and daily database comparisons.

The National Centre for Emissions Management renders available the information required (in accordance with Part E of Annex I to Decision 13/CMP.1), at the address: http://www.kobize.pl/en/article/rejestr-uprawnien/id/348/reports-public. The site is fully controlled by the Polish manager. The following data were posted on the website and have been subject to update once a month:

- account information (in accordance with paragraph 45 of part E of the Annex to Decision 13/CMP.1);
- information on projects as defined in Article 6. (in accordance with paragraph 46 of Part E of Annex 13 to CMP.1);
- information on units and their transfers (in accordance with paragraph 47 of Part E of Annex 13 to CMP.1) prepared on the basis of the SEF report;
- the list of entities authorized by the country (in accordance with paragraph 48 of part E of the Annex to Decision 13/CMP.1).

It should be noted that some of the data required under the above mentioned Decision has not been made public (e.g. balance of individual accounts, personal data of account representatives, etc.)

due to security requirements, in accordance with Art. 110 of the Commission Regulation No 389/2013 of 2 May 2013, establishing the Union Register under the Directive 2003/87/EC of the European Parliament and of the Council, Decisions No 280/2004/EC and 406/2009/EC of the European Parliament and of the Council and repealing the Commission Regulations No 920/2010 and No 1193/2011 (EU Journal of Laws 122 of 03.05.2013, p.1).

In 2015, the national emissions were calculated for the first commitment period (CP1, 2008–2012) under the Kyoto Protocol. Bearing in mind the provisions of Decision 3/CMP.10, which established the closing date for the CP1 review and the date of commencement of activities carried out in the additional period, intended for the settlement of commitments arising from CP1 (the so-called True-up period), final settlement of emissions generated in the Party to the Kyoto Protocol was to be completed by November 18, 2015, i.e. within 100 days of the completion of the inventory review (Decision 27/CMP.1, Annex, Section XIII). Following the approval by the Minister of the Environment, the emission was settled with the use of Kyoto units, through the appropriate withdrawal operations in the EU Registry, pursuant to Decision 13/CMP.1.

Current information and changes in the National Registry are presented annually in the National Inventory Report (NIR), submitted to the UNFCCC Secretariat before April 15.

CHAPTER 4. POLICIES AND MEASURES

4.1. The national reduction target

Poland contributes to the activities towards climate change mitigation undertaken by the international community – as a signatory to the United Nations Framework Convention on Climate Change since 1994 and to the Kyoto Protocol – since 2002. In the first commitment period under the Kyoto Protocol, Poland committed to reduce greenhouse gas emissions in 2008–2012 by 6%, compared to the base year. In the second commitment period, established in the Doha Amendment, the European Union, its Member States and Iceland committed to reduce their average annual greenhouse gas emissions in the years 2013–2020 under joint fulfilment of commitments. The common reduction target was expressed as a commitment to achieve average annual emissions of 80% of the total emissions of all countries in the base years (tab. 4.1). Poland established the year 1988 as the base year for carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) emissions, whereas for SF_6, fluorinated HFCs and PFCs – the year 1995, and for NF_3 – the year 2000.

In addition to the reduction target adopted under the Kyoto Protocol, the European Union set climate change goals of reducing greenhouse gas emissions by 20% by 2020, compared to 1990 (tab. 4.1).

Table 4.1. Summary of international and Community commitments for Poland

Specification	International commitments (UNFCCC)			EU law	
	Kyoto Protocol (KP)		Convention	Climate and energy package	
				EU ETS	ESD
Commitment period and the target year	First commitment period (CP1) (2008−2012)	Second commitment period (CP2) (2013−2020)	2020	2013−2020	2013−2020
Emission reduction target	-6%	-20%	-20%	Total emission reduction in the EU by 21% compared to 2005	Emission increase by 14%, compared to 2005, consistent with annual emission limits
Other commitments	–	–	Provisionally: -30% if other Parties to the Convention will commit adequately	Increase of RES use up to 20% in final energy consumption and increase of energy efficiency by 20%	
Base year	1988 for CO_2, CH_4, N_2O 1995 for HFCs, PFCs, SF_6	1988 for CO_2, CH_4, N_2O 1995 for HFCs, PFCs, SF_6, 2000 for NF_3	1990	1990 for total emission; 2005 for RES and energy efficiency, and for emissions under EU ETS and ESD	
LULUCF	Including ARD and other selected measures	Including ARD, forest management and other selected measures (new accounting rules)	Excluded	Excluded	
Aviation	National aviation included, international aviation excluded	National aviation included, international aviation excluded	Aviation under EU ETS included (practically aviation included as a whole)	National and international aviation included in EU ETS	Generally aviation excluded, except for selected air operations (below the ETS threshold)

Specification	International commitments (UNFCCC)			EU law	
	Kyoto Protocol (KP)		Convention	Climate and energy package	
				EU ETS	ESD
Use of international credits	Use of KP mechanisms, compliant with KP provisions	Use of KP mechanisms, compliant with KP provisions	Subject to limitations	Subject to quantitative and qualitative limitations	Subject of quantitative and qualitative limitations
Transferring units from previous periods	Not applicable	In compliance with the KP and Doha Amendment provisions	Not applicable	EU ETS allowances may be kept for subsequent EU ETS periods, starting from the second trading period	Without consent to transfer from the previous period
Gases included	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	CO_2, CH_4, N_2O, HFCs, PFCs, SF_6	
Sectors	In compliance with Annex A to KP (energy, industrial processes and product use, agriculture, waste), LULUCF in compliance with CP1 accounting policies	In compliance with Annex A to KP (energy, industrial processes and product use, agriculture, waste), LULUCF in conformity with CP2 accounting policies	Energy, industrial processes and product use, agriculture, waste, as well as aviation in the scope of the EU ETS	Electricity and heat production, as well as industry, including: cement, chemical, coke, refinery and other industries, aviation (compliant with Annex I to the ETS Directive)	Transport (except for domestic aviation), municipality sector, industries, agriculture and waste
GWP indicators	IPCC SAR	IPCC AR4	IPCC AR4	IPCC AR4	

Source: Own elaboration

In Poland, in the years 1988–2015, GHG emissions decreased significantly (excluding Sector 5: Land use, land-use change and forestry), and the value accomplished was over 30% lower than that in the base year (fig. 4.1). The reduction of emissions was achieved as a result of the implementation of a set of nation-wide policies and measures, designed primarily to improve energy efficiency and to change the structure of fuel and energy consumption.

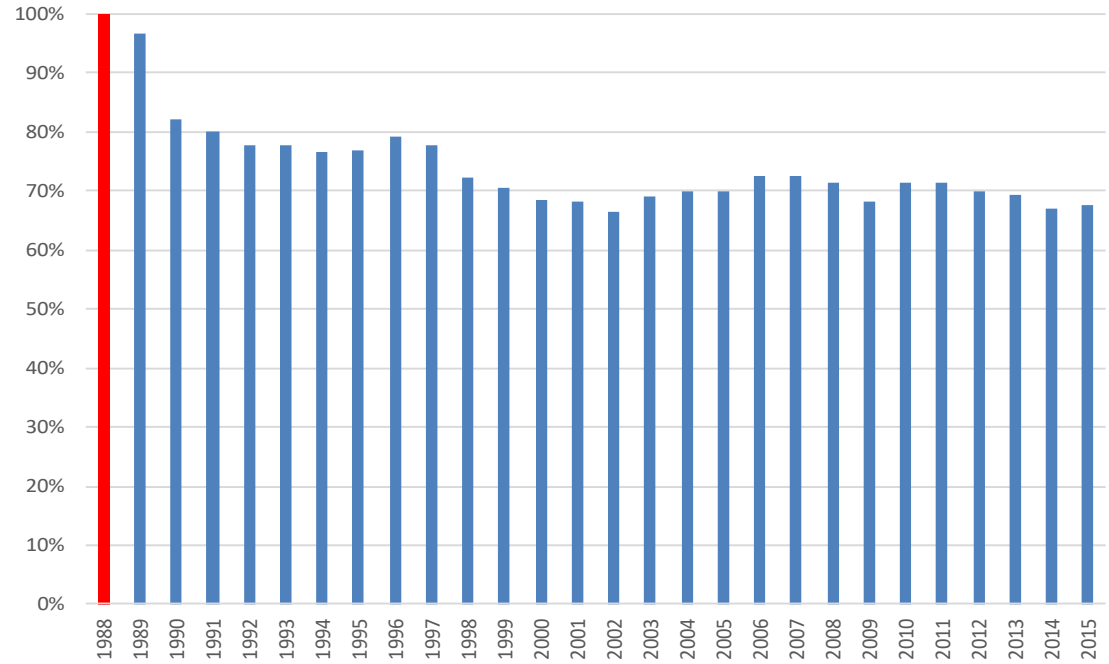


Fig. 4.1. Changes in greenhouse gas emissions in Poland compared to 1988; source: IOŚ–PIB, KOBIZE

4.2. The basis for policy-making

In recent years, Poland's government has undertaken a number of initiatives for strategic programming and towards a comprehensive system of development management. The foundations of a new system of strategic documents have been formed, defining the vision and directions of the country's development, both in the current decade (The National Development Strategy 2020, 9 Integrated Strategies and the Strategy for Responsible Development) and in the long-term perspective until the year 2030 (Poland 2030 "Long-term National Development Strategy 2030". Third Wave of Modernity; LTNDS).

4.2.1. Poland's strategic documents

The National Development Strategy 2020 – active society, competitive economy, efficient state was adopted by the Council of Ministers on 25 September 2012, and until February 2017, it was the main medium-term strategy for steady development of the country. The document identified three strategic areas with relevant measures – Efficient and Effective State, Competitive Economy, Social and Territorial Cohesion. The main objective of the Strategy was to use and reinforce economic, social and institutional capacities to ensure faster and sustainable development of the country and improve people's quality of life.

The Strategy constituted a starting point for 9 Integrated Strategies that ought to contribute to the implementation of the Strategy's objectives, along with the assumed actions intended to develop and refine the assigned reforms (fig. 4.2).

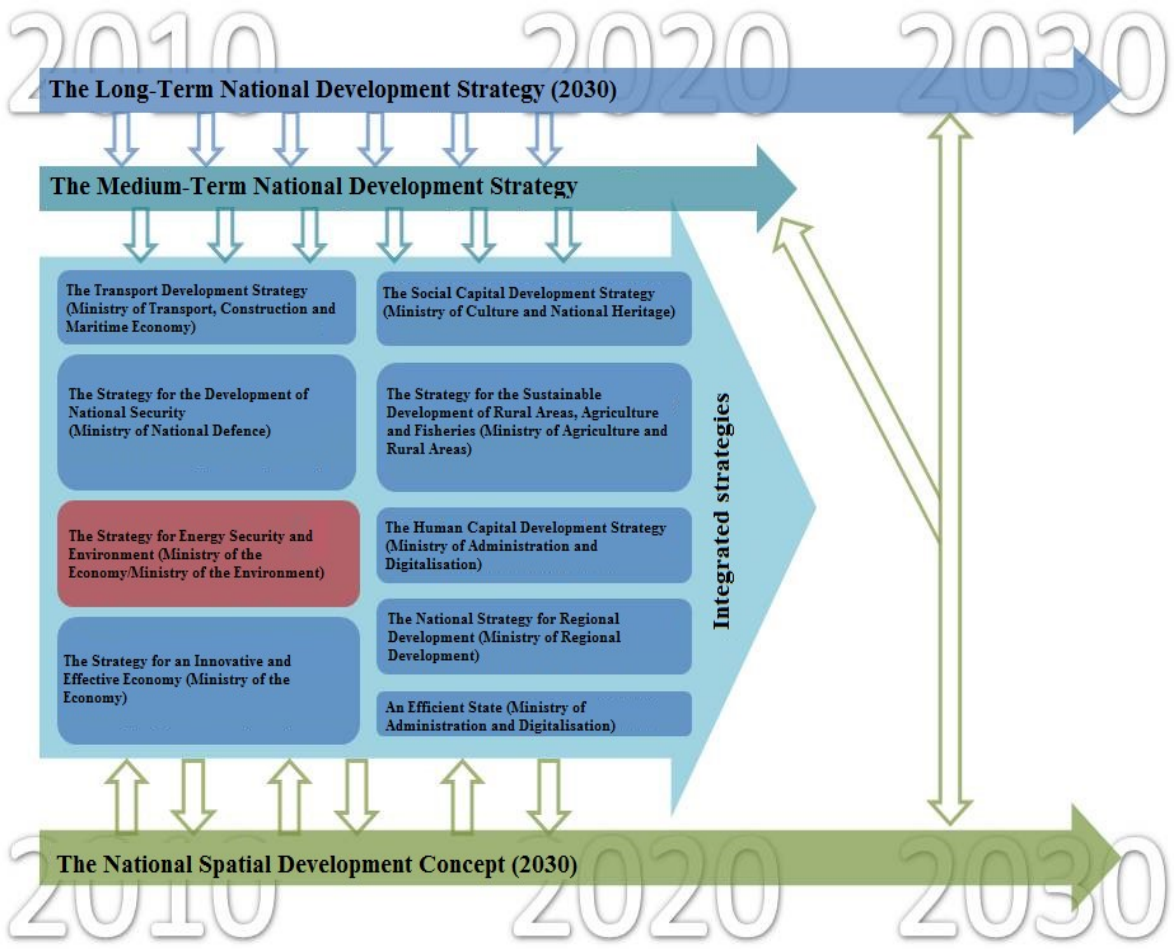


Figure 4.2 National Strategic Documents, valid until February 2017

At the present time, the Strategy for Responsible Development, adopted by the Council of Ministers on February 14 2017, is a key document in the area of medium- and long-term economic policy in Poland, which specifies the goals to be achieved in the perspective by 2020 and 2030. This Strategy amends the National Development Strategy 2020, and sets out a new model of economic and spatial planning. The main objective is to develop modalities for raising incomes and – at the same time – strengthening cohesion in terms of the social, economic, environmental and territorial dimension. The Strategy's specific objectives are as follows:

Specific objective I - Sustainable growth, more and more based on sound knowledge, data and organizational excellence

Specific objective II - Socially sensitive and territorially sustainable development

Specific objective III - Effective state and institutions for progress, as well as social and economic participation

Under the first specific objective, there will be supported low-carbon measures and sectors (including low energy intensity), e.g. collective transport, ecodesign (including wood constructions), investments to decarbonise industry and improve its energy efficiency.

The second specific objective embraces promoting measures to improve urban environment quality and to build "green" cities by enhancing carbon efficiency and energy efficiency, optimizing solutions for urban transport and urban mobility, as well as activities towards eliminating low-emission.

The Strategy also identifies the areas affecting the achievement of the above objectives. These include: human and social capital, transport, energy, the environment and national security.

In the Transport sector, among the investments significant for GHG emissions reduction, there are emphasized: expansion of transport networks alternative to road transport, including development/improvement of rail networks and waterways; implementation of projects linked to the construction of an integrated, connected transport network in support of competitive economy – such as the National Railway Programme; expansion of the inland waterway sector as well as further development of intermodal passenger transport. In addition, it is planned to increase the share of ecological transport in cities and their functional areas, by supporting mechanisms for public transport management and improvement, fostering effective solutions for public transport organization, replacing the current stock for urban passenger transport by ecological transport units and promoting urban rail systems providing passenger service.

In the policy area Energy, the goal is to reduce primary energy consumption by 20% to be achieved by: increasing energy efficiency of public utility buildings and multi-family housing; increasing energy efficiency in enterprises; reducing industrial energy losses; improving efficiency of energy production, as well as implementing energy-efficient and high-efficiency technologies. In addition, the reduction of GHG emissions will be affected by the implementation of high temperature HTR reactors for industrial heat generation, expansion of low-carbon transport, promotion and initiation of local energy projects (propagating RES development). Among others, strategic projects, such as Nuclear Cogeneration and/or Distributed Power Generation will contribute the implementation of the above.

In the policy area Environment, one of the directions of intervention is the elimination of sources of air pollution emissions or significant reduction of their impact in the municipal-residential and transport sectors.

A key government document as regards Poland's environmental policy is the Strategy for Energy Security and the Environment, one of the nine Integrated Strategies. This Strategy comprises the responds to the most important challenges faced by Poland in perspective of 2020, pertaining to the environment and energy, and especially those related to the goals of the Europe 2020 Strategy and the objectives of the medium-term development strategy of the country. The core objective of the Strategy for Energy Security and the Environment is to provide good quality of life for present and future generations, and to develop modalities for sustainable development of the modern energy sector, capable of providing Poland with energy security and the competitive and energy-efficient economy. The core goal of this Integrated Strategy will be pursued by the following three specific objectives and directions of intervention:

- sustainable management of environmental resources (including minerals, water, biodiversity and spatial planning/management);
- assurance of the secure and competitive energy supply at a national economy level (through energy efficiency improvement, energy sector modernization, enhancement of fuel and energy market competitiveness and import security);

- improvement of the environment status (including water and air protection, rational waste management, promotion of environmental technologies and ecological attitudes).

The Strategy for Energy Security and the Environment sets environmental priorities, and above all these are:

- the reduction of air pollution,
- the reform of the water management system.

In the area Air Pollution Reduction and the concurrent enhancement of electricity and heat production, emissions reduction ought to concern air pollutants such as: nitrogen and sulfur compounds, carbon monoxide and carbon dioxide. This task will be implemented, among others, by modernizing the energy and heating sector and the limitation of low-emission, as a result of strengthening available financial support mechanisms for relevant investments. The Strategy highlights the need to address the issues concerning adaptation to already observed climate change impacts.

In the area the Protection and Conservation of Water Resources, it is crucial to provide the necessary quantity of good water quality, and also to flood prediction, prevention and mitigation. These tasks will be implemented, among others, through: building new and modernizing existing wastewater treatment plants, developing maps of areas threatened with floods, elaborating flood risk management plans, and promoting good agricultural practices.

The Europe 2020 Strategy (endorsed in 2010) has been implemented through the National Reform Programmes (NRPs, in Polish: KPR), which are updated annually. The initial Polish document was the National Reform Programme for the implementation of the Europe 2020 Strategy, adopted by Poland's Council of Ministers on 26 April2011. This Programme set out the commitments in the perspective of 2020, under the five flagship objectives of the Europe 2020 Strategy, taking into account national modalities as well as the directions specified in Polish strategic documents. The Government of the Republic of Poland decided to focus on three priority areas:

1. Infrastructure for sustainable growth,
2. Innovation for smart growth,
3. Activities for inclusive growth.

Revision of the KPR 2017/2018 takes into account the directions of actions outlined in the Responsible Development Strategy (adopted by the Council of Ministers on 14 February 2017). The development vision comprised by the Strategy, is to change the paradigm of development processes in favor of greater uniformity of these processes in a territorial dimension.

The National Spatial Development Concept 2030 (NSDC 2030) – adopted by the government in December 2011 – is the most important national strategic document that addresses the spatial planning management of Poland. The national spatial strategy identifies the most urgent issues of spatial development, as well as specific measures, among others, with regard to creating energy efficient spatial structures or else developing transport and telecommunication infrastructure.

4.2.2. Basic legal regulations and instruments

The most important goal of activities in the area of air protection, including those on combating climate change, is to reduce air pollution and improve air quality. Polish basic legal acts related to air and climate protection are presented in table 4.2.

Table 4.2. Basic legal acts related to air and climate protection

Title	Description
Act of 27 April 2001 – Environmental Law (Official Journal of the Laws of 2017, Item 519, as amended).	The Act comprises regulations on air protection to ensure air best possible quality.
Act of 17 July 2009 on the System to Manage the Emissions of Greenhouse Gases and Other Substances (Official Journal of the Laws of 2017, Item 286, as amended).	The Act lays down: the tasks of the National Centre for Emissions Management (KOBiZE); the operating rules for the National System of Emissions Management, the rules for management of emissions of greenhouse gases and other substances; the operating rules for the National Registry of Kyoto units; the rules for trading and management of Kyoto units; the operating rules for the National Green Investment Scheme; conditions and principles of the realization of joint implementation projects within the territory of the Republic of Poland; conditions and principles of the realization of joint implementation projects and CDM projects beyond the territory of the Republic of Poland.
Act of 20 July 1991 on the Inspectorate for Environmental Protection (Official Journal of the Laws of 2016, Item 1688, as amended).	The Act establishes the State monitoring of the environment and the rights and obligations of the State with regard to monitoring the environmental status and enforcement of environmental law pertaining to air, water, nature, noise, electromagnetic fields and waste.
Act of 3 October 2008 on the Provision of Information on the Environment and its Protection, Public Participation in Environmental Protection and Environmental Impact Assessments (Official Journal of the Laws of 2016, Item 353, as amended).	The Act regulates the principles and procedures concerning the provision of information on the protection of environmental, as well as regulates issues related to environmental impact assessments and public participation in environmental protection; besides, it establishes the institutions governed by the General Director for Environmental Protection and regional environmental directors, with the aim, among others, to streamline the environmental management process.
Act of 12 June 2015 on the Greenhouse Gas Emissions Trading Scheme (Official Journal of the Laws of 2017, Item 568, as amended)	The Act establishes the governing scheme for greenhouse gas emission allowance trading towards the implementation of the Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, later amended by the European Parliament and the Council on 23 April 2009 so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community (Directive 2009/29/EC).

Source: Ministry of Environment, Poland

Air protection instruments, resulting from the above regulations, include:

- environmental quality standards, including air (requirements that must be fulfilled at a certain time with respect to the environment as a whole or its particular natural features);
- responsibility to measure substance concentrations in the air (air monitoring under the framework of the State Environmental Monitoring (PMŚ) includes studies and assessments

of air quality with reference to pollutants, aimed at observing trends at a continental and global levels);

- air quality assessment system;
- air protection programmes developed to meet acceptable standards and target levels of air substances;
- emission standards for industrial installations – emission limit values, the BAT emission levels (BAT-AELs);
- responsibility to carry out emission measurements;
- permits to use the environment;
- environmental management systems – voluntary commitments by institutions/organizations (production or service entities, the units of the financial, education and health sectors, public administration divisions, etc.) to take measures to systematically reduce environmental impacts of their activities;
- charges for emission of gases or particulate matter (fees charged constitute revenues of the National Fund for Environmental Protection and Water Management and the Voivodeship Funds for Environmental Protection and Water Management or are they assigned to municipality budgets);
- administrative fines (for exceeding polluting substance emission levels specified in permits);
- carbon dioxide allowance trading scheme;
- anti-smog resolutions adopted by local authorities (provincial parliaments), introducing restriction/ban on operation of installations with solid fuel combustion;
- obligation to provide information on air quality.

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

In Poland, the Minister of Environment is responsible for the implementation of tasks resulting from the United Nations Framework Convention on Climate Change, done at New York on May 9, 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, done at Kyoto on 11 December 1997 (Official Journal of the Laws of 2005, No. 203, Item 1684). The tasks of the Minister include the preparation/coordination of draft national strategies; monitoring of the activities of the government administration bodies and interinstitutional working teams in the field of climate policy; submission of the required reports on climate issues and supervision of the operation of the EU ETS in Poland.

At a central government level, in addition to the Minister of Environment, the following ministers – obligated to implement the strategy for sustainable development, as well as state environmental policy and climate policy into sectoral policies – are held responsible for the implementation of the United Nations Framework Convention on Climate Change (Climate Convention, UNFCCC):

- Minister of Energy – responsible for energy policy;
- Minister of Development and Finance – responsible for the implementation of the development strategy, socio-economic development of the country, economy innovation;

- Minister of Agriculture and Rural Development – responsible for the implementation of government policy in the area of agriculture/rural development;
- Minister of Infrastructure and Construction – responsible for the sectors: transport construction and housing;
- Minister of Maritime Economy and Inland Shipping – responsible for maritime economy and inland waterway transport.

The Minister of Environment engages R&D institutions to accomplish the tasks resulting from UNFCCC and the Kyoto Protocol. These are primarily:

- the Institute of Environmental Protection – National Research Institute (IOŚ–PIB), within the framework of which, the Department of Climate Protection and the National Centre for Emissions Management (KOBiZE) – the national focal point for the EU ETS – prepare reports on greenhouse gas and pollutant emissions into the atmosphere, as well as drafts of national communication and biennial reports;
- the Forest Research Institute (IBL) who is engaged in the issues of carbon sequestration in land use, land-use change and forestry (LULUCF);
- the Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB) who carries out systematic observations of climate change.

As the independent entities, the National Fund for Environmental Protection and Water Management (NFOŚiGW), together with the Voivodeship Funds for Environmental Protection and Water Management (WFOŚiGW), constitute a system of financing environmental protection in Poland. NFOŚiGW has been financing ecological undertakings of transregional character, and among others: activities on emissions reduction.

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

The basic legal act regulating matters related to fulfilling obligations, monitoring, reporting, archiving information and assessments of progress in achieving reduction goals is 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 2017, Item 286, as amended), that lies down the tasks of the National Centre for Emissions Management (KOBiZE); the operating rules for of the National System of Emissions Management; the rules for management of emissions of greenhouse gases and other substances; the operating rules for the National Registry of Kyoto units; the rules for trading and management of Kyoto units; the operating rules for the National Green Investment Scheme; conditions and principles of the realization of joint implementation projects within the territory of the Republic of Poland; conditions and principles of the realization of joint implementation projects and CDM projects beyond the territory of the Republic of Poland.

The national reporting on greenhouse gas emissions is supported by the Act of 12 June 2015 on the Greenhouse Gas Emissions Trading Scheme (Official Journal of the Laws of 2017, Item 568, as amended). The Act establishes governing a scheme for greenhouse gas emission allowance trading towards the implementation of the Directive 2003/87/Ec of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC, later amended by the

European Parliament and the Council on 23 April 2009 so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community (Directive 2009/29/EC).

The provisions of the Act of 17 July 2009 define the rules necessary for proper functioning of the greenhouse gas emission allowance trading system in Poland, as well as serve to improve and extend the EU ETS. The Act constituted the legal basis for the comprehensive monitoring of the implementation of policies and measures to reduce GHG emissions. An important role in the monitoring system is performed by KOBIZE, who has been entrusted with performing tasks related to:

- the functioning of the National System of Emissions Management;
- reporting, preparation of reports and emissions projections;
- monitoring of climate policy measures, as well as preparation of analyzes, reviews and evaluations of policy implementation;
- forecasting the effects of climate policy implementation;
- developing tools to support the achievement of the goals of the emissions management system and tools for modeling economic, financial and social impacts of climate policy;
- integration of environmental reporting systems.

The Central Statistical Office (GUS), who conducts research and makes available its results in the context of official statistics, is another body playing an important role in the implementation of reporting tasks related to greenhouse gases. Statistics include aggregated data on GHG and other air pollutants emissions, energy, fuel production and consumption and many other data related to the Climate Convention along with those on the production, import and export of ozone depleting substances.

4.3. Financial mechanisms to support measures with regard to reduction of GHG emissions

The basic institutional and financial mechanism supporting the implementation of climate policy, particularly with regard to energy efficiency improvement, renewable energy development and modernization of energy production processes, is the system of financing environmental actions managed by the National Fund for Environmental Protection and Water Management (NFOŚiGW) and the Voivodeship Funds for Environmental Protection and Water Management (WFOŚiGW) (table 4.3).

Table 4.3. Programmes funded by NFOŚiGW and WFOŚiGW in 2013–2017

Programme	Sector concerned	Short description	Implementation period
Improvement of air quality Part 2) KAWKA – Elimination of low – emission to support energy efficiency and development of distributed renewable energy sources	Health protection by improving air quality, distributed energy (RES)	Reduction of exposure of people to air pollution in the zones with pollutant (PM_{25}, PM_{10}) concentrations significantly in excess of the limit and target values, through decreasing pollutant and CO_2 emissions by improvement of energy efficiency and the use of high efficiency cogeneration and renewable energy sources.	2013–2018[1]
Improving energy efficiency Part 1) Intelligent Energy Networks (ISE)	Energy	Co-financing measures to optimize and rationalize energy consumption.	2014–2017[1]

Programme	Sector concerned	Short description	Implementation period
Improvement of air quality Part 4) LEMUR – Energy-efficient public buildings	Construction	Grants to develop design documentation and loans to partially cover the qualified costs of construction and supervision. The amount of financial support depends on the class of energy efficiency of public buildings and collective housing.	2013–2020
Effective use of energy Part 2) Co-financing investment tasks resulting in energy savings or improved enterprise energy efficiency	Industry	Co-financing projects on investments, modernization and improvements that bring about new facilities, control systems, installations and technical equipment, with the aim to improve enterprise energy efficiency, as well as upgrading existing facilities in terms of technological solutions as to installations and technical equipment.	2011–2017[1]
Support for entrepreneurs with regard to low-carbon and resource-efficient economy Part 2) Enhancement of energy efficiency	Industry	Co-financing projects with the aim to improve enterprise energy efficiency and/or upgrade existing facilities, installations and technical equipment, in conformity with the Announcement of the Minister of Economy of 21 December 2012 on a detailed list of energy efficiency improvement projects (M.P. Official Gazette, 2013, Item 15)	2014–2017[1]
Support for projects on low-carbon and resource-efficient economy Part 4) EWE – Energy efficiency in enterprises	Industry	Co-financing projects related to reduction of energy consumption, and as a consequence – reduction of CO_2 emissions – owing to measures undertaken to improve energy efficiency in enterprises. Dedicated to small entrepreneurs who are unable to obtain grants from the EU's Operational Programme Infrastructure and Environment (POIiŚ)2014–2020.	2017–2023
Improving energy efficiency Part 3) Energy-saving investments in small and medium-sized enterprises	Industry, distributed energy (RES)	Partial financing of repayment of bank loans taken out by SMEs to invest in solutions associated with energy efficiency and RES.	2014–2016
Improving energy efficiency Part 2) Subsidies for bank loans taken out to build energy-efficient homes	Construction	Partial financing of repayment of bank loans taken out; the amount of financing depends on the annual rate of individual demand for energy for heating and ventilation (EUco), calculated on the basis of the Regulation of the Minister of Infrastructure on the methodology of energy performance of building /dwelling.	2013–2018[1]
Improvement of air quality Part 3) BOCIAN – Distributed, renewable energy sources	Industry, distributed energy (RES)	Reduction/avoidance of CO_2 emissions by increasing energy production from installations using renewable energy sources.	2014–2023[2]

Programme	Sector concerned	Short description	Implementation period
SYSTEM – Support for environmental protection and water management measures, carried out by external partners Part 3) Prosument: co-financing purchasing/ setting up micro-installations producing renewable energy	Construction	Increasing energy production from renewable sources through purchasing/setting up micro- or small installations as renewable energy sources for electricity or heat generation. The programme promotes new RES technologies and prosumer attitudes. The programme is a continuation and extension of the 2014 programme "Supporting Distributed, Renewable Energy. Part 3) Partial financing of repayments of current bank loans in capital taken out by individual persons or residential communities to purchase and set up solar panels".	2014–2019 (2016: change of the programme title)
Support for renewable energy sources Part 2) Programme for renewable energy sources and high-efficiency cogeneration projects	Distributed energy (RES)	Co-financing investments, the implementation of which results in limiting or avoiding CO_2 emissions as a result of increased energy production from renewable sources.	2009–2019[1]
Support for projects pertaining to low carbon and resource-efficient economy Part 2) Co-financing of POIiŚ projects 2014–2020	Energy, construction, distributed energy (RES),	Co-financing projects positively evaluated in the framework of the Priority Axis I of POIiŚ 2014–2020	2016–2023
Support for projects pertaining to low carbon and resource-efficient economy 3) Efficient heating and cooling systems	Energy (heating)	Co-financing projects aimed at achieving the defined effective heating and cooling system in compliance with the Directive on energy efficiency	2016–2023
GIS system: Part 1) Power management in public buildings	Construction	Co-financing projects that improve energy efficiency of public buildings	2010–2018
GIS system: Part 2) Agricultural biogas plants	Agriculture, distributed energy (RES)	Co-financing agricultural biogas plants which utilize renewable raw materials	2010–2018[1]
GIS sytem: Part 3) biomass CHP and heat-only plants	Distributed energy (RES)	Co-financing modernization/construction of biomass CHP and heat-only plants with thermal output less than 20 MW.	2010–2018
GIS system: Part 4) Construction, extension and reconstruction of power grids to enable the connection of wind power generation sources (RES) to the electric power transmission network.	Energy, distributed energy (RES)	Co-financing the connection of wind power generation sources to the National Electricity System (KSE).	2010–2020[1]
GIS system: Part 5) Energy management in buildings of selected entities in the public finance sector	Construction	Co-financing undertakings that improve energy consumption efficiency in buildings of selected entities of the public finance sector.	2010–2017
GIS system: Part 6) SOWA –Energy-efficient street lighting	Infrastructure	Co-financing projects that improve energy efficiency of street lighting systems.	2013–2017[1]
GIS system: Part 7) GAZELA – Low-carbon transport	Transport	Co-financing projects on decreasing energy and fuel consumption in urban transport	2013–2018[1]

Programme	Sector concerned	Short description	Implementation period
GIS system: Part 2) GEPARD – No-emission public transport	Transport	Co-financing undertakings aimed at reducing energy and fuel consumption in public transport	2017–2020
Support for projects with regard to low carbon and resource-efficient economy Part 1) E-KUMULATOR – Ecological Battery for Industry	Industry	Co-financing projects with the aim to: reduce consumption of primary raw materials or/and to limit/avoid emissions (CO_2, SO_2, NO_x and PM), not included in the Announcement of the Minister of Economy of 21 December 2012 on a detailed list of projects aimed at improving energy efficiency (M.P. Official Gazette 2013, Item 15).	2015–2023
Improvement of air quality. Part 1) The use of geothermal resources	Energy	Increasing energy production from renewable energy sources through construction and extension of geothermal CHP and heat-only plants	2016–2025
Improving air quality Part 2) Reducing energy consumption in construction industry	Construction	Co-financing undertakings aimed at reducing energy consumption (utility, final and primary), and thus reducing CO_2 emissions by facilities, such as: hospitals, care and treatment centers, nursing homes, hospices, shelters, museums, student homes, sacred objects, as well as those associated with religious worship, caring for, bringing up and education	2016–2022
SYSTEM – Support for activities concerning environmental protection and water management implemented by external partners. Part 2) REGION	No sectoral restrictions	Co-financing projects on environmental protection/water management included in action plans of Voivodeship Funds for Environmental Protection and Water Management (e.g. RES and energy efficiency activities).	2015–2020

[1] The tasks of the concluded contracts are realized under the programme framework. No co-financing new tasks is available.
[2]Programme suspended due to legislative changes

Source: NFOŚiGW, WFOŚiGW

In the context of both financial perspectives 2007–2013 and 2014–2020, under the EU Operational Programme Infrastructure and Environment (POIiŚ), there have been implemented in Poland the projects which result in GHG emissions reduction, energy efficiency increase, promotion of renewable energy sources and adaptation to negative effects of climate change.

For example, under the POIiŚ 2007–2013 Priority Axis IX, there were promoted highly-efficient energy production and distribution, as well as thermo-modernization of public utilities. The National Fund for Environmental Protection and Water Management (as the Implementing Institution) participated in spending € 378 million from the EU funds.

Within POIiŚ 2014–2020 (Priority Axis I Low-emission economy) – the total EU allocation exceeds 1.8 billion euro. The projects supported within the POIiŚ Axis managed by the Minister of Energy, include among others:

- energy generation from renewable energy sources, including their connection to the grid,
- promotion of energy efficiency and use of renewable energy sources in enterprises,
- promotion of energy efficiency in public buildings and residential housing sector,

- efficient distribution of heat and cold;
- highly efficient cogeneration;
- reducing emissions in urban areas.

The Ministry of Environment, as the Intermediate Body for POIiŚ Priority Axes, has participated in the activities aimed at supporting environmental monitoring and combating negative effects of climate change. Within the framework of the POIiŚ 2007–2013 Priority Axis III, Resource management and counteracting environmental risks, there were implemented the projects related to water retention and flood safety (the total allocation exceeded 600 million euro – including 516 million euro from the EU funds). Under the Priority Axis III, there also were supported the activities on prevention/reduction of natural hazards, prevention of major accidents, environmental monitoring (in total: nearly 50 million euro). Besides, under the Priority Axis IV POIiŚ 2007–2013 Initiatives aimed at adjusting enterprises to the requirements of environment protection, there were supported undertakings focused on adapting entities to environmental protection requirements, including propagation and implementation of the environmental management systems, the use of BAT as well as reduction of emissions to air, water and soils. Over € 500 million (including the EU funds = € 152 million) budget was allocated to support actions aimed only at air protection.

Under POIiŚ 2014–2020, as part of the Priority Axis II Environmental protection, including adaptation to climate change, there has been implemented the measure (2.1) concerning adaptation to climate change in terms of disaster preparedness and resilience as well as environmental monitoring. Its aim is to increase water retention and to improve the efficiency of identification and response in the event of natural hazards and major accidents. There will be promoted the implementation of the projects aimed at strengthening resilience to threats related to climate change and increasing prevention/preparedness/response to natural hazards to which Poland is particularly vulnerable, i.e. floods and droughts. The allocation for this measure (EU contribution) amounts to 700 million euro.

Furthermore, low-carbon activities, co-financed by the EU, have been implemented within the framework of the Regional Operational Programmes and the Rural Development Programme, managed by the local self-governments and the Minister of Agriculture and Rural Development, respectively.

4.4. Financial Mechanism of the European Economic Area and the Norwegian Financial Mechanism 2009–2014

Non-refundable financial assistance has been available for Poland in the form of two instruments: the EEA Financial Mechanism and the Norwegian Financial Mechanism. The donor states are three EFTA countries: Norway, Iceland and Liechtenstein. Both Mechanisms comprise uniform rules and procedures, and are subject to one management and implementation system. At present, the Ministry of Development is the National Focal Point and coordinates the management and implementation of the mechanisms.

Environmental Operational Programmes under the European Economic Area Financial Mechanism and the Norwegian Financial Mechanism 2009–2014 include:

- Operational Programme PL02 "The protection of biological diversity and ecosystems";
- Operational Programme PL03 "Improving environmental monitoring and inspection";
- Operational Programme PL04 "Saving energy and promoting renewable energy sources".

The scope of PL02 programme "The protection of biological diversity and ecosystems" focuses on:

- improved management and monitoring of Natura 2000 sites;
- enhancement of resistance of native ecosystem to invasive alien species;
- raising social awareness on biodiversity as well as education in this area, in conjunction with climate change and the economic value of ecosystems.

PL03 Programme "Improving environmental monitoring and inspection" is focused on improving the quality and reliability of environmental assessments and information, as well as strengthening compliance with Poland's environmental regulations, by supporting activities of public administration responsible for environmental monitoring and inspection. As a result of the programme implementation, the monitoring of environmental status has been improved on a national scale, through the implementation of new tools and techniques for conducting research and assessments along with upgrading those already applied. As a result, there was improved dependability of the results obtained, at the same time as the quality and reliability of environmental assessments, which is essential for environmental management at all administration levels.

PL04 Programme "Energy Saving and Promoting Renewable Energy" constitutes, above all, financial support for the following tasks:

- improving energy efficiency in buildings;
- increasing public awareness/education on energy efficiency;
- increasing energy production from renewable sources;
- reduction of waste production and emission of pollutants into air, water and land.

The main beneficiaries of the projects are:

- municipalities, hospitals, as well as convalescent clinics and universities in the area of improving energy efficiency in buildings,
- municipalities and hospitals – renewable energy production,
- CHP plants, chemical plants and milk powder plants – reduction of waste production and pollutant emissions into the air, water and soil.

Exemplary projects implemented under PL 04 Operational Programme in the years 2014–2017 are presented in table. 4.4.

Table 4.4. Projects implemented under PL04 Operational Programme in the years 2014–2017

Project	Main objective	Number of activities	Implementation period	CO_2 reduction [Mg/year CO_2]		
				2015	2016	2017
Thermo-modernization of buildings	improvement of energy efficiency in buildings	94	2014–2017	354.02	6 989.84	102 795.28
Renewable energy sources	increase of energy production from renewable sources	5	2014–2017	0	0	10 688.29
Exhaust emissions *	reduction of waste production and emission of pollutants into air, water and soil	24	2014–2017	0	0	230 505.51

*The reduction of CO_2 emissions is addressed in 7 projects out of 24 implemented (CO_2 reduction level has not been established for the remaining projects)

Source: NFOŚiGW

4.5. Climate and energy package

In December 2008, the climate and energy package was endorsed and launched the implementation of the climate change targets adopted by the European Council in 2007, which assume that by 2020 the European Union will:

- reduce greenhouse gas emissions by 20% compared to 1990 levels;
- increase the share of renewable energy in the final energy consumption to 20%;
- increase energy efficiency by 20% compared to the projections for 2020 (non-mandatory target);
- increase at least by 10% the share of biofuels in total consumption of transport fuels.

The energy and climate package includes the following legal acts:

- 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, known as the European Union Emissions Trading System (EU ETS) (OJ L 140 of 5.6.2009, p. 63);
- Decision No 2009/406/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (OJ L 140 of 5.6.2009, 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 1013/2006 (OJ L 140 of 5.6. 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 (so-called the RES Directive) (OJ L 140 of 5.6.2009, 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 (OJ L 140 of 5.6.2009, p. 88).

In the context of the work on the reform of the EU ETS, two additional legislative acts were adopted, which will affect the total EUA pool by 2020, i.e.:

- Decision (EU) 2015/1814 of the European Parliament and of the Council of 6 October 2015 concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and amending Directive 2003/87/EC (so-called the MSR Decision) (OJ L 264 of 9.10.2015, p. 1);
- Commission Regulation (EU) No 176/2014 of 25 February 2014 amending Regulation (EU) No 1031/2010 in particular to determine the volumes of greenhouse gas emission allowances to be auctioned in 2013-20 (OJ L 56 of 26.2.2014, p. 11).

4.6. Policies and measures and their effects

This chapter outlines the key national policies and measures with an impact on Poland's commitments to reduce GHG emissions by 2020, that will be binding after the ratification of the Doha Amendment to the Kyoto Protocol by Poland. A summary of the policies and measures related to GHG emissions/removals is presented in Annex 1, table 3.

4.6.1. Cross-sectoral policies and measures

Implementation of the Greenhouse Gas Emissions Trading Scheme (EU ETS)

As required by the Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 and its amendments, the emission trading scheme was implemented in Poland. The latest amendment to the Directive was introduced by the provisions of the Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009. The amendments made to the Directive 2009/29/EC have significantly altered the functioning of the EU ETS. The new EU ETS rules have been valid since 1 January 2013. The principal reason behind the amendments is the establishment of the EU's new ambitious reduction targets.

Since 2013, the auctioning of allowances has been the main principle of allocation of allowances in the EU ETS. In the previous accounting periods, the EU ETS system was based in principle on free allocation of emission allowances, established on the basis of historical emission values, whereas allowance sale was used to a limited extent.

Directive 2003/87/EC was transposed into Poland's national law by the Act of 22 December 2004 on greenhouse gases (GHG) and allowances trading in the emission of other substances (Emission Trading Act, Official Journal of the Laws No. 281, item 2784, as amended; repealed) and the Act of 17 July 2009 on the management of emissions of GHG and other substances (Emission Management Act, Official Journal of the Laws No. 122, Item 695 and Official Journal of the Laws of 2013, Item 1238; repealed). The Act of 12 June 2015 on Greenhouse Gas Emissions Trading Scheme (Official Journal of the Laws of 2017, Item 568) transposed into national law the Directive 2003/87/EC and the amendments introduced under the Directive 2009/29/EC.

The number of installations covered by EU ETS and overall CO_2e emissions in the EU ETS, in the years 2008–2016, are presented in table 4.5.

Table 4.5. The number of installations and aircraft operators participating in the EU ETS and the value of CO_2e emissions, under the EU ETS in the years 2008–2016, when compared to GDP

Year	Number of installations	GHG emission from installations [t CO_2e]	Number of aircraft operators	GHG emission from aviation [t CO_2e]	Total GHG emission [t CO_2e]	Change of CO_2 eq. emissions compared to previous year [%]	GDP (fixed prices)[3] previous year=100
2008	832	204 107 419	0	0	204 107 419	-2.63	103.9
2009	828	191 174 249	0	0	191 174 249	-6.34	102.6
2010	810	199 726 907	0	0	199 726 907	4.47	103.7
2011	811	203 026 525	0	0	203 026 525	1.65	105.0

[3] Data in accordance with the methodology of the European System of National and Regional Accounts (ESA 2010). Fixed prices of the previous year were used as fixed prices.

Year	Number of installations	GHG emission from installations [t CO_2e]	Number of aircraft operators	GHG emission from aviation [t CO_2e]	Total GHG emission [t CO_2e]	Change of CO_2 eq. emissions compared to previous year [%]	GDP (fixed prices)[3] previous year=100
2012	764	196 636 280	12	641 424	197 277 704	-2.83	101.6
2013	784	205 735 395	7	616 587	206 351 982	4.60	101.3
2014	769	197 129 387	7	629 899	197 759 286	-4.16	103.3
2015	737	198 700 536	6	591 020	199 291 556	0.77	103.8
2016	727	198 051 726	5	749 946	198 801 672	-0.25	102.7

Source: KOBiZE, IOŚ–PIB

The aviation sector was included into the EU ETS in 2012. The number of aircraft operators varied in the years 2012–2016, depending on undertaken aviation activities under the EU ETS, the range of which also changed between the year 2012 and the period 2013–2016. Only air operations within the European Economic Area are now included in the system.

The number of installations under the EU ETS slightly fluctuated due to the inclusion of new installations meeting the criteria for participation in the ETS or else – installation exclusion from the Scheme, as a result of the cessation of activities or the decrease of threshold values related to production capacity of installations not qualified for participation in the Scheme, otherwise caused by the installation merger/split.

In the third accounting period (2013–2020), substantial changes were made to the rules for the allocation of allowances. The allocation of free emission allowances was restricted to the installations where no electricity was generated. The exception to this rule is the allocation of emission allowances under Art. 10c of the Directive 2003/87/EC, the so called derogation. Poland is one of the countries that meets the criteria defined as: the dependence of electricity production on one type of fossil fuel, at a level of more than 30%, and GDP per capita less than 50% of the average EU GDP. This results in granting allowances to electricity producers in Poland. The total amount of emission allowances granted to Poland under derogation is approx. 404.65 million EUA (the maximum number of free emission allowances in 7 years); this will be gradually reduced to zero in 2020.

The implementation of derogation required the adoption of a national investment plan (NIP). In the case of Poland, the National Investment Plan (KPI) covers mainly investments related to new installations for electricity production and modernization of old power generation units. In addition, KPI aims to limit the increase in energy prices that could occur in the absence of derogation.

For non-electric installations, EU-wide harmonized allocation rules based on emissions quotas for the product, heat, fuel and process emissions, as defined by the European Commission in the Commission Decision of 27 April 2011 determining transitional Union-wide rules for harmonised free allocation of emission allowances pursuant to Article 10a of Directive 2003/87/EC of the European Parliament and of the Council (notified under document C(2011) 2772). Main differences in the approach to allocating free allowances between the commitment periods are shown in table 4.6.

Table 4.6. Comparison of allocation rules between the first, second and the third trading periods

Principles for allocation of allowances	
I and II trading period	**III trading period**
National allowance limits	Allowance limit at a EU level
Fixed allowance limit	Free allowance limit is reduced every year. The allocation of free allowances for installations not exposed to the risk of "carbon leakage" is decreased from 80% in 2013 to 30% in 2020; allowance limit is 100% in the case of "carbon leakage" installations (fixed limit).
3- and 5-year trading periods	8-year trading period
Limited auction to pool to 5% – 10% of the national allowance limit	More than half of eligible emission allowances for sale though auction (i.e. auction pool)
Free allocation of allowances for industry and electricity production	Transitional free allowances for industry and heat production (no allowances for electricity generation)
Free allocation based on emissions at an installation level	Free allocation based on a historical production level (*Historical activity level* -HAL) and emission factor
Free allocation based on historical emissions	Free allocation based on actual production data and relevant emission factor
-	Mechanism of allowance adjustment: – significant increase in production capacity; – significant reduction in production capacity; – total cessation of activity; – partial cessation of activity.
Legal basis: – Directive 2003/87/EC; – national allocation plans; – EC decision on NAP; – the decision to load the NAP table into the general Community register.	Legal basis: – Directive 2003/87/EC as amended; – rules on the harmonized allocation of allowances in the EU, laid down in the Decision 2011/278/EU (CIMs – Community-wide Implementing Measures) – National Implementing Measures – national allocation table.

Source: KOBIZE, IOŚ–PIB

Effort Sharing Decision (ESD)

For the sectors not covered by the EU ETS (non-ETS), greenhouse gas emissions limits (the so-called national limits on non-ETS emissions) are laid down in the Commission Decision of 26 March 2013 on determining Member States' annual emission allocations for the period from 2013 to 2020 pursuant to Decision No 406/2009/EC of the European Parliament and of the Council (notified under document C(2013) 1708). The national limits for the period 2017–2020 were further adjusted by the Commission Decision (EU) 2017/1471 of 10 August 2017 amending Decision 2013/162/EU to revise Member States' annual emission allocations for the period from 2017 to 2020 (notified under document C(2017) 5556). Under provisions of this decision, in the period 2013–2020, Poland is allowed to produce a total of 1.59 billion t CO_2 from non-ETS sectors.

Consistent with legislation, management of **annual emission allocations (AEA)** is based on a strategy prepared at a national level. The strategy is developed by the minister responsible for the environment and then agreed it with the members of the Council of Ministers. The Council of Ministers adopts the strategy by a resolution. The strategy contains the assumptions and guidelines for the methodology for accounting and projecting greenhouse gas emissions not covered by the emissions trading scheme, taking into account:

1) actual greenhouse gas emissions not covered by the emission trading scheme in a given year, in the Republic of Poland and other Member States of the European Union;

2) projected for subsequent years national greenhouse gas emissions not included in the emission trading scheme in the Republic of Poland and other Member States of the European Union;

3) the price of Kyoto units, AEA values, temporary certified emission reductions (tCERs) and long-term certified emission reduction (lCER);

4) geographical distribution of the projects related to the units referred to above (point 3);

5) volume of demand and supply of units on the EU and international markets;

6) trends in the movement of greenhouse emissions covered by the EU ETS beyond the Scheme.

It is estimated that Poland will meet own reduction target under ESD (+14% compared to ESD emissions in 2005) with a significant surplus, which will be cumulative from year to year in the period 2013–2020. After accounting performed for 2013 and 2014, the aggregate AEA surplus totaled about 21 million AEAs (table 4.7).

Table 4.7. Assessment of ESD emissions in relation to annual emission allowances (AEA) in the years 2013–2014

Specification	**CO_2 emission [t CO_2e]**		
	2013	**2014**	**Total surplus**
AEA limit	193 642 822	194 885 546	
ESD emission	186 095 049	181 543 023	
Surplus	7 547 773	13 342 523	**20 890 296**

Source: Commission Implementing Decision (EU) 2016/2132 of 5 December 2016 on greenhouse gas emissions for each Member State for the year 2013 covered by Decision No. 406/2009/EC of the European Parliament and of the Council

Commission Implementing Decision (EU) 2017/1015 of 15 June 2017 on greenhouse gas emissions covered by Decision No. 406/2009/EC of the European Parliament and of the Council for the year 2014 for each Member State

National Green Investment Scheme (GIS)

The National Green Investment Scheme (GIS) was derived from the emissions trading mechanism. The concept and purpose of the Scheme is to generate/strengthen the pro-ecological effect, resulting from the transfer of the surplus of Assigned Amount Units (AAUs).

The GIS is a mechanism linking sales of AAUs to investments that reduce GHG emissions and allows selling AAUs to countries or entities (authorized by the countries), committed to meet their Kyoto Protocol reduction targets. The legal framework for the National Green Investment Scheme in Poland was laid down in the Act of July 17 2009 on the management of emissions *of* greenhouse gases and other substance (Official Journal of the Laws of 2017, Item 286). The Act regulates the functioning of the GIS, also in terms of organization patterns and project selection. Additionally, the regulation by the Council of Ministers of 20 October 2009 (Official Journal of the Laws No. 187, Item 1445) defines the projects and programmes to be implemented under GIS. These include projects to avoid/reduce greenhouse gas emissions, as well as those on emission

removals, carbon sequestration, adaptation to climate change, and other measures related to air protection. Selecting specific areas is always negotiated with the buyer.

The Minister of Environment has so far signed eleven contracts on AAUs sales, amounting in total to more than 196 million euro.

The revenues from AAU sales are allocated for co-financing tasks related to the support of projects implemented within the framework of programmes and projects covered by the National Green Investment Scheme. Table 4.8 presents priority GIS programmes implemented.

Table 4.8. Priority programmes implemented under GIS

Programme	Period of implementation	GHG emission reduction [kt CO_2e]	
		year 2015	year 2020
Energy management in public buildings	2010–2018	94.7	101.2
Agricultural biogas plants	2010–2018		161.5
Biomass CHPs and heating plants	2010–2018	10.6	26.7
Construction, extension and reconstruction of power grids to enable the connection of wind power generation sources (RES – renewable energy sources)	2010–2020	*	1 335.3
Energy management in selected public finance sector buildings	2010–2015	10.6	83
SOWA – Energy-efficient street lighting	2013–2017	4.8	26.2
GAZELA – Low-carbon urban transport	2013–2018	*	0.8
GEPARD – Emission-free public transport	2017–2020	*	**

* effect after 2015
** effect after 2020
Source: NFOŚiGW

4.6.2. Sectoral policies and measures: Production and consumption of energy

4.6.2.1. Legal basis

In the Energy policy of Poland until 2030, adopted by the Council of Ministers on 10 November 2009, the following basic directions for energy development were defined:

- Improvement of energy efficiency;
- Increased security of fuel and energy supply;
- Diversification of electricity generation structure – introduction of nuclear power;
- Expansion of the use of renewable energy sources;
- Development of competitive fuel and energy markets;
- Reduction of energy impact of on the environment.

Enhancement of energy efficiency is a priority. The main goals in this area are to maintain zero-energy economic growth and to consistently reduce the energy intensity in Polish economy down to the EU-15 level.

Financial support will be given to the development of efficient and low-carbon technologies, which will allow to obtain liquid and gaseous fuels from domestic raw materials.

The main tools for implementing the current energy policy include:

- legislation regulating operation of the fuel and energy sector and establishing technical standards;
- systemic mechanisms to support the implementation of measures aimed at achieving the energy policy basic goals (e.g. "certificates" market, tax reductions and exemptions);
- constant monitoring the fuel and energy markets by the President of the Office of Competition and Consumer Protection as well as the President of the Energy Regulatory Office and taking intervention in conformity with the competences held;
- information activities carried out by the governmental authorities and co-operating R&D institutions;
- public support, including the EU funds, for the implementation of energy projects, relevant on a national scale (e.g. investment projects, research and development).

Table 4.9. Main documents and legal acts concerning the energy and industry sectors in Poland

Legal act	Description
Energy Policy of Poland until 2030, established by the Minister of Economy in the Announcement of 21 December 2009 on the state energy policy 2030 (M.P No. 2, Item 11)	The document includes a long-term strategy for development of the energy sector, a forecast of fuel and energy demand, and the action plan until 2012. The implementation of the solutions indicated in the document will help to meet growing energy demand, develop production and transport infrastructures and lessen dependence on natural gas and oil external supplies, as well as fulfill international environmental commitments
Energy Law Act of 10 April 1997 (Official Journal of the Laws of 2012, Item 1059, as amended)	The Act laid down the rules on the production and use of energy and saving its resources; it stresses the role of "Green certificates" in promotion of the use of renewable energy sources; it also establishes certificates of origin of energy produced in cogeneration[4]
Act of 20 May 2016 on Energy Efficiency (Official Journal of the Laws of 2016, Item 831)	The Act defines the principles for the development of a national energy efficiency action plan and establishes the rules for obligatory obtaining energy savings and carrying out the enterprise energy audit. The Act also identifies the tasks of public sector entities in terms of energy efficiency, introduces changes to the white certificate system – energy efficiency certificates, which confirm the implementation of measures on determined energy savings. In terms of energy efficiency, the Act specifies the targets to be achieved by public sector bodies/entities by 2020.
Act of 14 September 2012 on obligation to provide information on energy consumption by energy-using products (Official Journal of the Laws of 2012, Item 1203, as amended)	The Act defines obligations in connection with providing information on the consumption of energy and other essential resources by energy-using products. The requirements concerning the preparation of technical documentation and labels/fiches for these products and with regard to their impact on energy consumption are determined in the EC Decisions. The Act lays down the rules for organization/performance of the control system of providing relevant information.
Act of 20 February 2015 on Renewable Energy Sources (Official Journal of the Laws of 2015, Item 478)	The Act is aimed at: shaping mechanisms and instruments supporting the production of electricity, heat or cold, or agricultural biogas in RES installations; determining the optimum and sustainable end-user supply in electricity, heat or

[5] High-efficiency cogeneration is the generation of electric or mechanical energy and utility heat in cogeneration, which saves primary energy. According to the Energy Law Act, the support for high-efficiency cogeneration was possible until 31 December 2012. Currently, the Government of the Republic of Poland proposes extending the support for high-efficiency cogeneration by 2015, i.e., support for the existing principles of electricity and heat production in high-efficiency cogeneration technology. The draft of the amendment of the Energy Law in this area was adopted by the Council of Ministers on 2 January 2013.

Legal act	Description
	in agricultural biogas from RES installations; creating new jobs as a result of the increase in the number of new RES installations; ensuring the use of energy by-products or residues from agriculture and industry using agricultural raw materials.
Act of 20 May 2016 on Investments in wind power plants (Official Journal of the Laws of 2016, Item 961)	The Act specifies conditions and procedures for the location and construction of wind turbines and conditions for the location of wind turbines in the vicinity of existing or planned housing developments.
"*National reform programme for the implementation of the Europe 2020 strategy – update 2017/2018",* adopted by the Council of Ministers on April 25, 2017.	The document identifies the most important measures for the years 2017–2018, that will supporting economic growth, competitiveness and employment.
Act of 25 August 2006 on biocomponents and liquid biofuels (Official Journal of the Laws of 2015, Item 775)	Amendment to the regulations, included in the Act of 21 March 2014 amending the Act on biocomponents and liquid biofuels and some other acts (Official Journal of the Laws of 2014, Item 457) as regards the issues arising from the mandatory goal of the Directive 2009/28/EC, i.e. 10% share of renewable energy in transport by 2020, as well as the issues related to establishment of sustainability criteria for biocomponents and liquid biofuels. Compliance with these criteria, including the sources of raw materials for the production of biocomponents, the minimum levels of GHG emissions reductions for biocomponents as well as their verification will be a condition for their inclusion in the implementation of the National IndicativeTarget and financial support for the production of biocomponents as well as the use of them in liquid fuels and liquid biofuels. The amendment introduced registration obligations for newly defined entities, as well as new regulations concerning the reporting of selected entities operation on the market of biocomponents and liquid biofuels; this will enable more efficient monitoring of the market due to the establishment of legislation on the need to meet sustainability criteria.
Act of 25 August 2006 on fuel quality monitoring and control system (Official Journal of the Laws of 2014, Item 1728, as amended)	As of 1 January 2007, the Act allowed vehicles and machinery (group of at least 10 types of vehicles) to use biofuels with an increased share of biocomponents.
Act of 27 May 2011 Amending the Act on the Monitoring System and the quality control of fuels and certain other acts (Official Journal of the Laws No. 153, Item 902, as amended) and the Regulation of the Minister of Economy of 7 February 2012 amending the regulation on quality requirements for liquid fuels (Official Journal of the Laws of 2012, Item 136)	Legislation amendment allowed for using diesel oil with a content of up to 7% fatty acid methyl esters (so-called fuel B7).
Act of July 11, 2014 Amending the Act on the Monitoring System and the quality control of fuels and certain other acts (Official Journal of the Laws of 2014, Item 1088) and the Regulation of the Minister of Economy of 3 November 2014 amending Regulation on quality requirements for liquid fuels (Official Journal of the Laws of 2014, Item 1547)	The Act implements the provisions of the Directive 2009/30/EC of 23 April 2009 of the European Parliament and of the Council, as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions as well as regards the increase of the permitted amount of biocomponents in gasoline from 5% to 10% (E10 petrol). Following the entry into force of the Act, implementing measures were established, as regards the quality parameters for E10 gasoline.
Act of 6 December 2008 on excise duty (Official Journal of the Laws of 2014, Item 752, as amended)	The Act sets out excise tax rates for motor gasoline and diesel fuel.

Legal act	Description
Resolution No. 134/2007 of the Council of Ministers of 24 July 2007 on the "Multiannual Programme for the Promotion of Biofuels or Other Renewable Fuels for the Years 2008–2014" (M.P. No. 53, Item 607)	The Resolution's objective is to create favorable conditions for the production and use of biofuels in Poland. The programme includes measures to support biocomponents and liquid biofuels production as well as those aimed at increasing demand for biofuels. The overall goal is to achieve the share of biocomponents in the market of transport fuels of at least 10% in 2020 (indirect targets: 7.1% in 2013, 7.55% in 2014).
Resolution No. 15/2014 of the Council of Ministers of 28 January 2014 on the multiannual programme "The Programme of the Polish Nuclear Power" (M.P., *Official Gazette* Item 502)	The Programme of the Polish Nuclear Power (PEJ) sets out the agenda for the construction of two nuclear power plants and the preparation of regulatory and organizational infrastructure for these investments. The document defines the roles and responsibilities of the institution appointed for the implementation of the Programme and the issues related to nuclear safety and radiological protection. The Programme also includes: economic validation of nuclear power plant operation in Poland, possibilities of its financing and the methods of dealing with spent fuel and radioactive waste.
"Development directions of agricultural biogas plants in Poland in the years 2010–2020" adopted by the Council of Ministers on 13 July 2010.	The main objective of the document is to optimize the legal and administrative system for establishing agricultural biogas plants in Poland and to indicate the possibility of co-financing of such installations from public funds, both national and European, available within national and regional operational programmes. The document assumes that by 2020, in each Polish municipality, on average one biogas plant using agricultural biomass will be established, assuming that the municipality has adequate conditions for starting such a project. In 2020, the total capacity of the biogas plants installed shall be 980 MW.
Strategy "Energy security and the environment – a 2020 vision" adopted by the Council of Ministers on April 15, 2014.	The Strategy sets out the objectives of national policy on sustainable development, until 2020. The specific objectives and directions of the Strategy are: (i) sustainable management of environmental resources; (ii) safe domestic economy and competitive energy supply through improving energy efficiency and upgrading the energy sector; (iii) improvement of the environment through, inter alia, air protection, i.e. lessening energy impacts, promoting Polish energy technologies and supporting new solutions and promoting pro-environmental attitudes.
Responsible Development Strategy adopted by the Council of Ministers on 14 February 2017.	The Strategy defines a new model of economic, social and spatial development by 2020 in the perspective 2030. The specific objectives set out concern, inter alia, supporting low-carbon activities and energy efficiency measures.

Source: Ministry of Environment, Poland

4.2.6.2. Measures in the production and consumption of energy sector

Enhancing the use of renewable energy sources, including biofuels

The national targets as regards the renewable energy share in the transport, electricity, heating and cooling sectors in 2020, were adopted on 7 December 2010, in the document entitled: "National Action Plan for energy from renewable sources", which was amended by the "Supplement to the National Action Plan for energy from renewable sources", adopted by the Council of Ministers on 2 December 2011.

The Plan identifies the measures to be taken to achieve the national overall RES targets for final energy consumption, i.e. 15% of the share of renewable energy in gross energy consumption (figure 4.3). It is assumed that an increase in the share of renewable energy in Poland will be due to the greater use of biomass and wind energy.

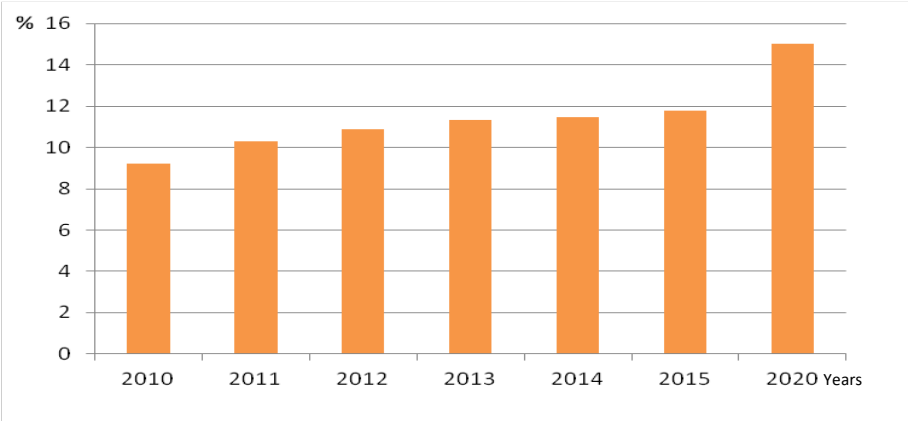


Fig. 4.3. RES energy share in gross final energy consumption in 2010–2015 and 2020, source: Central Statistical Office (GUS)

In order to support the expansion of energy from renewable sources in Poland, a system of instruments has been implemented, including the obligation to purchase energy from renewable sources and the obligation to obtain and after that to submit to the President of the Energy Regulatory Office, the so-called "green certificate", otherwise to pay a compensation fee. The adopted Act of February 20, 2015 on Renewable Energy Sources (Official Journal of the Laws of 2015, Item 478) contains solutions aimed at sustainable development of renewable energy in Poland, by optimizing the flow of funds for individual RES technologies.

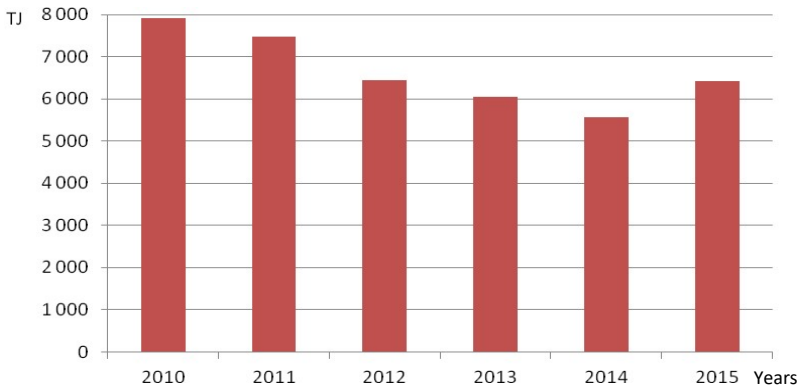


Fig. 4.4. Bioethanol use in 2010-2015, source: Central Statistical Office (GUS)

The minimum required contribution of biocomponents in transport fuels was determined in the Regulation of the Council of Ministers on National Indicative Targets for 2013–2018 (Regulation of the Council of Ministers of 23 July 2013, Official Journal of the Laws of 2013, Item 918). The results of targets implementation in Poland are presented in figure 4.4.

Nuclear Power Programme for Poland

By 2035, two nuclear power plants, with combined installed capacity of 6000 MW, are due to be completed, subsequent to necessary arrangements with regard to the regulatory and organizational infrastructure associated with these investments. As a result of impediments in Programme implementation, there have been ongoing the works on amending the Programme. The deadline agreed for completing the work is set out for the end of 2017. The Committee for Nuclear Power Development has been appointed with the aim to coordinate the Programme implementation.

National Energy Efficiency Action Plan for Poland 2014

The National Energy Efficiency Action Plan for Poland 2014 was developed on the basis of the Act on Energy Efficiency of April 15, 2011 (Official Journal of the Laws No. 94, Item 551, as amended) and adopted in October 2014. The Action Plan includes the approved and planned measures to improve energy efficiency in a range of economy sectors – necessary to achieve the final energy savings in 2016 amounting to < 9% of the average national final energy consumption in the years 2001–2005. In addition, it outlines the measures to achieve 20% savings in primary energy consumption in the EU by 2020.

Over the past several years, the energy intensity of GDP has decreased significantly, and Poland's gap to the European average achieved for key energy efficiency indicators has decreased to a dozen or so percent, however, the gap is still significant as compared to the most effective economies. Poland's industrial sector, who improved indicator values due to favorable structural changes, was the main contributor to energy efficiency increase.

The following priority measures were identified as most contributing to energy efficiency improvement:

Horizontal measures:

1) Energy efficiency obligation system (white certificates);
2) Priority Programme: Intelligent Energy Networks;
3) Development and implementation of intelligent distribution systems for medium and low voltage levels;
4) National Energy Efficiency and Renewable Energy Advisory Programme;
5) Information and education campaigns focused on energy efficiency.

Among other sectors, the Construction and Housing are perceived as the sectors with a considerable potential to reduce energy intensity, thus – greenhouse gas emissions, at comparatively the greatest and most profitable levels.

Measures on energy efficiency of buildings and energy efficiency in public institutions:

1) Tightening requirements with regard to energy savings and building insulation, through inter alia: lowering the maximum permissible value of the indicator of building annual demand for

non-renewable primary energy for heating, ventilation, cooling, production of hot utility water and lighting;

2) Assessment of building energy performance. An obligation has been made for the creation and placement of an energy performance certificate in a visible place for buildings occupied by the judicial authorities, public prosecutor's offices and public administration bodies;

3) Thermo-modernization and Renovation Fund – upgrading of public utilities and residential buildings. Support in the form of repayment of the portion of the loan taken out to implement the project on thermo-modernization of the building, including renovation works carried out in multi-family residential buildings, the use of which began before 1961;

4) Green Investment Scheme – energy management in public buildings and energy management in buildings of selected public finance sector entities;

5) Promotion of energy efficiency, smart energy management and the use of renewable energy sources in public infrastructure, including public buildings and those residential;

6) Subsidies for loans for the construction of energy efficient homes;

7) Energy saving and promotion of renewable energy sources (programme PL 04 "Energy saving and promotion of renewable energy sources", implemented under EEA and Norwegian Financial Mechanisms). Thermo-modernization of public buildings and modernization or replacement of existing sources of energy by modern, energy-efficient and ecological sources of heat or electricity (including RES), and installation, upgrading or replacement of heat distribution centers in public buildings. Establishment of a requirement to analyze the feasibility of using highly efficient alternative energy and alternative energy supply systems from renewable sources, including heat pumps;

8) *Swiss-Polish Cooperation Programme.* Goal 2: Improvement of energy efficiency and reduction of emissions, in particular greenhouse gases and hazardous substances;

9) Programme LEMUR – Energy Efficient Public Buildings;

10) Programme SOWA – Energy efficient street lighting;

11) Awareness raising among managers, owners and users of buildings in terms of energy savings. Promotion of activities leading to energy savings.

Energy efficiency measures in transport:

1) Urban transport in metropolitan areas. Development of intelligent transport systems,

2) Green Investment System: GAZELA – Low carbon urban transport.

Measures concerning efficiency of energy production and supply:

1) Promotion of low-carbon strategies for all types of areas, in particular for urban areas, including support for sustainable multimodal urban mobility and adaptation measures with climate change mitigating effects;

2) Promotion of high-efficiency cogeneration of heat and electricity, in proportion to the demand for utility heat.

Clean Transport Package

The Clean Transport Package, endorsed in Poland at the beginning of 2017, consists of three pillars: the Electromobility Development Plan in Poland (areas and stages of electromobility development, with the proposal of intervention tools), the National framework for alternative fuel infrastructure development (objectives and tools for infrastructure development), and establishment of the Low-Carbon Transport Fund (a financial instrument supporting producers and consumers of vehicles powered by alternative fuels).

Basic assumption of the Electromobility Development Plan, adopted on March 16, 2017, is achieving 1 million electric vehicles in Poland by 2025. It is important to undertake projects concerning electrification of public transport that are essential in reducing emissions from transport and improving air quality in cities.

According to the Plan, Poland's electromobility development should be divided into three stages, differentiated by the market maturity degree and that of necessary involvement of the state:

- The first, preparatory stage (until 2018) will concern setting out regulations and targeted public funding for electromobility development.
- In the second stage (2019–2020), in selected agglomerations, there will be built electric power supply infrastructure and the incentives for purchasing electric vehicles (EV) will be strengthened. There is expected commercialization of the results of electromobility research started in the first stage, as well as the implementation of new business models of widespread adoption of electric vehicles.
- In the third stage (2020–2025), the electromobility market is expected to reach maturity, which will enable gradual withdrawal of support instruments.

The Low-Carbon Transportation Fund will finance projects related to electromobility development (vehicles powered by electricity) and transport based on alternative fuels (CNG, LNG, biofuels and other renewable fuels). As projected, the Fund will receive annual subsidy from the state budget, amounting to 0.5% to 1.5% of revenue from the excise tax on motor fuels in the previous year, as well as funds provided by the operator of the power transmission system in the amount of 0.1% of justified return from the capital employed in the business activity regarding transmission of electricity.

In 2017, as part of the implementation of the Package:

- the letters of intent were signed with 41 cities with regard to electromobility development;
- strategic programming documents were adopted, i.e. Electromobility Development Plan in Poland (16 March), National framework for the development of alternative fuels (29 March). The concept of the Low Carbon Transportation Fund was positively reviewed by the Economic Committee of the Council of Ministers;
- the National Centre for Research and Development launched the Non-Emission Public Transport Programme;
- the draft law on electromobility and alternative fuels was agreed, which creates a market framework (e.g. defines a new service: vehicle loading) and the framework for development of alternative fuel infrastructure;

- the draft law on biocomponents and biofuels and some other aspects was prepared; the Low-Carbon Transportation Fund (state-owned special purpose fund) constitutes amendment to national law.

Support for the use of methane from hard coal mines to produce electricity and heat

There has been observed a gradual development of the economic use of captured methane in heat and power installations. Measures to increase utilization of methane from coal deposits include:

- support for electricity produced in high-efficiency cogeneration, using sources of combustion of gaseous fuels (methane released and deposited at underground mining works in active and liquidated coal mines), by granting violet certificates to producers of energy in methane or biogas-fired cogeneration units;
- developing cost-effective methane recovery and utilization as a source of clean energy from the hard coal mining industry, landfill sites, waste water management, agriculture and oil and gas systems – works realized under the Global Methane Initiative.

Reduction of methane emissions from fuel production and distribution

Legislation has been issued concerning fuel transport safety, requiring operators of liquid fuel facilities to set up installations for the hermetic storage, as well as tank filling/emptying with the use of first class oil products, so as to control annual losses of petroleum products in the liquid fuel storage facilities to less than 0.01% of their capacity[5].

4.6.3. Sectoral policies and measures: industrial processes and product use

Greenhouse gas emissions from industrial processes are covered by the EU ETS – the basic policy pertaining to GHG emissions reduction in the industry sector. In addition, measures have been taken to increase energy use efficiency and to enhance renewable energy use in industrial processes, as discussed in the section on energy production and consumption. Measures concerning emissions of fluorinated greenhouse gases are presented below.

Use of fluorinated greenhouse gases

The use of fluorinated greenhouse gases and products, equipment and systems containing fluorinated greenhouse gases is regulated by the Act of 15 May 2015 on substances depleting the ozone layer and some fluorocarbons (Official Journal of the Laws of 2015, Item 881) implementing the provisions of the Regulation (EC) No 1005/2009 of the European Parliament and of the Council of 16 September 2009 on substances that deplete the ozone layer (EU Official Journal L 286, 31.10.2009, p. 1, as amended) and Regulation (EC) No 842/2006 of the European Parliament and of the Council of 17 May 2006 on certain fluorinated greenhouse gases (OJ L 161, 14.6.2006, p. 1, as amended). These concern inter alia:

- obligations of entities conducting economic activity related to production and services connected with the use of substances that deplete the ozone layer and fluorinated greenhouse gases,

[5] Regulation of the Minister of Economy of 21 November 2005 on technical conditions that should be met by liquid fuel bases and stations, long-distance industrial pipelines for crude oil and oil-products and their localization (Official Journal of the Laws No. 243, Item 2063, as amended)

- sanction for violation of regulations on substances that deplete the ozone layer and fluorinated greenhouse gases and the products, equipment, fire protection systems and fire extinguishers, as well as air conditioning systems on certain motor vehicles containing such means,
- establishment of a certification system for persons performing specific activities and undertakings comprising specific activities connected with fluorinated greenhouse gases and ozone depleting substances;

The measures undertaken with regard to fluorinated greenhouse gases will significantly reduce emissions to the atmosphere of certain fluorinated greenhouse gases in the refrigeration, air conditioning, fire protection and electricity sectors.

4.6.4. Sectoral policies and measures: transport, construction and housing

4.6.4.1. Legal basis

Transport

The development of transport has mainly been focused on carrying-over the establishment of the efficient system of routes, as well as improving conditions for sustainable development, for better exploitation of the existing economic, social and territorial potential so as to contribute to modern and competitive economy. The main priorities were: linking major economic centers in Poland with a network of expressways and highways, modern rail networks; ensuring communication links in European networks (within the TEN-T network); improving the transport system quality and enhancing its development in conformity with the principles of sustainable development, and strengthening the role of public transport in public service.

In Poland, road transport and passenger air traffic were relatively the fastest growing categories of the transport sector. In relation to air transport, Poland reinforced efforts to establish the Single European Sky package (European Commission initiative – SES), with the focus on the Single European Sky ATM Research (SESAR) programme to provide the future technology (next-generation air traffic management system).

Strategic, programme and legal framework

The Transport Development Strategy by 2020 (with perspective by 2030), adopted by the Council of Ministers on 22 January 2013, sets out the objectives and directions of intervention and enables the implementation of the medium- and long-term development strategies of the country. The objectives and directions of measures identified in Poland's and the EU's strategic documents are addressed in this document as well.

The main objective of the above Strategy is to increase territorial accessibility, improve safety of traffic participants and enhancement of transport sector efficiency by creating a coherent, sustainable and user-friendly transport system in the local, national, European and global dimension. One of the specific objectives is to "reduce the negative impact of transport on the environment". With regard to climate, EU climate policy is addressed, including reduction of GHG emissions in the context of adapting to the requirements as regards the infrastructure and transport services.

The Act of 6 December 2006 on the principles of implementing the development policy impose obligations on bodies preparing development strategies and programmes to include: environmental protection issues, public participation in environmental protection as well as environmental impact assessments. In addition, the process of implementing operational programmes is linked to the requirement to follow the procedures concerning environmental impact assessment in the case of projects co-financed by national or regional operational programmes.

A number of the EU's regulations is applied in Poland's transport, including those related to vehicle environmental standards. Reference may be made to the regulations on limiting CO_2 emissions from new passenger cars (443/2009) and vans (510/2011) as well as still amended provisions concerning type-approval of motor vehicles and engines with regard to emissions (EURO6/VI) or the Directive on development of alternative fuels for transport (2014/94). These are supplemented by the national legislation, among others, the Act of 16 December 2010 on public transport (Official Journal of the Laws of 2016, item 1867, as amended), which defined the obligation to develop plans for sustainable development of public transport (transport plans) – in case public transport organizers plan to undertake activities for the public interest. When awarding a public contract for the performance of public transport, definite specifications of the contract may include, above all, quality standards and the availability of services, including technical solutions used in transport means to ensure environmental protection. An obligation was also placed on public transport organizers to meet requirements for transport means, including modern technical solutions, consequently, the operators are required to take into account gaseous emission factors and energy consumption when purchasing vehicles for public transport services; in 2011 this obligation was imposed on all road vehicles purchased under public procurement procedures.

Construction, housing, spatial management and planning

Construction/housing is considered one of the sectors with the greatest and most cost-effective potential to reduce energy intensity and, in the long term perspective, to considerably reduce non-renewable energy consumption, and thus – to reduce of GHG emissions.

The implementation of housing policy is decentralized and is subject to decisions of local self-governments[6]. According to legislators, law amendments, together with increased requirements as regards thermal protection of buildings, stimulate measures to reduce construction energy intensity, improve the characteristics of the entire sector in view of the reduction of non-renewable fuel consumption, environmental protection, safety, as well as thermal comfort.

Strategic, programme and legal framework

The measures undertaken made possible the implementation of the provisions of the Directive 2010/31/EU of 19 May 2010 on the energy performance of buildings, which says that by 31 December 2020 all new buildings should be nearly net zero energy buildings (nZEBs), whereas by 31 December, 2018 – all new buildings occupied/owned by public authorities. The definition of a building with nearly zero energy consumption, i.e. a building with a very high energy performance and characteristic of the most efficient installation/construction solutions and the use of energy from renewable sources, will constitute the standard for all newly erected buildings. The changing

[6] In over 90% it is an individual or commercial construction. Construction investments are subject to the provisions of the Construction Law and construction supervision.

provisions take into account the development of the construction sector and they are gradually establishing the optimal requirements also with regard to costs.

As of 1 January 2009, as a result of the amended Act of July 7, 1994, the Construction Law (Official Journal of the Laws 2010, No 243, item. 1623), a system for evaluating the energy performance of buildings was implemented, by means of energy performance certificates and the protocols from the inspection of heating systems and air conditioning. Since 9 March 2015, the provisions of the Act of 29 August 2014 on the energy performance of buildings has been the legal basis for this system. The relevant provisions of the Act of 7 July 1994 on Construction Law were therefore repealed.

On 9 March 2015, there was launched the Central Register of the energy performance of buildings, as a result of the entry into force of the Act of August 29, 2014 on the energy performance of buildings. The Register issues the energy performance certificates and control protocols for heating and air conditioning systems. The Register gathers data on eligible persons authorized to inspect the heating or air-conditioning systems, as well as data (including those on basic energy consumption) on buildings occupied by the judicial authorities, public prosecutor offices and public administration bodies whose usable area exceeds 250 m^2, and in which the service is rendered to the clients.

There has been in force, the Regulation of the Minister of Internal Affairs and Administration of 16 August 1999 on technical conditions for the use of residential buildings, which specifies the technical conditions for the use of residential buildings, together with associated installations and technical facilities. The provisions of the Regulation also legalize periodic building inspections, including those on building components, the damage of which may cause environmental hazards.

The Regulation of the Minister of Infrastructure of 12 April 2002 on the technical conditions to be met by buildings and their location was also amended. Energy efficiency issues are included in the Section X "Energy savings and thermal insulation" and in Annex 2 to the Regulation. The regulation concerns new and existing buildings, which are subject to extension, reconstruction and use change. The purpose of legal regulations is to design and erect buildings with the systems of heating, ventilation, air conditioning, utility hot water (in the case of public buildings – also lighting), so that the amount of heat, cold and electricity needed for their intended use can be maintained at a reasonably low level. The amended content of the Regulation has been in force since 1 January, 2014, however, the Regulation assumes gradual tightening of the provisions. The requirements have been formulated so that different ways of supplying energy can be used, provided that technical standards are met, and the regulations require the use of systems with higher energy efficiency.

In December 2016, a mandatory for the EU's Member State review of the minimum energy performance requirements for buildings was commissioned by the Ministry of Infrastructure and Construction. In addition, an expert opinion was prepared to determine the feasibility of energy efficiency improvement measures in buildings, depending on their purpose. The outcome of these activities will constitute a contribution to future legislative work aimed at further improving the energy performance of buildings in Poland.

On 3 October 2013, there entered into force the Regulation of the Minister of Transport, Construction and Maritime Economy of 25 April 2012, amending earlier Regulation on detailed

scope and form of the construction project. For all newly designed buildings, it is mandatory to develop, at the stage of preparation of building design, an analysis of various building solutions for heat, including high-efficiency alternative systems using energy derived from renewable sources and heat pumps.

The National Plan to increase the number of low-energy buildings, adopted on 22 June 2015, addresses the issue of energy efficiency in a comprehensive way. The Plan defines a low-energy building and actions for government administration to promote low-energy buildings and to increase the share of renewable energy in new and existing buildings. The Plan also provides information and guidance to investors, as well as designers and contractors, with regard to building design and construction/reconstruction in a way that ensures energy efficiency.

Under the National Action Plan on Energy Efficiency For Poland 2014, a document entitled "Support for Investment in Modernization of Buildings" was prepared and amended in December 2016, whose main objective is to specify possible to implement measures to improve the energy performance of the buildings in use. This action will contribute to reducing the annual energy demand for heating and ventilation, hot water preparation, cooling and building lighting.

In addition to legislative actions towards improving the energy performance of buildings, a guidebook has been developed to improve the energy performance of buildings. The guidebook aims to summarize information on available measures to improve the energy performance of categorized buildings in terms of their types, as well as to disseminate knowledge on energy efficiency of buildings.

Description of the most important Polish documents in the field of transport, construction/housing and spatial management in Poland are presented in table 4.10.

Table 4.10. Legislation as regards transport, construction, and spatial management in Poland

Legal act	Description
The Concept of Spatial Development of the Country 2030, adopted by the Council of Ministers on December 13, 2011	The document sets out the directions of activities in spatial policy, and one of these is increasing the protection against extreme natural and anthropogenic events, including those related to climate change. One of the goals is dedicated to changes in the spatial planning system, giving grounds for, among others, restraining uncontrolled suburbanization.
The Transport Development Strategy by 2020 (with perspective by 2030), adopted by the Council of Ministers on 22 January 2013 (detailed in the Implementing Document adopted by the Council of Ministers on October 13, 2014)	Strategy is a basic planning document for the development of the transport sector in the medium term (2020/2030). Achieving the main objective (described above) involves five objectives specific to each of the transport sectors: creating a modern, coherent transport infrastructure network; improving organization and management of the transport system; improving safety of traffic users and goods transported; limiting the negative impact of transport on the environment; building a rational model for financing infrastructure investments. In order to reduce the negative impact of transport on the environment, there are projected measures concerning system organization/operation, investments, technology and innovation.
National Railway Programme until 2023, adopted by the Council of Ministers on 15 September 2015, updated on 23 November 2016.	The National Railway Programme (KPK) is a multiannual programme that defines financing as to railway lines(including EU funds and national funds). The document implements strategies adopted by the Council of Ministers with regard to improving the technical condition and current parameters of railway infrastructure. KPK replaced the Multi-Year Railway Investment Programme, which was in force in the years 2011–2015. The overarching

Legal act	Description
	objective of the Programme is to strengthen the role of rail transport in the integrated transport system of the country by creating a coherent and a modern railway network. This includes mitigation of negative impacts on the environment.
National Road Construction Programme for 2014-2023 (with a view to 2025), established on September 8, 2015; amended on 25 May, 2017 r., 20 June 2017 and 12July 2017	Poland implements further road infrastructure development programmes. The Road Programme is defined as the medium term, and includes the financial framework for planned investments.
National Road Safety Programme 2013–2020 adopted by the National Road Safety Council on 20 June 2013.	This is a programme of activities undertaken by the government administration, aimed at implementing, in the field of road safety, the main objective and specific objectives of the "Vision zero" adopted by Poland. The programme is a diagnostic and assessment of the road safety status in Poland, and takes into account Polish and European modalities of road safety programmeming
"Assumptions to the development plans for inland waterways in Poland for 2016–2020 with a perspective to 2030", adopted by a resolution of the Council of Ministers on June 14, 2016 (M.P. Oficial Gazette 2016, Item 711)	The document sets the direction of the national inland water policy. It is the basis for the development of plans for modernization or construction of missing sections of the most important waterways in Poland. The document presents an analysis of the current status of the major national inland waterways and focuses on actions aimed at restoring their transport and economic functions, i.e. setting out shipping parameters consistent with at least IV class of navigability and meeting inland waterway infrastructure requirements for TEN-T.
Act of 16 March 1995 on the Prevention of Pollution from Ships (Official Journal of the Laws of 2017, Item. 2000)	The Act supports the application of the requirements of the EU Regulation 2015/757 and transposes into Polish law the MARPOL convention which addresses, among others, energy efficiency of ships. The Regulation 2015/757 lays down provisions for the monitoring, reporting and verification of CO_2 emissions and other relevant information from vessels arriving at ports under the jurisdiction of the EU Member States (within or out of those ports). The aim is to reduce maritime transport emissions in a cost-effective manner.
Operational Programme "Infrastructure and Environment 2014-2020"	Financial support for transport projects takes place within the priority axes: III Development of the TEN-T road network and multimodal transport IV Road infrastructure for cities V Development of rail transport in Poland VI Development of low-carbon transport in cities
National TSI Control-command and Signalling Implementation Plan	The "National Implementation Plan for TSI Controll-command and Signalling" replaced the "National Implementation Plan for ERTMS", dated March 2007. The new plan was developed in 2017 on the basis of Art. 6 sec. Article 4 (4) of Commission Regulation (EU) No 2016/919 of 27 May 2016 on the technical specification for interoperability relating to the Railway Control Subsystems in the European Union. The most important element of the plan is the establishment of the deadlines for the implementation of the ERTMS system on individual railway lines in Poland. The cost-benefit analysis of the system is also part of the plan. The information provided in the plan will allow railway undertakings to carry out appropriate scheduled train investments in the context of equipping rail vehicles with ERTMS on-board equipment.
Programme for the development of airports and aerial equipment networks approved by Resolution No. 86/2007 of the Council of Ministers of 8 May 2007	The conditions set out for the development of air transport, including its infrastructure, are largely due to environmental reasons. The development of airports requires an integrated approach to environmental issues, notably the maximum reduction of airborne noise and the planned spatial management of the area around airports, as a necessary condition for reducing noise nuisance and the inclusion of aerodromes in the intermodal transport network, their impact.

Legal act	Description
Regulation of the Minister of Infrastructure and Construction of 8 December 2016 amending the regulation on the public transport sustainable development plan for the communication network in interwar Poland and international passenger transport in rail transport (Official Journal of the Laws of 2016, Item 1996)	The plan sets out the basic principles for the functioning and development of inter-government and international passenger services as regards public transport on the market under the principles of regulated competition. The plan is based on the decisions of the governmental strategic documents defining the country's development, in which, in the case of rail transport, there is pointed out, inter alia, the need to minimize the negative impact on the environment.
Regulation of the Minister of Transport, Construction and Maritime Economy of 25 April 2012 on the detailed scope and form of the construction project (Official Journal of the Laws of 2012, Item 462, as amended)	The Regulation specifies the detailed scope and form of the construction project, which forms the basis for issuing a building permit decision. The amended content imposes an obligation to take into account prior to the commencement of construction, if available – technical, environmental and economical possibilities of the implementation of high efficiency alternative systems using renewable energy and heat pumps.
The Act of 21 November 2008 on the Promotion of Thermo-modernization and Renovation (Official Journal of the Laws of 2017, Item 130, as amended).	The Act defines the principles of partial reimbursement of the costs incurred during implementation of thermal-modernization projects as well as due to undertakings related to thermal-modernization during implementation of renovation projects, by the Thermo-modernization and Repair Fund (financed by the State Budget).
Regulation of the Minister of Infrastructure of 12 April 2002 on technical conditions to be met by buildings and their location (Official Journal of the Laws of 2015, Item 1422)	The regulation specifies the technical conditions to be met by the buildings and related equipment, the location on the building site and the development of plots for development. The regulations concern design, construction and reconstruction as well as changes in usage of buildings. Section X together with Annex 2 to the Regulation deals with energy savings and thermal insulation. The application of substantive rules contributes to reducing energy consumption in the construction sector, thus GHG emissions reduction.
Regulation of the Minister of Internal Affairs and Administration of 16 August 1999 on technical conditions for the use of residential buildings (Official Journal of the Laws No. 74, Item 836, as amended)	The Regulation specifies the technical conditions for the use of residential buildings and related installations/technical equipment, including the provision of adequate technical condition of building components, taking into account their environmental impact.
Act of 29 August 2014 on the energy performance of buildings (Official Journal of the Laws of 2017, Item 498)	The Act specifies the principles of preparation of energy performance certificates, the rules of control of the heating system and the air conditioning system in buildings. It provides the rules for the implementation of the central register of the energy performance of buildings and specifies the statutory delegation to develop a National Action Plan to increase the number of buildings with low-energy consumption
National Plan to increase the number of buildings with low energy consumption (M.P. Official Gazette 2015, Item 614)	The Plan includes: the definition of low-energy buildings and their specific features; government actions undertaken to promote low energy buildings, including the design, construction and reconstruction of buildings in an energy-efficient way, and increase in the share of renewable energy in new and existing buildings as well as the timetable for achieving the above targets.
National Housing Programme (Resolution of the Council of Ministers No 115/2016 as of September 27, 2016 on the adoption of National Housing Programme)	The Programme is among the autonomous instruments supporting the implementation of the „Strategy for Responsible Development by 2020 with a further perspective until 2030 r." Its main objective is to take advantage of the investment potential of the Polish economy to secure qualitatively and quantitatively the citizen housing needs at the level which takes into account the demographic, social and economic challenges that our country faces, while assuming the necessity to continue the sustainable socio-economic development. One of the four priorities of the Programme is to provide modern, energy efficient and technically safe houses. Within the framework of the above priority, regulatory measures have been undertaken relevant to technical standards of the new and existing dwelling stock as well as measures to support the improvement of technical status of the dwelling stock with the aim to increase energy

Legal act	Description
	performance of houses, while taking advantage of products of ecological house construction. The planned activities cover financial support for the overhaul and thermal modernization investments as well as a review of regulations pertaining to technical parameters which affect energy efficiency of the dwelling stock.
The Act of 9 October 2015 on revitalization (Journal of Laws of 2017, item 1023)	The Act sets out the rules and procedures for preparing, conducting and evaluating the revitalization of degraded areas, including areas requiring application of appropriate solutions with regard to energy efficiency of construction works and environmental protection.

Source: Ministry of Infrastructure and Construction

In view of the adoption of new macroeconomic strategy documents, such as the Responsible Development Strategy and the Transport Development Strategy, as well as due to the ongoing programming of the new EU Financial Perspective 2014–2020, the planning documents will be updated or replaced by new development and operational programmes implementing the above documents.

4.6.4.2. Measures in the transport sector

Actions undertaken in the transport sector can be systematized as follows:

Package for road transport

1) The construction of motorways and express roads continues. The investments are aimed at ensuring the continuity of road infrastructure, and thus allows smooth traffic on long routes. Roadside urban bypasses have been also being implemented to eliminate transit traffic from urban areas and improve traffic flow. Eliminating bottlenecks and road congestion contributes to reducing road transport emissions.

2) Improvement of energy efficiency and emissions of road vehicles through reduced emission limits for light vehicles Euro 6 and heavy vehicles Euro VI, as well as annual reduction of CO_2 emissions limits for new passenger cars and commercial vans registered in the EU. Also, the system of technical tests vehicles/trailers contributes to the elimination of inefficient and out-of-date vehicles, which aggravate the energy and emission efficiency in this category of transport. Tolls for vehicles with a maximum permissible mass of over 3.5 tons depend on the Euro emission class in certain sections of the motorway network, expressways and national roads. The environmental charges differ depending on the type of vehicle and fuel, and significantly cheaper gas fuels can influence the decision to replace the vehicle with a more environmentally friendly vehicle. Since 2011, there is an obligation to apply additional energy and emission criteria for purchasers of vehicles to provide public passenger transport services, as well as the obligation to provide information on fuel consumption and CO_2 emissions by vehicles offered for sale or lease.

3) Promotion of collective transport in cities and their functional areas. Action includes: widespread establishment of traffic preferences in the form of bus lanes, giving priority at intersections, financial support for the replacement and modernization of public transport stock, integration of links, travel and ticket information for various public transport operators and the construction of Park&Ride infrastructure. Integrated Territorial Investments initiative, a new form of cooperation between local self-governments, is of particular importance for the development of sustainable, efficient transport linking the city and its functional areas.

4) Optimal traffic management, based on integrated spatial, transport and low-carbon planning and propagation of traffic management systems, including the implementation of Intelligent Transportation Systems in 11 cities and two Regional Transport Unions, as well as the support of logistics services. With regard to cities, it is crucial to optimize the speed of traffic, parking policy and to support urban logistics services.

5) Enhancing environmentally conscious attitudes of drivers and users of transport services through the promotion of environmentally friendly driving techniques (through unprofessional/professional driving trainings, driving license tests) along with social campaigns such as the European Mobility Week and Car-Free Days. There are also carried out many projects addressed to drivers and passengers, e.g. ad hoc joint car-pooling (such as the Bla Bla Car initiative or Otodojazd.pl).

6) Propagation of the use of alternative fuels, including biofuels and gas fuels: LPG (Liquefied Petroleum Gas), LNG (Liguefied Natural Gas), CNG (Compressed Natural Gas). Also, there have been launched the instruments for low-carbon vehicle purchase by public entities, e.g. buses powered by natural gas or hybrid and electric vehicles (figure 4.5). At present, LPG consumption in transport is about 1.8 million tons/year, which is about 12%–15% of the transport fuel market. The number of LPG loading stations established is 5.39 thousand, available for about 3 million LPG vehicles. The number of CNG loading stations is 26 (in more than 20 cities, there operate natural gas-powered buses), and the annual consumption of CNG by 3.6 thousand vehicles amounts to about 18 million m^3. With regard to electricity powered vehicles, in 2014, there were 45 electric vehicles and 3887 hybrid vehicles in use. At present, there are about 305 publicly accessible charging stations. Further development of the use of alternative fuels, will be based on the *National framework for the development of alternative fuels infrastructure* adopted by the Council of Ministers on March 29, 2017, promoting the dynamic development of the energy supply infrastructure for vehicles with gas fuels and charging stations for electric vehicles, as programmed in the document.

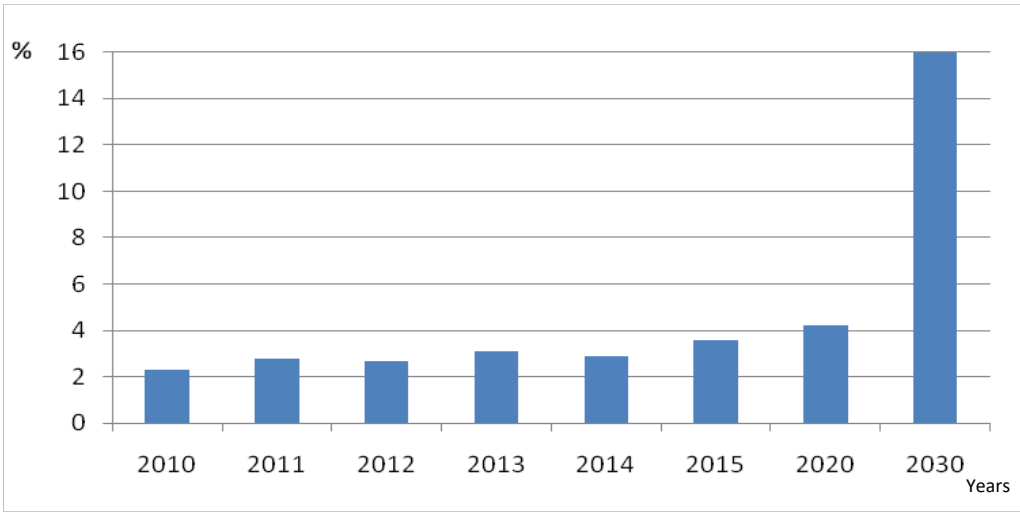


Fig 4.5. Share of buses for alternative fuel in the total number of buses serving urban transport, Source: strateg.stat.gov.pl.

7) Supporting the development of non-motorized transport, in particular dynamically developing bicycle traffic. Traffic rules changed on promoting and improving the safety of

bike users and above all, investments are made in bicycle routes, service areas and parkings and city bike networks (currently, there operate over 30 bike network systems, mainly in large cities, e.g. in Wrocław, Kraków, Poznań, Warsaw, Opole, Sopot, Białystok, Szczecin, Lublin, Toruń, Rzeszów, Bydgoszcz, Bielsko-Biała, Katowice, but also in smaller ones such as Grodzisk, Konstancin-Jeziorna or Juchnowiec Kościelny). These investments are carried out by local government units, but also by infrastructure managers, such as the General Directorate for National Roads and Motorways (GDDKiA). In the years 2014-2020, voivodeships will allocate approximately EUR 375,5 million for bicycle transport. One of the largest projects currently being implemented is the "Eastern Green Bicycle Route Velo", which will comprise 2 thousand km of routes located in five Polish voivodeships: Warmińsko-Mazurskie, Podlasie, Lubelskie, Podkarpackie and Świętokrzyskie. Project funding amounts to PLN 297.5 million, of which PLN 236.3 million is co-financed by the European Regional Development Fund.

Package for rail transport

1) Modernization of railway infrastructure: lines and nodes, stations and stops. In the years 2007-2013, almost 5 billion euro was invested in railway lines, and for the period 2014–2020 financing amounts to 9.53 billion euro.

2) Modernization of stock for passenger and freight transport, e.g. support for the purchase of locomotives including multi-system locomotives, train sets and light rail vehicles (including subways and trams) and carriages. In addition, since the beginning of 2012, locomotives and motor carriages have been subjected to stricter (IIIB) requirements as regards emission limits compliant with the Regulation of the Minister of Economy on detailed requirements for combustion engines in relation to reduction of gaseous and particulate pollutants by these engines (Official Journal of the Laws of 2014, Item 588).

3) Strengthening inter-branch integration by supporting the upgrading of intermodal terminals, stock and logistics services (e.g. operator services in the "port to door" system – rail transport between Tri-City ports and conventional terminals (Kąty Wrocławskie) as well as broad gauge terminals (Sławków). Between 2007 and 2013, more than € 145 million was allocated for the construction and modernization of intermodal terminals, as well as the purchase of necessary equipment and rolling stock. In the new perspective, five times more funds were allocated for this purpose. It will be possible to finance, for example, the reconstruction of terminals located in logistic centers (not only railway, but also sea ports).

Fig. 4.6. Share of intermodal transport in the total rail transport. Source: strateg.stat.gov.pl.

4) Promotion of rail transit by developing public transport based on key transport axes operated by rail (rail and metro) and integration of other passenger services (connections, Park&Ride, Kiss&Ride); detailed scope of a plan for sustainable development of public transport in domestic and international passenger railway transport set out in regulations issued by the Minister responsible for transport; integration of travel/ticket information from various operators (Joint Ticket initiative); financial support for infrastructure modernization/development; exchange and modernization of rolling stock for public transport (under previous operational programmes and new current financial perspective).

5) Modernization of rail traffic management systems, including the implementation of the European Rail Traffic Management System (ERTMS) –this will enhance the safety and operational efficiency of rail transport, the transport system's sustainability will be supported, followed by decreased negative impacts on people and the environment. Implementation projects have been realized. The rail sector is preparing to use financial resources dedicated to research and development as part of the European Commission initiative SHIFT2RAIL, aimed at replacing a part road transport with rail transport.

Package for domestic air transport

1) Improvement of operational efficiency by optimizing air corridors as well as increasing taxiway capacity. This way fuel consumption can be reduced to 15%, and therefore, CO_2 emissions can be reduced. To make this possible, it is necessary to expand and develop Asynchronous Transfer Mode (ATM), which will improve air traffic safety by reducing the number of voice calls and errors in transmitted information. This can be supplemented by the Airport Collaborative Decision Making Solution (A-CDM system), which supports airport services co-operation towards sharing information on current and the anticipated situation at the airport.

2) Polish LOT Airlines established operating procedures in accordance with the Continuous Descent Approach (CDA) system. The CDA procedure makes it possible to reduce the landing time at increased engine power, resulting in a reduction in carbon dioxide emissions.

3) Gradual implementation of the Single European Sky ATM Research System (SESAR), including the integration of airspace through the establishment of the Functional Airspace Blocks, as well as the implementation of SESAR technology. These activities contribute to improving the efficiency and capacity of the Air Traffic Management (ATM) system while maintaining a high level of security and financial savings. The application of modern technologies and procedures will, among others, reduce negative impacts on the environment.

4) Functional Airspace Block (FAB) is one of the most important elements of the Single Sky initiative. This solution allows for reaching maximum capacity and efficiency of the air traffic management network in Europe, maintaining a high level of security, reducing flight durations and delays in air transport.

Package for international air transport

1) Improved operational efficiency, aircraft certificates and flight optimization as described above (domestic air transport).

2) Investing in modern technology and systematic upgrading of the fleet, e.g. purchasing Boeing 787 Dreamliner by LOT Polish Airlines – high-performance passenger jet designed for long-distance flights – which fuel and significantly reduces CO_2 emissions.

3) Inclusion in the EU ETS – the use of the economic mechanisms contained in the emissions trading system is expected to control CO_2 emissions in aviation. It is crucial to connect the system with market mechanisms, which provides the opportunity to remain competitive and not impose additional charges on carriers, and consequently on passengers. Attempts to move away from these mechanisms can decrease the effectiveness of the system.

Package for inland waterway transport

1) Modernization of existing waterways on the Odra and Vistula Rivers (implemented within the Operational Programme Infrastructure and Environment).

2) Modernization of the fleet financed under the Inland Waterway Fund: co-financing the purchase, modernization or reconstruction of ships as well as other undertakings towards upgrading the inland waterway sector. Support is provided to ship owners introducing innovative technical solutions, which also improve the conditions and safety of their work. Modernization measures may be affected by fees collected from vessels using environment, an these depend on vessel production date and type of fuel used.

3) Introduction of emission limits for internal combustion engines in inland waterway transport, compliant with the Regulation of the Minister of Economy of April 30, 2014 on specific requirements for internal combustion engines as regards the reduction of emissions of gaseous and particulate pollutants by these engines (Official Journal of the Laws of 2014, Item 588).

Package for maritime shipping

1) In July 2011, the International Maritime Organization (IMO) introduced into the International Convention for the Prevention of Pollution from Ships, 1973/1978 (MARPOL Convention) (Official Journal of 2016, item 761, 1979 and 1449) operational and technical

measures, in particular the Energy Efficiency Design Index (EEDI) for new ships and the Ship Energy Efficiency Management Plan (SEEMP), which will limit the increase in greenhouse gas emissions from part of the world's commercial fleet. Poland immediately transposed these requirements into national law. They are in force compliant with the provisions of the Act of 16 March 1995 on the Prevention of Pollution from Ships (Official Journal of the Laws of 2017, item 2000), as a result of ratification of amendments to the MARPOL Convention. However, SEEMP and EEDI do not yet guarantee the absolute reduction of greenhouse gas emissions from international shipping, to the extent that the global temperature increase would be limited to 1.5°C. Because of this, Poland continues to actively support and implement further emission reduction measures emerging in the global arena. On 28 October 2016, the IMO Marine Environment Protection Committee (MEPC) adopted amendments to MARPOL Annex VI (Air Pollution Prevention Regulations) for a global fuel consumption data collection system. The amendments will enter into force on 1 March 2018. According to the global amendments, fuel consumption reporting will begin in 2020. A mandatory data collection system is to be the first step in a three-step process where the analysis of the data collected would be the basis for an objective and transparent debate on the reduction. possible emissions to be achieved in global shipping. This will allow you to make a decision on further measures to increase energy efficiency and reduce greenhouse gas emissions from international maritime transport. During the MEPC 71 session (July 3–7, 2017), a draft outline of the global IMO strategy for reducing greenhouse gases from maritime transport was developed, as well as reduction targets for shipping, emission reduction scenarios, and other measures to reduce greenhouse gas emissions. The strategy is to complement the global actions stemming from the Paris Agreement, adopted on December 2015, when 195 countries agreed a legally binding global climate agreement. Instruments and arrangements for the reduction of emissions from shipping are implemented in the national law on a regular basis – in coherence with the solutions that result from the EU regulations. The agreed efforts to reduce CO_2 emissions from shipping at EU level resulted in the establishment of a monitoring, reporting and verification (MRV) system for CO_2 emissions from fuel consumption by ships. The establishment of this system is the first step in the approach to address emissions from maritime transport in the EU's commitment to reduce greenhouse gas emissions, together with emissions from other sectors that already contribute to the fulfillment of this obligation. The MRV was established by Regulation (EU) 2015/757 of the European Parliament and of the Council of 29 April 2015 on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport and amending Directive 2009/16/EC. Reinforcing the effective implementation of the requirements of this regulation in Poland has been made through appropriate amendments to the Act on the prevention of pollution from ships.

2) For the purpose of monitoring vessel traffic, including management and supervision of ship movements, the National Vessel Traffic Monitoring System and the Transmission of Information, were addressed in the Act of 18 August 2011 on Maritime Safety (Official Journal of the Laws of 2015, Item 611, as amended). Effective traffic management is tailored to optimize navigation towards lower emissions to the air.

3) Intermodal infrastructure in seaports: within the framework of the Transport Development Strategy until 2020 (2030 perspective), following the adoption of the Responsible

Development Strategy and the Programme for the Development of Polish Seaports until 2020 (2030 perspective), there were established modalities for adapting the infrastructure of selected port terminals to handle intermodal transport and expanding alternative fuel infrastructure, including LNG. At the same time, investments are made to improve the availability of ports from the sea.

4.6.4.3. Measures undertaken in the construction and housing sector

The measures taken in the construction and housing sectors are primarily focused on improving energy efficiency of buildings, and therefore, they are indicated in the National Energy Action Plan for Poland 2014 (reg. manufacturing and energy sectors). One of the planned activities is the Urban-Building Code, which will provide a framework for conducting spatial policy by local self-governments contributing to GHG emissions reduction and adaptation to climate change.

Urban-Building Code

Counteracting the effects of climate change and adapting to the effects of these changes are the principles of spatial management, which will be implemented by the legislative act of the draft Urban-Building Code. The Code will enable:

- shaping appropriate conditions of sunlight and ventilation in urban areas,
- reducing the energy consumption and transport intensity of the settlement network,
- minimizing potential losses associated with natural disasters, in particular floods, droughts and natural geological hazards by means of spatial planning tools,
- counteracting the fragmentation and disappearance of elements of the natural system, among others, in order to ensure adequate air quality and climate control, e.g. by application of urban standards in the area of access to urban green and blue infrastructure through developing appropriate regulations on the share of biologically active areas.
- increasing the efficiency of the use of technical infrastructure networks,
- putting an emphasis on investment operation through a network of technical infrastructure, allowing for meeting the requirements of air protection.

It should be stressed that the planning of measures depends on the initiative of local self-governments, so it is not possible to directly translate the regulations dedicated to climate change proposed in the Code to the level of expected effects.

4.6.5. Sectoral policies and measures: agriculture

4.6.5.1. Legal basis

Basic principles of rural development policy in the EU for the years 2007–2020, as well as support instruments that can be used by the Member States and regions, are set out 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 21.10.2005 p.1) for rural development policy for the period 2007 to 2013 and for Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 december 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation

(EC) No 1698/2005 (OJ L 347 20.12.2013 p.487) for rural development policy for the period 2014 to 2020[7].

The above programmes support rural development by the EAFRD and form the basis for the implementation of measures based on the concept of multifunctionality of agriculture and rural areas. Main provisions and programme documents, including environmental protection in Polish agriculture, are presented in Table 4.11.

Table 4.11. Basic legal acts and programme documents defining actions aimed at environmental protection in Polish agriculture

Legislation	Description
Act of 3 February 1995 the protection of agricultural land and forests (Official Journal of the Laws of 2017, Item 1161)	The Act regulates the rules of protection of agricultural and forest land and the reclamation and improvement of land use value, as well as the possible transformation of agricultural and forest areas into non-agricultural and non-forest areas.
Act of 10 July 2007 on fertilizers and fertilization (Official Journal of the Laws of 2015, Item 625)	The Act regulates inter alia (i) the marketing of fertilizers and their use, (ii) the prevention of risks to humans and animals and the environment that may result from the transportation, storage and use of fertilizers, (iii) agro-chemical operations of agriculture.
Act of 25 June 2009 on organic farming (Official Journal of the Laws of 2015, Item 497)	The Act defines the tasks and characteristics of public administration bodies and organizational units in organic farming as regards the implementation of the provisions of Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labeling of organic products (Official Journal UE L 189 of 20.07.2007, p.1).
Act of 7 March 2007 on the promotion of rural development with the participation of the European Agricultural Fund for Rural Development (Official Journal of the Laws of 2013, Item 173)	The Act defines the tasks and characteristics of bodies and organizational units in support of rural development, with funding from the European Agricultural Fund for Rural Development as defined in Council Regulation (EC) No 1698/2005 of 20 September 2005.
Rural Development Programme 2007–2013 (RDP 2007–2013)	The programme sets out the objectives, priorities and principles for promoting sustainable rural development under the European Agricultural Fund for Rural Development.
National Strategic Plan for Rural Development 2007-2013	This document is the basis for the implementation of the "Rural Development Programme 2007–2013", taking into account the Community Rural Strategic Guidelines.
Strategy for sustainable rural development, agriculture and fisheries for years 2012–2020 adopted by the Council of Ministers on April 25, 2012	The strategy is to define a long-term vision for rural development and the fisheries sector in Poland and to identify actions that will bring this vision closer to 2020. The Strategy also serves as a platform for coordinating support across policy-making in rural areas.
Act of 20 February 2015 Support for rural development with the participation of the European Agricultural Fund for Rural Development under the Rural Development Programme 2014–2020 (Official Journal of the Laws of 2015, Item. 349)	The Act defines the tasks and responsibilities of bodies and organizational units in the field of support for rural development with the participation of EFRROW funds under the RDP 2014–2020 set out in Council Regulations 1305/2013, 1306/2013 and 1303/2013. In addition, the Act includes the conditions and procedures for granting, withdrawing and reimbursing financial assistance within the scope of activities covered by the Programme.
Rural Development Programme for 2014–2020 (RDP 2014–2020)	The programme defines the objectives, priorities and principles for supporting rural development through the EFRROW.
Act of 26 January 2007 on payments under direct support schemes (Official Journal of the Laws of 2012, Item 1164, as amended)	The Act regulates inter alia responsibilities of authorities and organizational units regarding direct payments and supplementary payments connected to specific crops and special financial support.

Source: Ministry of Environment

[7] Rural development policy for the period 2014 to 2020 was accepted by European Commission administration on December 12, 2014.

4.6.5.2. Measures in agriculture

Rationalization of the use of fertilizers, including nitrogen fertilizers

Among others, the Act on fertilizers and fertilization establishes: (i) reduction of natural fertilizer dose to 170 kg N/ha per year, (ii) ban on the use of natural fertilizers from the end of November to the beginning of March, (iii) mandatory training for fertilizer service providers, (iv) ban on the use of fertilizers on waterlogged, snowy and frozen soils and (v) on sloping fields >10%) (vi) obligation to store liquid manures in hermetic tanks, thus – reducing methane emissions. Besides, regular monitoring of the content of mineral nitrogen in soils of arable land and grassland is conducted. In addition, a nationwide information campaign was launched in 2014 "Rational Fertilizer Management", which aimed to raise awareness among farmers about nutrient management and the efficient use of nutrients for preserving the soil and aquatic environment. In the years 2014–2020, there are planned investments with regard to for the construction of tanks for liquid manure and slurry as well as the construction of

Afforestation of agricultural land and afforestation of non-agricultural land

Afforestation activities directly contribute to CO_2 sequestration as well as adaptation to climate change. Afforestation is carried out under the Rural Areas Development Plan for 2004–2006 and Rural Areas Development Programme for 2007–2013 and 2014–2020 as an investment in forest growth and improvement of forest vitality.

Afforestation activities are undertaken to maintain and restore the existing carbon sequestration potential and to expand existing forest complexes by afforestation of marginal agricultural land. In addition, it results in increased water retention, reduced erosion processes and positive changes in microclimate.

The most important aspects of this measures are (1) establishment of forest plantations adapted to site conditions (introduction of admixture and biocoenotic species), (2) protection of newly established forest crops; and (3) enhancement of tree resistance through appropriate nursing care (weed control, thinning, shrinkage) to ensure the best forest quality. In addition, afforestation carried out under the Rural Development Programme contributes to maintaining and enhancing the ecological stability of forest areas by linking fragmented forest tracts into compact and continuous landscape structures connected with ecological corridors, which constitute migration routes for animals.

Thanks to the selection criteria, lands selected for afforestation include areas threatened with water erosion, sloping terrains above 12° and those adjacent to existing forests. Thus, afforestation contributes to reducing organic carbon losses from the soil and directly fulfils the task 5E RDP 2014–2020: Promoting the protection of carbon sinks and carbon sequestration in agriculture and forestry.

By the end of 2016, about 71.2 thousand ha of lands were afforested under RDP 2014–2020 hectares (under RDP 2004–2006, RDP 2007–2013 and RDP 2014–2020). The budget of RDP 2014–2020, along with the continuation of RDP 2004–2006 and RDP 2007–2013, amounts to 301 million euro.

Restoring the forest production potential destroyed by disasters and implementing preventive measures

In 2014–2015, under RDP 2007–2013, efforts were undertaken to restore and maintain the stands destroyed by biotic and abiotic factors and to establish mechanisms to prevent natural disasters in forests, with particular emphasis on fire protection. The activities performed had beneficial effects on the environment and contributed to carbon sequestration processes.

Sustainable management of agricultural land

Compliance with good agricultural standards, e.g. soil protective cover, under the framework of the direct payments system or selected RDP 2007–2013 activities and RDP 2014–2020 have positive effects on CO_2 balance.

In a variety of site and production conditions, the efficiency of the use of mulch systems is improved through (i) reduction in the intensity of soil cultivation and, consequently, reduction in the mineralization of organic matter in the soil; (ii) the increase in the organic matter content decomposing into nutrients, as a result – mineral fertilization can be reduced, (iii) enhancement of soil organic contents, as a result – the sorption capacity is increased – thus, storage capacity of mineral fertilizers is improved.

An additional effect of implementing simplified cultivation is the reduction of CO_2 emissions from fuel combustion. Lesser tillage with the use of modern machines results in lower fuel consumption, and therefore it contributes to reduction of CO_2 emissions.

As part of the above measure, financial support under the direct payments system for cultivation of leguminous plants was continued. Cultivation of these plants reduces the use of nitrogenous fertilizers and has a significant impact on GHG emissions in agriculture, by reducing the energy needed for the production and application of nitrogen fertilizers, as well as by improving the soil structure and increasing carbon sequestration in the soil.

As a result of amendments to the Common Agricultural Policy, since 2015, a mandatory component of the new direct payments system has been established, i.e. greening. Greening involves diversification of crops, maintenance of permanent grassland (pol. TUZ) and preservation of Ecological Focus Areas (EFAs).

In Poland, the practice of crop diversification concerns farms with more than 10 hectares of arable land and involves the obligation to run at least 2 or 3 different crops on arable land, depending on their area within the farm. Crop diversification is also included in RDP 2014–2020: Agri-environment and climate measures.

Farmers holding permanent grasslands are obliged to respect the ban on land conversion/plowing within naturally valuable permanent natural grassland, as well as to fulfill the requirement to restore a given permanent natural grassland, in the case of a reduction of its area by more than 5% on the country's scale, with respect to the 2015 reference index.

The obligation to preserve EFA areas on the area of at least 5% of arable land applies to farms with an area of over 15 ha.

Rational management of agricultural land is also associated with development of organic farming. Works in this field are conducted in accordance with the "Framework Action Plan for Food

and Organic Farming in Poland for 2014–2020" adopted in 2014. This plan outlines the actions to be undertaken and implemented by the Ministry of Agriculture and Rural Development and subordinate bodies towards the development of organic farming and the market organic food.

In addition, in the years 2011–2015, the research/implementation programme "Improvement of national sources of plant proteins, their production, trading system and use in feed" was realized in 2011 and 2015 by the Institute of Soil Science and Plant Cultivation in Puławy (IUNG-PIB), Institute of Plant Genetics Poznan University of Life Sciences (IGR), Poznan University of Life Sciences (UP), Institute of Technology and Life Sciences (ITP), who were supported by other research centers, plant breeding stations, food processors and agri-food producers. The main objective of the Programme was to reduce the import of feed protein (soybean meal extract) by approximately 50%, as a result of increased crop area and increased biological and useful value of plant proteins derived from native raw materials. Apart from the main objective of the Programme, it was also assumed that increasing the area of native protein crops would affect the diversification of crops, enable sustainable use of natural resources and combat climate change through carbon sequestration in the soil.

The continuation of the Programme described above is the programme 2016–2020: "Increasing the use of domestic feed protein for the production of high-quality animal products under sustainable development principles" covering the period. The present project has verified and updated existing research directions and expanded the scope of research by including soybean – a completely new species in domestic agriculture.

Support for adaptation and reduction measures in agricultural holdings

Starting from 2015, 2010, the Organic Farming Action has been implemented as a financial support to farmers who voluntarily undertake to go through or maintain organic farming practices and methods, by discontinuing the use of agricultural, veterinary and food chemicals, and based on the means not technologically processed but of biological and mineral origin. This action is a continuation of the support provided to organic farmers under the RDP 2004–2006 and RDP 2007–2013.

Through environmentally friendly practices, primarily those on the protection of soils and waters, ecological management measures are important for carbon sequestration in the soil, thus these constitute the factors contributing to reduction of GHG emissions and adaptation to climate change.

Organic farming concerns, inter alia:

- maintenance and improvement of soil life, natural soil fertility, stability and biodiversity, thereby increasing soil fertility an organic substance and limiting the need for soil mineral fertilization (reduction of CO_2 emissions, reduction of N_2O emissions);
- prevention and eradication of soil erosion – inhibition of soil organic matter decomposition (reduction of CO_2 emissions into the atmosphere),
- crop rotation resulting in a positive balance of organic matter in the soil (reduction of CO_2 emissions to the atmosphere, reduction of nitrogen demand for nitrogenous fertilizers – reduction of N_2O emissions)
- abandoning the use of synthetic fertilizers and plant protection products, low fertilization (reduction of N_2O emissions),

- interplanting, so that carbon bonding increases in the biosphere, soil erosion is reduced, thus, soil degradation and the need for fertilization are reduced (reduction of CO_2 and N_2O emissions)
- linking plant and animal production with fertilization level adapted to the plant nutritional needs– balanced fertilization (reduction of N_2O emissions).

The farmer undertaking the measure: organic farming under RDP 2014–2020 is also obliged not to deform permanent grasslands on the farm and to preserve elements of the agricultural landscape which is not used for agriculture (nature refuges), thus increases carbon sequestration. Activities as such prevent soil erosion and decomposition of soil organic matter, which reduces the emission of CO_2 into the atmosphere.

Budget for organic farming under RDP 2014–2020 amounts to about € 700 million, including the continuation of implantation the Package 2. Organic farming under RDP 2007–2013 (about € 198 million).

By the end of 2016, under RDP 2014–2020, financial support was provided for the area approx. 422.9 thousand ha (about 21 thousand beneficiaries).

In addition, under agri-environment-climate measures in the framework of RDP 2014–2020, farmers who voluntarily implement environment-friendly practices are financially supported. This measure promotes climate mitigation/adaptation activities in the agricultural sector. Practices promoted are as follows:

- improvement of organic matter balance, through crop rotation, and optimization of fertilization, among others, by means of fertilization plan (Package 1. Sustainable Agriculture)
- interplanting as a soil cover e.g. in areas threatened with erosion and those with low humus content (Package 2. Soil and Water Conservation);
- extending production in/outside Natura 2000 sites (Package 4. Valuable habitats and endangered bird species in Natura 2000 sites and Package 5. Valuable habitats outside Natura 2000 sites), in addition to preservation of old traditional orchards (Package 3. Preservation of orchards of traditional fruit varieties).

All of the above mentioned practices, which lead to the preservation or enhancement of organic matter content in the soil, and impediment of soil erosion, contribute to agriculture resilience in view of climate change impacts. Environment-friendly measures undertaken also contribute to implementation of other RDP objectives (Package 6. Preservation of endangered genetic resources of plants, Package 7. Preservation of endangered animal genetic resources).

RDP 2014–2020 budget allocated for agri-environmental-climate measures is about € 1.37 billion, of which approximately € 419.1 million euro is allocated for the continuation commitments under the RDP 2007–2013 (excluding the Package 2).

By the end of 2016, under RDP 2014–2020, financial support was provided for area 1 187.8 thousand ha (about 68 thousand beneficiaries).

Climate issues are addressed in measures as regards investments under RDP 2014–2020 (e.g. modernization of farms, restructuring of small farms). RDP promotes activities that

directly/indirectly contribute to achieving the objectives as regards mitigation/adaptation to climate change.

Improvement of monogastric livestock systems, reduction of methane emissions from livestock manure

Increasing demand for poultry meat and the need to reduce the cost of pork production forced feed manufacturers to introduce full-scale industrial feeds, based on total or partial supplementation with synthetic amino acids. On account of high digestibility of proteins in feed of this kind, there was observed the reduction of greenhouse gas emissions from manure produced by animals in poultry and pig farms. In addition, multipurpose feeds are used in broiler farms, which additionally lowers production costs and improves the competitiveness of the domestic production. With the development of the dairy sector and upgrading its equipment – used to separate liquid manure, there has been observed the reduction of methane and nitrogen oxides emissions. Studies are carried out on (i) the use of solid manure cover with elastic, impermeable foils, (ii) modification of filtration and biofiltration methods, (iii) the effect of enzyme supplements on monogastric animal nutrition, (iv) acidification of liquid manure.

Elimination of gaseous pollutants emitted from livestock buildings

Work was carried out on the implementation of research results on low-carbon livestock buildings (pigsty, barn, shed). Tests on elimination of emissions from livestock buildings with ducted air circulation systems are in the preparatory phase. This technology allows conversion of methane and nitrous oxide in the ventilated air from livestock rooms.

In addition, the studies are also underway to determine national emission factors for specific animal maintenance techniques.

4.6.6. Sectoral policies and measures: waste

4.6.6.1. Legal basis

The principles of waste management, including the hierarchy of procedures for dealing with waste, are set out in the Act on Waste of 14 December 2012 (Official Journal of the Laws of 2016, Item 1987, as amended), transposing into Polish law the provisions of Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. The status of waste management is described in the National Waste Management plan, which is part of the strategic documents adopted at the EU and national levels. The national plan identifying objectives and directions for waste management activities is periodically updated. During the reporting period, the National Waste Management Plan 2014 was set up for 2011–2014 and for the period 2015–2022 and adopted in 2016. The National Waste Management Plan 2022 defines the objectives and tasks for the period 2016–2022 and for the years 2023– 2030. Poland is committed to achieving the recycling and re-use of the following municipal waste fractions: paper, metal, plastics and glass by 2020 – at least 50% by weight, and construction and demolition waste – at least 70% by weight.

A description of the most important Polish documents and acts dealing with waste management is presented in Table 4.12.

Table 4.12. Main documents and regulations concerning waste in Poland

Legislation	Description
Act of 14 December 2012 on waste (Official Journal of the Laws of 2016, Item 1987)	The Act sets out the principles of waste management in a way that human life and health and environment are protected in line with the principle of sustainable development. The Act establishes a hierarchy of waste management practices 1) waste prevention; 2) preparing for re-use; 3) recycling; 4) other recovery processes; 5) neutralization.
Act of 13 September 1996 Maintaining cleanliness and order in municipalities (Official Journal of the Laws 2017, Item 1289)	The Act sets out tasks of the municipality and the obligations of property owners regarding the maintenance of cleanliness and order, the conditions of performing activities as for municipal waste collection from land owners, waste management and the conditions of granting permits to entities providing services within the scope regulated by the Act.
National Waste Management Plan 2014 adopted by the Resolution No. 217 of the Council of Ministers of December 24 on National plan of waste management 2014, 2010 (M. P. of 2014 No. 101, Item 1183)	The plan covers the full range of tasks required to achieve integrated waste management in the country in an environmentally sound manner, taking into account current and future opportunities and economic conditions and the technological level of existing infrastructure. The objectives and tasks set out in the plan are for the period 2011–2014 and for the period 2015–2022.
National Waste Management Plan 2022 adopted by resolution No. 88 of the Council of Ministers of July 1, 2016 on National plan of waste management 2022 on (M. P 2016, Item 784)	The plan outlines the goals and directions for waste management activities, in line with the waste hierarchy and the polluter pays principle. The objectives and tasks set out in the plan relate to the period 2017–2022 and to the perspective of the period up to 2030.
Act of 20 January 2005 on recycling of decommissioned vehicles (Official Journal of the Laws of 2016, Items 803 and 1948)	The Act sets out the rules for dealing with end-of life vehicles in a way that protects human life and health and protects the environment in a sustainable way.
Act of September 11, 2015 on Waste Electrical and Electronic Equipment (Official Journal of the Laws of 2015, Item 1688)	The main purpose of the Act is to create a waste and electrical waste management system, through reducing the negative impact of waste (electrical and electronic equipment) on the environment and obligation to selectively collect them and recovery, including recycling.
Act of 24 April 2009 on batteries and accumulators (Official Journal of the Laws of 2016, Item 1803)	The law establishes the requirements for: waste batteries and accumulators; waste generated from these products; equipment that is fully or partially powered by batteries or accumulators or is adapted to such power supply.
Act of 10 July 2008 on mining waste (Official Journal of the Laws of 2017, Item 1849)	The Act specifies: 1) principles of management of extractive waste and uncontaminated soil; 2) rules of conducting the disposal of extractive waste; 3) procedures for obtaining permits related to the management of extractive waste; (4) procedures for the prevention of serious accidents in waste disposal facilities of cat. A.

Source: Ministry of Environment

4.6.6.2. Waste management measures

National Waste Management Plan 2022

The National Waste Management Plan 2022, adopted on July 1, 2016, sets the framework for proper planning of tasks, including waste management investments, in line with waste hierarchy. As a result of the implementation of the National Waste Management Plan, the amount of waste deposited on waste landfills should be reduced and gradual reduction of the amount of biodegradable waste in the mass of generated and stored waste, which will reduce pollutant emissions to water and air, including landfill gas emissions and reduce the nuisance caused by the fume. It is also expected

to reduce the risk to health and the environment by reducing waste generation as well as correct handling of waste, particularly hazardous waste. In addition, the prevention of waste and their selective collection for recovery and recycling will allow less consumption of raw materials for production. This will it's more economical to manage resources. Wastes that are not collected selectively (for technological, economic or environmental reasons) and flammable waste can be thermally transformed into waste incineration plants. This will reduce the amount of mixed municipal waste and the recovery of Energy in the form of heat or electricity. This will help to reduce the use of conventional energy sources, which require extraction and transport.

By 2020, the level of recycling and re-use of the four fractions (paper, metals, plastics and glass) at least 50% by weight (based on the weight of these fractions). At the same time, the amount of biodegradable municipal waste should be reduced so that there is no more storage in 2020 than 35% of the mass of these wastes generated in 1995. Target recovery level and recycling of packaging waste should be carried out: 60% and 56%, respectively.

The national plan outlines the objectives and directions for waste management measures, and detailed measures to achieve the waste management objectives will be identified along with the investment plans in the updated waste management plans.

The implementation of this policy comprises, among others, promoting waste/waste-free technologies, environmentally-friendly waste processing (e.g. recycling), raising fees for storing waste containing biodegradable fraction, changes in recycling levels, preparation for reuse and recovery by other methods and changes in the levels of reduction of the amount of biodegradable municipal waste transferred to landfill in 2010–2016 (table 4.13.)

Table 4.13. Levels of recycling of municipal waste, preparation for reuse and recovery by other methods, and the levels of reduction of the mass of biodegradable municipal waste disposed for storage

Indicator	Years							Target value in 2020
	2010	2011	2012	2013	2014	2015	2016	
Recycling and preparation for reuse of selected waste fractions: paper, metals, plastics and glass [%]	-	-	18,0	24	26	26	28	50
Level of recycling, preparation for re-use and recovery by other methods, other than non-hazardous construction and demolition waste [%]	69	90	73	84	91	105	-	70
Level of reduction of the mass of biodegradable municipal waste transferred to landfill compared with waste generated in 1995	79	61	56	40	35	31	12	35

Source: Ministry of the Environment

4.6.7. Sectoral policies and measures: forestry

4.6.7.1. Legal basis

Forestry policy pursues the objectives set out in the State Forestry Policy (PLP) adopted by the Council of Ministers on 22 April 1997, established on the basis of the Forest Act of 28 September 1991, that points out the linkage of forestry in inter-sectoral and international systems, as well as puts a great emphasis on increasing the forest area.

Among the main objectives of forestry policy there are the following:

1. The need to ensure the sustainability of forests together with their multifunctionality, which will be achieved by increasing forest resources of the country, including:
   - improving the status of forest resources and ensuring their comprehensive protection,
   - reorientation of forest management from the previous dominance of the raw material model to a model of pro-ecological and economically sustainable multifunctional forest management.
2. Augmentation of forest resources, which will be ensured by:
   - increase in the forest cover of the country to 30% in 2020 and 33% in the middle of the 21st century, gradually with afforestation of unprofitable land for agriculture, and the achievement of spatially optimal forest structure in the landscape – by protecting and exploiting the productive potential of habitats,
   - restitution and rehabilitation of forest ecosystems, mainly through reconstruction into mixed stands on suitable habitats, among others – by means of bio-melioration procedures,
   - regeneration of devastated and neglected stands in private forests, then their ecological rehabilitation.

Sustainable forest management is directly related to preserving and enhancing forest resources and the richness of their biodiversity. The protection and preservation of biodiversity in Poland's forests is confirmed by the inclusion of considerably large forest areas in the European Ecological Network Natura 2000 (nearly 40% of the forest area in Poland).

Table 4.14. Main forestry documents in force in Poland

Legislation	Description
Act of 28 September 1991 on forests (Official Journal of the Laws of 2015, Item 2100)	The Act defines the principles of preservation, protection and enhancement of forest resources and the principles of forest management in connection with other elements of the environment and the national economy. The aim is to preserve forests and their beneficial effects on climate, air, water, soil, living and human health and on the balance of nature.
State Forestry Policy (PLP), adopted by the Council of Ministers on 22 April 1997.	The document directs activities in the area of Forestry and indicates the linkage of forestry in inter-sectoral and international systems
National Programme on Augmentation of Forest Cover adopted by the Council of Ministers in 1995 and updated in 2003.	The programme sets out tasks aimed at increasing the forest cover to 30% by 2020 and 33% after 2050. It specifies the amount of agricultural land intended for afforestation and presents a comprehensive action plan aimed at rationalizing the structure of the use of the natural environment of the country. New afforestation is part of multifunctional implementation and sustainable development of the country.
Act of 16 April 2004 on Nature Conservation (Official Journal of the Laws of 2015, Item 1651, as amended)	The Act defines the scope of protection (necessary for effective protection of Natura 2000 sites) – fulfilling the obligation arising from the Habitats Directive and the Birds Directive, including the objective of the directives – to maintain or restore the proper state of protected objects in the Natura 2000 network.

Source: Ministry of the Environment

4.6.7.2. Forestry measures

Counteracting changes in land use

Transformation of forest areas due to non-forest purposes has a marginal importance in Poland when compared to ever-increasing forested areas. The past and projected changes in Poland's forest cover are shown in fig. 4.7

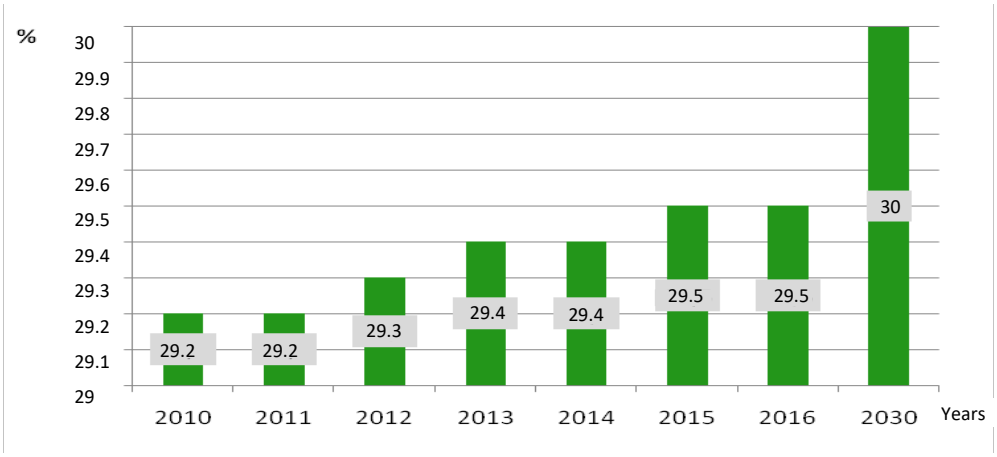


Fig. 4.7. Forest area in Poland, source: GUS Forestry

Rationalization of forest management, incentives and actions supporting afforestation and the protection of ecological stability of forests

Forest management is carried out in accordance with the Act of 28 September 1991. Forests include both afforestation, reforestation and stock raising, as well as timber harvesting, which accounts for 60–65% of the current annual increase.

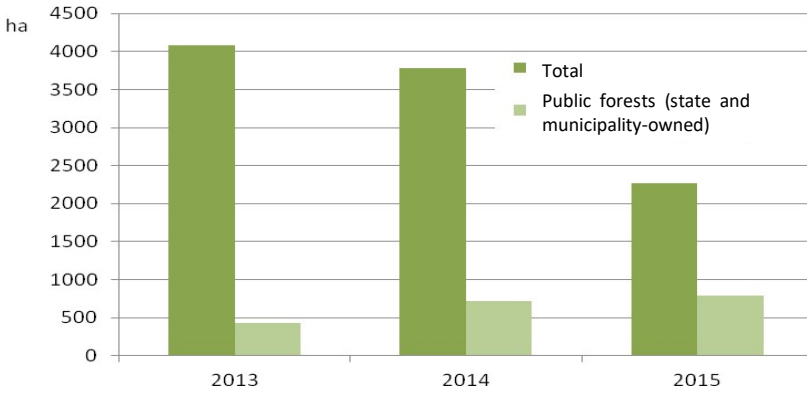


Fig. 4.8. Afforestation in 2013–2015, source: GUS Forestry

Afforestation activities are carried out every year on former agricultural lands, now unsuitable for agricultural production and on public lands owned by the State Treasury and municipalities and private owners (table 4.18). In 1995–2015, there were afforested in total 276.7 thousand ha lands, of which 132.1 thousand hectares of land owned by the State Treasury (GUS, Forestry 2016).

4.7. Outdated policies and measures

Given the long-term nature of the above described policies, their implementation has begun relatively recently, thus, it is not hitherto possible to identify which of them are the least effective and should be neglected. The policies and measures described fulfill a number of functions and not only have influence on emissions reductions or enhanced carbon sequestration, therefore, even when their impact on greenhouse gas emissions is not substantial, they should be implemented.

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

The evaluation of the potential of long-term emission reduction, i.e. by the year 2030, was carried out by McKinsey&Company in 2009, and next presented during the review of the fifth national communication in 2011. Another expert report, prepared by the Institute for Structural Research in 2013, covers the period up to 2050. The analysis shows that in Poland, GHG emissions can be reduced by 55%, at no cost, without the use of expensive or poorly understood technologies. Identified, most economically advantageous and most effective, policies and measures to achieve this goal are presented in Figure 4.9.

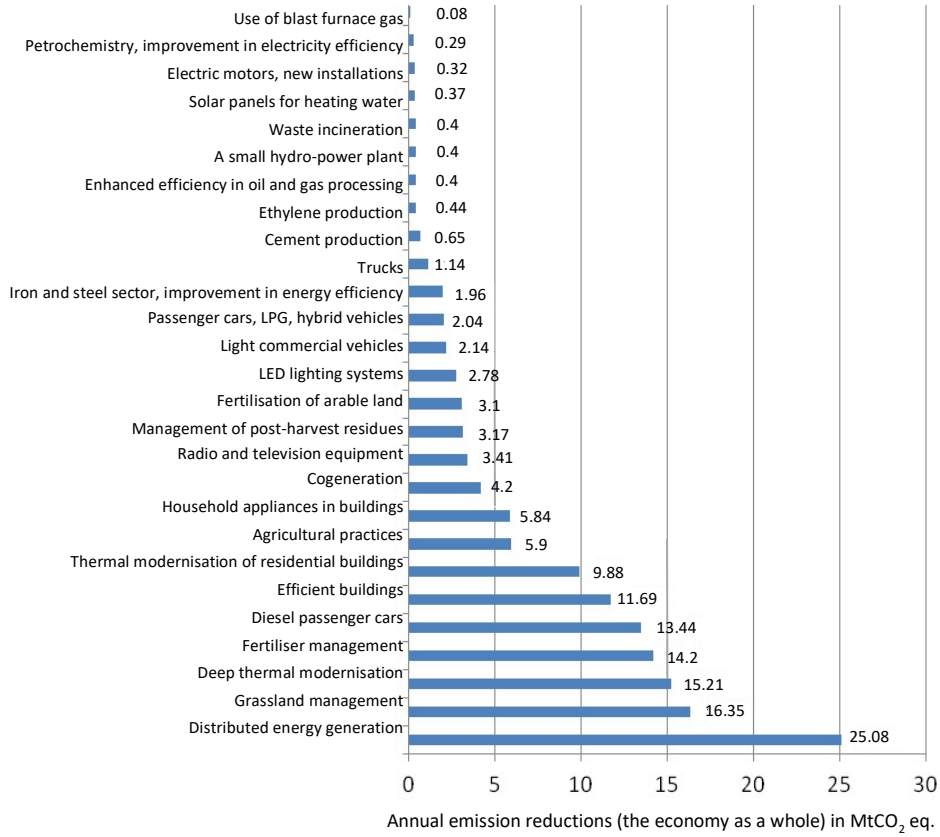


Fig. 4.9. The most effective measures to reduce greenhouse gas emissions by 55% by 2050, source: IOŚ–PIB based on IBS

The implementation of distributed energy, including that pro-consumer, shows the greatest reduction potential. The four measures described below are related to agriculture, construction and road transport.

4.9. Implementation of the Kyoto Protocol (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 of 2017, Item 286, as amended) established in Poland three mechanisms resulting from the Kyoto Protocol: the Joint Implementation Mechanism, the Clean Development Mechanism and the Emissions Trading.

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

The existing procedure of approval of joint implementation projects in Poland is compliant with the international guidelines and was laid down in 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 2017, Item 286, as amended). The provisions of the Act regulate issues related to JI projects, giving legal basis for their approval and implementation. Poland has implemented joint implementation projects under Track I, which allows for the approval of projects under national procedures (included in the Act), with no requirement to participate in the Joint Implementation Supervisory Committee (JISC). The implementation of joint implementation projects in Poland obtaining the Letter of Endorsement and then Letter of Approval. Both letters were issued, in the form of an administrative decision, by the Minister of the Environment. Under this procedure, 38 joint implementation projects were approved in Poland, which generated 21.1 million tons of verified GHG emissions reductions by 2012. Their ecological effects, sustainable investment in modern technologies and the implementation of valuable experience, as well as enhancement of awareness on possibilities of linking environmental efforts with the design instruments supporting innovative technical solutions, must not be underestimated. Despite the recent approval procedure of joint implementation projects, due to international circumstances (no entry into force of the second commitment period under KP), no project has been approved in Poland after 2012.

Table 4.15. List of joint implementation projects holding the letters of approval, implemented in the territory of the Republic of Poland

No.	Joint implementation project	Date of the letter of approval
1.	"The use of wood chips from urban green areas for heating purposes in Jelenia Góra"	2000.06.15
2.	"Small hydroelectric power plant on the river Bóbr, Leszno Górne"	2001.05.14
3.	"Degasification of municipal waste landfill in Konin"	2004.06.25
4.	"Zagórze wind farm"	2005.01.10
5.	"Utilization of methane from landfill and sewage sludge in Zakopane"	2005.01.25
6.	"Geothermal heating plant in Stargard Szczecinski"	2005.10.05
7.	"Package of Masurian Landfill Gas"	2006.03.31
8.	"Ostrowo Wind Farm"	2007.01.31
9.	"Reduction of N_2O emissions in Zakłady Azotowe Anwil SA"	2008.01.28
10.	"Landfill gas in Łubna, Sosnowiec and Łęgajny"	2008.06.19
11.	"Reduction of N_2O emissions from production facilities for nitric acid, in Zakłady Azotowe w Tarnowie Mościcach SA"	2008.06.19

No.	Joint implementation project	Date of the letter of approval
12.	"Collection and utilization of methane derived from processing of pig manure, biomass and organic waste, Pomeranian Voivodeship, Poland and Zachodniopomorskie Voivodeship, Poland"	2009.01.15
13.	"Recovery of landfill gas at Radiowo landfill in Warsaw, Poland"	2009.06.15
14.	"Catalytic reduction of N_2O in ammonia oxidation reactors of nitric acid plant in Puławy, Poland"	2009.07.21
15.	"Acquisition and utilization of methane mine in KWK Borynia in Poland"	2010.02.05
16.	"Enlargement and Development of Geothermal Energy, Zakopane, Poland"	2010.07.29
17.	"Reduction of nitrous oxide emissions from nitric acid plant in Zakłady Azotowe Kędzierzyn S.A."	2010.09.17
18.	"Management of methane from coal resources of KWK Sośnica-Makoszowy "Ruch" Sośnica"	2011.12.22
19.	"Management of methane from coal resources of KWK "Knurów-Szczygłowice" Ruch "Szczygłowice""	2011.12.22
20.	"Energy Efficiency Programme in the buildings of the Bank Ochrony Środowiska"	2012.01.16
21.	"Programme of modernization of boilers of Bank Ochrony Środowiska"	2012.01.16
22.	"Utilization of gas from methane drainage conducted in the Pniówek mine in Upper Silesian Coal Basin, Poland"	2012.04.06
23.	"Utilization of gas from methane drainage conducted in the closed mine Żory in Upper Silesian Coal Basin, Poland"	2012.12.12
24.	"Utilization of gas from methane drainage conducted in the Jas-Mos mine in Upper Silesia, Poland"	2012.12.12
25.	"Utilization of gas from methane drainage conducted in the closed mine 1 Maja in Upper Silesian Coal Basin, Poland"	2012.12.12
26.	"Utilization of gas from methane drainage conducted using the condensation method in the Krupiński mine in Upper Silesia, Poland"	2012.12.12
27.	"Replacement of electricity and heat production through the utilization of gas from methane drainage of Krupiński mine in Upper Silesia, Poland"	2012.12.24
28.	"Replacement of electricity and heat production with utilization of gas from the methane drainage conducted in the Budryk mine in Upper Silesia, Poland"	2012.12.24
29.	"Avoiding emissions in electricity and heat production by utilization of gas from methane drainage in the the Pniówek mine in Upper Silesian Coal Basin, Poland"	2012.12.28
30.	"Wind Energy Project RWE Renewables Polska"	2012.12.28
31.	"Wind Farm Dobrzyń 34MW_{el}"	2012.12.28
32.	"Wind Farm Śniatowo 32MW_{el}"	2012.12.28
33.	"Wind Farm Gołdap 28MW_{el}"	2012.12.28
34.	"Wind Farm Inowrocław 32MW_{el}"	2012.12.28
35.	"Tefra"	2012.12.28
36.	"Wind bonus – promotion of small wind farms in Poland"	2012.12.31
37.	"PWB Renewable Energy Sources Group I"	2012.12.31
38.	"Wind farm project of RP Global company in Poland"	2012.12.31

Source: IOŚ–PIB, KOBIZE

4.9.2. Clean Development Mechanism – Article 12 of the Kyoto Protocol

The principles and procedures for the implementation of CDM projects by Poland are set out in 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 2017, Item 286, as amended). Participation in the CDM project requires the consent of the Minister of the Environment in the form of an administrative decision. The consent is granted at the request of an entity interested in participating in the project. Poland has implemented no such projects, even though CDM procedures have been established.

4.9.3. Emissions trading – Article 17 of the Kyoto Protocol

Compliant with the provisions of Decision 11/CMP.1, which defines the rules and guidelines for emissions trading under the Kyoto Protocol (FCCC/KP/CMP/2005/8/Add.3), each country must meet certain conditions in order to participate in emissions trading (Article 17 of the Kyoto Protocol). On 29 April, 2008, Poland turned into the country that meets the requirements with no objection from the Compliance Committee Enforcement Branch.

(http://unfccc.int/kyoto_protocol/compliance/ items/2875.php).

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

5.1. Assumptions underlying projections

The national projections covered the forecasted greenhouse gas emissions up to 2040 (with the breakdown by the years: 2020, 2025, 2030, 2035 and 2040), taking into account the effects of adopted and implemented policies and measures for emission reduction. These projections constitute the so-called scenario "with measures". The main source of assumptions for the projection of emissions is the *Forecast of fuel and energy demand until 2050*, commissioned by the Ministry of Economy and developed by the National Agency for Energy Conservation S.A. (KAPE S.A.) in 2013.

For the purpose of this Report, the emission projections were prepared for the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), HFC group of gases (hydrofluorocarbons), PFC group of gases (perfluorocarbons) and SF_6 sulphur hexafluoride; so far no NF_3 emission has been reported in Poland, therefore it was assumed in projections that NF_3 emission will not occur in the future. The following sectors have been considered according to the classification of IPCC sources: *Energy* (including *Transport), Industrial Processes and Product Use, Agriculture* as well as *Waste*. With respect to *Land use, land-use change and forestry* sector, the underlying methodological assumptions were relevant to the requirements of the UNFCCC and the Kyoto Protocol, relating to the anthropogenic activities identified under Art. 3.3. (Afforestation, reforestation and deforestation) and actions under Art. 3.4. (Forest management).

The country's estimated CO_2 emissions (responsible for 92.5% of national CO_2 emissions in 2015) are based on the *Forecast of fuel and energy demand until 2050* (KAPE S.A., 2013) and the related study: *Analysis for assessing the effect of EU climate and energy policy on Poland's energy policy* (KAPE S.A., 2014). The above sources contain information consistent with the *Polish Energy Policy Project until 2050*, and, in particular, with Appendix 2: *Conclusions from Prognostic Analysis for the Polish Energy Policy until 2050*.

The forecast assumes:

- improving energy efficiency,
- increasing the security of fuel and energy supply,
- diversifying the fuel structure in energy industry,
- developing the use of renewable energy sources,
- developing competitive fuel and energy markets,
- reducing energy impact on the environment.

Three main areas of action were identified, with respect to energy efficiency improvement, including: improving energy efficiency in residential and non-residential buildings, improving fuel efficiency in transport and further promotion of cogeneration (heat and energy production). In particular, it is envisaged to promote and develop energy-efficient and passive construction, as well as further tightening of emission standards in transport, which will translate into a decrease in vehicle fuel consumption, and a decrease in the dependence of Poland and the European Union on non-Community oil imports.

The European energy markets and transmission infrastructure will become still more developed, which will ensure the diversification and sustainability of energy carriers, and particularly, of natural gas.

An important element contributing to the diversification of the fuel mix in the energy sector will be the implementation of the nuclear programme.

It is assumed that there will be a significant reduction in investment costs for RES technologies – the fastest in photovoltaic and biogas plant installations.

It is expected that the price of EU ETS emission allowances will increase from the current level of about EUR 7 to EUR 12.5 in 2020, EUR 25 in 2030 and EUR 35 in 2040 (source: *Forecast of fuel and energy demand until 2050* (KAPE S.A., 2013). The price increase will be affected by the need to meet the reduction target for 2030 and the impact of the stabilization mechanisms that will be implemented in the years to come.

The forecasted dynamics of GDP changes is shown in Table 5.1.

Table 5.1. Synthesis of forecasts of dynamics of changes in Gross Domestic Product (GDP)

Average dynamics	**2016–2020**	**2020–2030**	**2030–2040**
GDP	4.0%	2.9%	2.5%

Source: Forecast of fuel and energy demand until 2050 (KAPE S.A., 2013)

The structure of the Polish economy will gradually become similar to the structure of Western European economies, while retaining a relatively large role of industry. The importance of agriculture in the economy will decrease and, conversely, the share of services will increase.

WISE MEEP (Microfoundations-based Energy and Emissions Projection model) models and WISE POESSIA (Polish Energy Sector Simulation Analytics toolbox) were used to develop forecasts for fuel combustion and electricity generation.

Estimated values of final energy demand, broken down by sectors of economy and broken down by fuel type are presented in Table 5.2 and Table 5.3, respectively.

Table 5.2. Final energy demand [Mtoe] broken down into sectors of economy

Economic sectors	**2020**	**2025**	**2030**	**2035**	**2040**
Agriculture	2.8	2.4	2.3	2.1	2.0
Industry and construction	16.8	17.8	18.9	20.0	20.9
Transport	20.9	21.4	21.0	19.5	17.9
Services	8.7	8.2	8.1	7.9	7.5
Households	22.4	22.5	22.0	21.0	19.9
Total	**71.6**	**72.3**	**72.3**	**70.4**	**68.2**

Source: Forecast of fuel and energy demand until 2050 (KAPE S.A., 2013)

Table 5.3. Final energy demand [Mtoe] by fuel type

Fuel type	2020	2025	2030	2035	2040
Carbon	11.9	11.2	10.5	9.9	9.4
Petroleum derived products	21.7	21.4	20.8	19.3	17.9
Natural gas	9.5	9.4	9.1	8.9	8.7
Electricity	11.9	12.6	13.8	14.6	15.0
Network heat	7.7	7.7	7.6	7.3	7.0
RES	8.4	9.4	9.8	9.7	9.5
Other	0.6	0.7	0.7	0.7	0.7
Total	**71.6**	**72.3**	**72.3**	**70.4**	**68.2**

Source: Forecast of fuel and energy demand by 2050 (KAPE S.A.,2013)

The structure of final energy demand will change significantly, in terms of both: sector and fuel approach. The forecast predicts that by 2040 Poland will remain a country with a developed industry and construction output and, consequently, the energy demand of the manufacturing sector will remain high. However, taking into account the increasing energy efficiency of buildings, electric appliances and equipment as well as lighting, there will be a drop in the primary energy demand on the part of households. Technological changes that will increase the fuel efficiency of heavy goods vehicles will help maintaining the demand for crude oil from transport services by slightly more than the current level by 2030. This will happen despite the significant development of the freight transport at the same time. In the following decade, when the Polish GDP growth rate will slow down, the increase in fuel efficiency – primarily in passenger cars, thanks to the promotion of hybrid vehicles – will further reduce the role of transport as an energy buyer.

Coal-fired power plants will remain the main source of electricity over the entire forecast period. The need to meet the rapidly growing demand will make it necessary to invest in a new coal capacities already in the current decade, particularly as energy blocks built in the 1960s and 1970s will be phased out. As a result of these two processes, electricity production by the coal fired power plants will increase by about 20% until the year 2030, as compared to 2010. At the same time, the demand for electricity will increase by about 40%, and the lignite resources in existing mines will begin to run out. Nonetheless, opening up new deposits of this raw material will be economically unjustified, if the price of carbon dioxide emission allowances will increase. Narrowing the gap arisen between the electricity production and demand will require investment into low carbon technologies.

Renewable energy sources, supported by gas sources, operating in the reserve and working in conjunction with heat production will primarily have to make up for the national energy system next to coal-fired power plants.

The expansion of renewable sources will be accompanied by the development of gas installations, which will gradually take over the role of the reserve and peak energy sources in the energy mix, technologically supporting the development of non-dispatchable solar and wind energy. Another important role of gas sources operating in the cogeneration will be to produce grid heat, although in this respect, the forecast provides for the maintenance of hard coal domination, which will be replaced by gas and RES to a limited extent only.

Table 5.4. Electricity production [TWh] by fuel type

Fuel type	2020	2025	2030	2035	2040
Hard coal	76.9	75.9	79.0	84.4	88.8
Lignite	53.8	49.6	38.1	11.1	11.3
Natural gas	11.8	11.9	13.0	18.4	17.5
RES	34.0	36.9	51.9	61.1	65.1
Nuclear energy	0.0	11.8	23.3	45.1	45.4
Other fuels	1.4	1.4	1.4	1.4	1.4
Total	**177.9**	**187.5**	**206.8**	**221.4**	**229.7**

Source: Forecast of fuel and energy demand by 2050 (KAPE S.A.,2013)

Main dataset for sector 1.A. *Fuel combustion*, concerning fuel consumption by stationary sources, was adopted based on the *Forecast of Fuel and Energy Demand until 2050* (KAPE S.A., 2013) and the related study: *Analysis for assessing the effect of EU climate and energy policy on Poland's energy policy* (KAPE S.A., 2014). The values used for the assessment of future greenhouse gas emissions are given in Table 5.5.

Table 5.5. Major inputs for projection of emissions from sector 1.A. Fuel combustion

Fuel type	Fuel consumption in years [PJ]				
	2020	2025	2030	2035	2040
1.A.1 *Energy industries*					
1.A.1.a *Public electricity and heat production*					
Hard coal	869	791	767	741	758
Lignite	536	494	375	100	100
Natural gas	60	61	60	96	109
Fuelwood and wood waste	190	151	131	124	116
Biogas	13	28	48	52	55
Industrial waste	1	1	1	1	1
Coke and semi-coke	0	0	0	0	0
Liquid petroleum gas	0	0	0	0	0
Diesel oil	1	1	1	1	1
Fuel oil	6	6	6	6	6
Coke oven gas	23	24	24	24	24
Blast furnace gas	12	12	12	12	12
1.A.1.b *Petroleum refining*					
Hard coal	0	0	0	0	0
Lignite	0	0	0	0	0
Natural gas	30	31	31	31	31
Fuelwood and wood waste	0	0	0	0	0
Biogas	0	0	0	0	0
Industrial waste	0	0	0	0	0
Other petroleum products	1	1	1	1	1
Coke and semi-coke	0	0	0	0	0
Liquid petroleum gas	0	0	0	0	0
Diesel oil	0	0	0	0	0
Fuel oil	18	15	14	14	14
Refinery gas	36	38	38	38	38
Coke oven gas	0	0	0	0	0
Blast furnace gas	0	0	0	0	0
1.A.1.c Manufacture of solid fuel and other energy industries					
Hard coal	1	0	0	0	0
Lignite	1	1	1	1	1

Fuel type	Fuel consumption in years [PJ]				
	2020	2025	2030	2035	2040
Natural gas	14	15	16	16	16
Fuelwood and wood waste	0	0	0	0	0
Industrial waste	0	0	0	0	0
Coke and semi-coke	0	0	0	0	0
Liquid gas	0	0	0	0	0
Diesel	2	1	1	1	1
Fuel oils	0	0	0	0	0
Coke oven gas	38	38	38	38	38
Blast furnace gas	0	0	0	0	0
1.A.2 ***Manufacturing industries and construction***					
Hard coal	106	114	115	121	127
Lignite	1	1	1	1	1
Natural gas	110	124	131	141	152
Fuwlwood and wood waste	31	35	37	40	42
Industrial waste	15	17	17	17	17
Municipal waste - non-biogenic fraction	4	4	4	4	4
Municipal waste – biogenic fraction	2	2	2	2	2
Coke	25	27	27	27	27
Liquid petroleum gas	2	2	2	2	2
Diesel oil	16	17	15	14	13
Fuel oil	5	4	3	3	3
Refinery gas	8	7	8	8	8
Coke oven gas	12	13	13	13	13
Blast furnace gas	12	13	12	12	12
1.A.4 ***Other sectors (including: commercial, institutional, residential, agriculture, forestry, fishing)***					
Hard coal	250	214	184	157	135
Lignite	5	5	5	5	5
Natural gas	267	266	264	257	251
Firewood and wood waste	167	171	173	171	169
Biogas	3	3	3	3	3
Coke and semi-coke (including gaseous)	6	5	5	5	5
Liquid petroleum gas	32	31	29	28	26
Diesel oil	96	91	87	82	78
Fuel oil	4	4	4	4	4

Source: Forecast of fuel and energy demand until 2050 (KAPE S.A.,2013) and Analysis for assessing the effect of EU climate and energy policy on Poland's energy policy (KAPE S.A., 2014)

The main source of greenhouse gas emissions, associated with fuel consumption by mobile sources, is road transport responsible for 98% of CO_2 emissions in the *Transport* (1.A.3.) sector. The assessment of future changes in emission from the road transport was made using prognostic assumptions developed by the Institute of Automotive Transport (ITS) included in the paper entitled "*Expert forecasts of changes in the activity of the road transport sector*" (in the context of the Act on the management system of greenhouse gas emissions and other substances) (Table 5.6). The paper was commissioned by the Ministry of Infrastructure and Construction in July 2017. Data for the year 2035 were taken in the projections for transport sector by 2040.

Table 5.6. Input data for emission projection from sector 1.A.3.b *Road transportation*

Emission sources			IU	2015	2020	2025	2030	2035	2040
Freight transport		Vehicle transport	million tkm	273107	318000	321000	323000	323000	323000
Fuel consumption	**Passenger cars**	Petrol	Gg	3196	3722	3887	3789	3741	3741
		Diesel	Gg	3413	4374	4942	4797	4430	4430
		Liquid gas (LPG)	Gg	1261	1377	1391	1317	1182	1182
		Biodiesel*	Gg	341	525	692	768	797	797
		Bioethanol **	Gg	160	372	544	644	748	748
		Natural gas	Gg	4	27	101	271	681	681
		Electricity	GWh	11	88	341	1189	3175	3175
		Hydrogen	Gg	0	0	0.3	4.5	30	30
	Vehicles other than passenger cars with a mass of up to 3,5 t	Petrol	Gg	179	160	135	112	93	93
		Diese oil	Gg	1546	1969	2280	2281	2025	2025
		Liquid gas (LPG)	Gg	210	230	227	210	183	183
		Biodiesel*	Gg	155	236	308	342	334	334
		Bioethanol **	Gg	9	16	19	19	19	19
		Natural gas	Gg	3	4	26	211	535	535
		Electricity	GWh	1.3	9.1	193	701	1306	1306
		Hydrogen	Gg	0	0	0.02	0.27	2.7	2.7
	Vehicles with a mass of over 3.5 t	Diesel	Gg	4325	4770	4653	4585	4323	4323
		Biodiesel*	Gg	432	572	628	688	713	713
		Natural gas	Gg	9	12	60	241	561	561
		Hydrogen	Gg	0	0	0	1.3	4.1	4.1
		Electricity	GWh	15	17.4	73.1	185.3	325.8	325.8
Fuel consumption by total fleet		Petrol	Gg	3375	3883	4023	3901	3835	3835
		Diesel	Gg	9284	11113	11875	11663	10778	10778
		Liquid gas (LPG)	Gg	1471	1607	1617	1527	1364	1364
		Biodiesel*	Gg	928	1334	1603	1749	1778	1778
		Bioethanol **	Gg	169	388	563	663	767	767
		Natural gas	Gg	16	42	187	722	1777	1777
		Electricity	GWh	27	114	607	2075	4806	4806
		Hydrogen	Gg	0	0	0.32	6	36.8	36.8

* in diesel mass

** in the mass of gasoline

Source: "Expert forecasts of changes in the activity of the road transport sector" (ITS, 2017)

The fuel consumption forecasts, developed by the Department of Aviation at the Ministry of Infrastructure and Construction, were taken to predict greenhouse gas emissions from aviation (Table 5.7). Estimates of aviation fuel consumption on domestic cruises (TJ) were developed based on the trend model analysis. The built-in theoretical model of a linear trend explains in 44% the variability of the explanatory variable. The determined from the model theoretical values (expired forecasts) of aviation gasoline consumption are somewhat different from the actual sale values which are based on historical data, by 25.5 TJ. According to analyzes, the consumption of aviation fuels on domestic cruises is only moderately correlated with the transport work, in both the cargo and passenger transport in aviation. In the above forecasting, no account was taken of the effect of technological efficiency on fuel consumption due to lack of relevant data.

Table 5.7. Input data for the projection of emissions from sector 1.A.3.a *Domestic aviation*

Fuel type	Unit	2015	2020	2025	2030	2035	2040
Aviation gasoline	TJ	176.00	225.18	248.15	271.12	294.09	294.09
Jet kerosene	TJ	1 568.00	2 109.51	2 493.11	2 876.70	3 260.30	3 260.30

Source: The Department of Aviation's own study, Ministry of Infrastructure and Construction

The assumption underlying projections of greenhouse gas emission from fuel combustion in railway transport was that the changes in total diesel consumption by railway carriers would occur on a regular basis (linearly), from the statistically recorded base year 2015 (3,526 TJ) to the target year 2035 (5,950 TJ). The data from 2035 were adopted for the year 2040.

With respect to the international fuel bunker, future aviation emissions were calculated on the basis of the forecasted consumption of jet kerosene in the international traffic (Table 5.8). In the case of shipping development, it has been assumed that its dynamics will follow the dynamics of the world shipping development, which will increase greenhouse gas emissions by about 10% in 2020, by about 32% in 2030 and by about 83% in 2040, as compared to 2015.

Table 5.8. Input data for the projection of emissions from international air transport

Fuel	unit	2015	2020	2025	2030	2035	2040
Jet kerosene	kt	586.46	678.18	780.54	882.91	985.27	985.27

Source: The Department of Aviation's own study, Ministry of Infrastructure and Construction

Projections of fugitive greenhouse gas emissions cover emissions from solid fuels (CO_2 and CH_4) and fugitive emissions from natural gas and oil (CO_2, CH_4 and N_2O). The input data included in the KAPE 2014 report are given in Table 5.9. The mining potential of hard coal and lignite was determined based on the report by the Institute of Mineral Resources and Energy of the Polish Academy of Sciences[8]. Having in mind the uncertainty as to the potential of unconventional oil and gas reserves, it was assumed to maintain the extraction of these fossil fuels at a level close to the current one.

Table 5.9. Input data for sector 1.B *Fugitive emissions from fuels*

Emission sources	2020	2025	2030	2035	2040
Extraction:					
Hard coal (kt)	70 533	65 088	62 283	62 283	62 283
Lignite (kt)	63 430	58 412	44 548	44 548	44 548
Crude oil (kt)	547	547	547	547	547
Natural gas (TJ)	162 636	162 636	162 636	162 636	162 636
Crude oil processing (PJ)	977	990	968	968	968
Crude oil import (kt)	23 383	23 685	23 152	23 152	23 152

Source: Analysis for assessing the effect of EU climate and energy policy on Poland's energy policy KAPE 2014

The emission factors used in the projections of fugitive emissions reflect the values of the indicators used in the national greenhouse gas inventory compiled in 2017.

Input data for projection of emissions from sector 2. *Industrial processes and product use* are shown in Table 5.9. The data were drawn from the study: *Analysis for assessing the effect of EU climate and energy policy on Poland's energy policy* (KAPE S.A.,2014) and from the updates of some of the forecasted industrial outputs, provided by the Ministry of Development in 2017.

[8] Forecast of the demand of the Polish economy for hard and brown coal as a raw material for the power industry in the perspective of 2050, Mineral and Energy Economy Research Institute, Polish Academy of Sciences in cooperation with AGH University of Science and Technology and the Energy Studies Institute, Krakow, 2013.

Estimates of the production dynamics of the most important industrial products were made within the framework of the study: *Assessment of technical condition of economic infrastructure*. This document includes conclusions from meetings with representatives of the chemical industry (the Polish Chamber of Chemical Industry), the mineral industry (Polish Cement Association) and the steel industry (Polish Steel Association), which took place in the framework of the work on this document.

Complementary estimates of future activity in the area of industrial processes were made using the WISE MEEP model based on historical trends.

Table 5.10. Main inputs for projections of emissions for major sources in sector 2. *Industrial processes and product use* [kt]

Industrial processes	**Industrial production in the years [kt]**				
	2020	**2025**	**2030**	**2035**	**2040**
2.A. *Mineral industry*					
Cement clinker production	13 000	14 000	15 000	15 600	16 500
Lime production	1580	1522	1466	1466	1466
2.B. *Chemical industry*					
Ammonia production	2944	3036	3022	3022	3022
Nitric acid production	2579	3196	3177	3177	3177
Black carbon production	28	33	38	38	38
Styrene production	125	125	125	125	125
Ethylene production	469	460	451	451	451
Caprolactam production	171	171	171	171	171
2.C *Metal industry*					
Sinter production	9604	9604	9604	9604	9604
Pig iron production	5786	6494	6494	6494	6494
Basic oxygen furnaces steel	6415	7200	7200	7200	7200
Electric steel production	4652	5200	5200	5200	5200
Ferroalloys production	75	75	76	75	74
Lead production	88	83	77	77	77
Zinc production	190	215	215	215	215

Source: KAPE 2014 and subsequent updates provided to KOBIE by the Ministry of Development.

The core data concerning the predicted dynamics of activity changes in sector 3. *Agriculture,* are given in Table 5.11. The prognostic data presented in the Table were developed with the participation of research institutes supervised by the Ministry of Agriculture and Rural Development, and based on, among others, a long-time trend analysis. Nevertheless, in view of the nature of agricultural production, and its unpredictability due to high dependence on natural conditions, the precise projections characterizing the state of the Polish agriculture after 2020 are hardly possible. The usability of mathematical models of trends is, in many cases quite limited in view of the possibility of future changes in the conditions of agricultural activity, taking into account such a long forecast period.

A decline is forecasted in the farmland area due to the increase in the area reassigned to other purposes, including transport, municipality and other non-agricultural purposes as well as due to the increase in forest areas (especially thanks to the grants from the Rural Development Programme). However, it can not be ruled out that the area of agricultural land and crop area will remain at the level of 2030 due to the projected decline in the population number, population aging and a negative

approach to new investments, while the decline of the afforestation dynamics may be due to the growing demand for food.

Between the years 2005–2015, the increase in cow milk yield in Poland was 2.6%, doubling the EU-15 level, thus it was assumed that the yield would continue to grow. Milk production may be, to some extent, replaced partly by meat production, so in the long term, the overall cattle population may show a slight downward trend. A conspicuous process is, and will continue to be, the concentration of livestock production, which can be observed, among other, in the predicted ever increasing use of non straw-bed housing of cattle and pigs. It is anticipated that the rise in cow milk yield will be accompanied by a decline in dairy cattle stock. In turn, sheep production is declining, and it is assumed that it will continue to be marginalized. Structural changes in rural areas will lead to complete abandonment of cold-blooded horses rearing for professional purposes. The growing population of warm-blooded horses will not compensate for the decline in the total number of horses in the longer term. In recent years, there has been a rapid reversal of the trend of swine population growth. Therefore, it is difficult to predict changes in this respect by 2040, due to strong international competition. In turn, the yields of the vast majority of crops in Poland will increase. Estimates of the expected yield were made on the basis of long-term trends.

Table 5.11. Main inputs for major emission sources from sector 3. *Agriculture*

Emission source categories	unit	2020	2025	2030	2035	2040
Farmland area	thousand hectares	14 450	14 275	14 075	14 000	13 925
Total area sown	thousand hectares	10 618	10 443	10 265	10 190	10 115
Average annual milk quantity per cow	litre/year	6 248	6 863	7 330	7851,5	8368,5
Cattle stock	thousand head	5 910	5 868	5 800	5 655	5 600
including dairy cattle	thousand head	2 200	1 979	1 807	1 735	1 700
Sheep and goats	thousand head	259	215	178	146	127
Horses	thousand head	233	214	205	175	155
Pigs	thousand head	10 488	10 423	10 445	10 350	10 250
Area of cultivated organic soils	thousand hectares	675	670	665	660	653
Production of major crops						
Cereals	thousand tonnes	29 375	29 695	29 853	30 420	31 000
Legumes	thousand tonnes	656	760	858	905	950
Oil-bearing plants	thousand tonnes	2 762	2 983	3 163	3 287	3 416
Root crops (including potatoes)	thousand tonnes	15 740	15 587	15 473	15473	15473
Fruits	thousand tonnes	3 900	4 050	4 150	4 277	4 479
Vegetables	thousand tonnes	4 750	4 900	5 525	5 784	6 056
Share of liquid animal waste management systems						
Dairy cattle	% of herd	35	55	70	72	74
Other cattle	% of herd	2	3	4	4	4
Pigs	% of herd	35	70	75	77	78

Source: Ministry of Agriculture and Rural Development

Table 5.12. shows activity data providing the basis for estimating greenhouse gas emissions in sector 5. *Waste*. The information for subsectors 5.A. *Solid waste disposal*, 5.B. *Biological treatment of solid waste* and 5.C. *Incineration and open burning of waste* was obtained from the

National Waste Management Plan 2022 (KPGO 2022) and the Voivodeship Waste Management Plans, which publish the forecasted quantities of:

- generated solid municipal waste (in 2025 and 2030),
- solid municipal waste processed in installations for mechanical and biological treatment (in the years 2020 and 2022);
- green waste and other bio-waste composted and fermented (in the years 2020 and 2022)
- incinerated municipal waste (in 2020 and 2025),
- incinerated medical waste (2020, 2025 and 2030),
- the annual increase in the share of biodegradable fraction in the overall stream of municipal waste.

The above forecasts result from the objectives set in the KPGO 2022, including:

- achieve the levels of recycling and preparation for re-use of paper, metals, plastics and glass from a municipal waste stream reaching at least 50% of their mass by 2020;
- achieve the level of 60% of municipal waste recycled by 2025 and 65% by 2030;
- reduce the amount of biodegradable municipal waste directed at landfill site, so that by 2020, the amount of landfilled waste would not exceed 35% of the waste amount produced in 1995;
- strive to reduce the amount of waste deposited;
- achieve adequate levels of recovery and recycling of post-consumer waste, including packaging waste, used tires and waste oils.
- introduce standards for selective collection of municipal waste across the entire country,
- introduce selective collection of green waste and other bio-waste in all communes by the end of 2021;
- limit thermal conversion of municipal waste and waste from processing of municipal waste to a maximum of 30% , in the scale of country and province (voivodeship).

Information for subsector 5.D. *wastewater treatment and discharge* information has been obtained from Appendix No. 2 to the Fifth *Updated National Programme for Municipal Waste Water Treatment Programme* (V NPMWWT 2017) and from GUS *Population Projection for the years 2014–2050*, where the forecasts were published for the following categories:

- the amount of dry matter of sludge produced in municipal sewage treatment plants (in 2021)
- urban and rural population and population of the country (in the years: 2020, 2025, 2030, 2035 and 2040).

The projected amount of sludge dry matter generated in municipal sewage treatment plants was based on the assumption that, by 2012, Poland meets the requirements under Directive 91/271/EEC for sewage systems and municipal sewage treatment plants.

The values of the above-described categories for the years not covered by the projections were estimated by interpolation and extrapolation. In cases where the use of extrapolation was not substantiated, the value equal to the predicted value for the most distant perspective was assumed.

In the case of activities, for which forecasts are not available, the averages of the last three years of inventory (2013–2015) have been used as fixed values.

Table 5.12. Input data for emission projection from Sector 5. *Waste*

Waste	Unit	Years				
		2020	2025	2030	2035	2040
Amount of municipal solid waste *	kt	11330.3	11797.1	12280.4	12280.4	12280.4
Amount of municipal soild waste treated in installations for mechanical and biological treatment **	kt	6607.8	6502.1	6502.1	6502.1	6502.1
Amount of green waste and other bio-waste composted and fermented**	kt	1 933.7	2 085.0	2 085.0	2 085.0	2 085.0
Amount of incinerated municipal waste **	kt	3118.6	3253.2	3253.2	3253.2	3253.2
Amount of incinerated medical waste *	kt	38.0	38.0	38.0	38.0	38.0
Increase in the share of biodegradable fraction in the general stream of municipal waste *	% per year	0.5	0.5	0.5	0.5	0.5
Amount of sludge dry matter produced in municipal sewage treatment plants ****	kt of dry mass	351.1	351.1	351.1	351.1	351.1
Urban population ***	thousand persons	22716.5	22216.2	21618.2	20945.2	20234.4
Rural population ***	thousand persons	15421.3	15525.3	15566.8	15531.5	15433.9
Population of the country ***	thousand persons	38137.8	37741.5	37185.1	36476.8	35668.2

Source:
** The National Waste Management Plan 2022 and the Ministry of the Environment*
*** Voivodship Waste Management Plans and the Ministry of the Environment*
**** GUS Population Projection 2014–2050*
***** V. Updated National Programme for Municipal Waste Water Treatment and the Ministry of the Environment*

Table 5.13 shows the data on predicted dynamics of changes in activity in sector: 4. *Land use, land-use change and forestry*. The land use in Poland is dominated by agriculture and forestry, however, significant changes in this respect have occurred over the recent years. Therefore, for the purpose of forecasting, attempts were made to present these changes, taking into account the variability of the ongoing processes. To this end, based on available statistics, a dynamic analysis was conducted of the land-use change trends in the years 1988–2015. In the period under analysis, a permanent declining trend for farmland area was noted in view of its conversion to other uses, such as e.g.: forest, development, etc. The changes in the area of permanent crops indicate that after the accession to the EU, the structural changes in agriculture are increasingly affected by the common agricultural policy (CAP) and the financial mechanisms involved. The analysis also shows that the dynamics and direction of land-use change are affected by the intensity of agricultural production. Thus, changes in the use of farmland are driven by numerous factors, such as: economic development, investment, agricultural policy and landscape protection activity resulting from binding legal regulations. Another important factor is the change in social needs and consumption style, as an expression of the increasing wealth of the society.

The latter processes are driven by a number of social and economic factors, whose strength, in the face of the declining economic importance of the agricultural sector, contributes to lowering its production potential. However, it should be stressed that this process, as a consequence of the dynamic economic development of the whole country, can also promote the restructuring of agriculture. This is particularly important in the face of the recent economic, social and political transformation that significantly affected the structure of land use. The ongoing process of concentration of the population, the subsequent development of urban areas, the declining importance of industry in the national economy, have been undoubtedly influencing the structural

changes in agriculture. All these processes have been accompanied by changes in the land use structure and competition for space between the different functions, subject to certain rules which order the principles of spatial land management and environmental protection.

Table 5.13. Area of particular forms of land use

Land use, land-use change and forestry (LULUCF)	Area [kha]				
	2020	2025	2030	2035	2040
4.A. Forest land	9549	9671	9793	9915	10037
4.B. Cropland	13882	13712	13549	13386	13223
4.C. Grassland	4200	4090	4060	4030	4000
4.D. Wetlands	1379	1384	1390	1396	1402
4.E. Settlements	2263	2343	2423	2503	2583
4 F. Other land	74	64	53	42	31

Source: tIOŚ–PIB, KOBiZE, own estimates

One of the main sources of data showing the direction and dynamics of the size and structure of forest resources in Poland is the forecast of the anticipated structure of timber stock, developed within the framework of an inter-institutional cooperation by the Team for Prognostic Data on Greenhouse Gas Emissions and Removals until the year 2040. The Team involved representatives of the Ministry of the Environment, the General Directoriate of the State Forests, the National Centre for Emissions Management, the Forest Research Institute and the Office of Forest Management and Geodesy. The development of wood resources (Table 5.14), which is influenced by the adopted in the State Forest Policy overarching principles of implementing the multifunctional forest management, depends largely on the implementation of climate protection policy mainstreamed to the forestry policy implemented by the State Forests. In the implementation of multifunctional forest management, in practice, there are strong and direct correlations between the present forest age structure and the state of timber stock and the associated intensity of forest harvest.

Table 5.14. Predicted structure of forest growing stock *

Tree species	Volume [million m^3]				
	Years				
	2020	2025	2030	2035	2040
Pine	1 634.64	1 637.23	1 637.23	1 697.97	1 723.53
Spruce	167.79	163.45	63.45	166.08	163.59
Fir	110.96	114.42	114.42	125.99	131.46
Other conifers	29.77	32.69	32.69	34.36	67.19
Total softwoood	**1 943.16**	**1 947.79**	**1 947.79**	**2 024.40**	**2 056.55**
Beech	184.03	185.24	185.24	194.71	198.64
Oak	175.91	179.80	179.80	194.71	201.57
Hornbeam	40.60	43.59	43.59	51.54	55.50
Birch	132.61	133.48	133.48	140.30	143.14
Alder	148.85	152.55	152.55	166.08	172.35
Poplar	2.71	2.72	2.72	2.86	2.92
Aspen	18.94	21.79	21.79	22.91	26.29
Other broadleaved	56.83	59.93	59.93	62.99	67.19
Total hardwoood	**763.19**	**776.39**	**776.39**	**838.97**	**864.69**
Total	2 706.35	2 724.18	2 724.18	2 863.36	2 921.24

*Source: * data provided by the Department of Forestry; Ministry of the Environment*

The methodology for projection of greenhouse gas emissions and removals for all the IPCC sectors presented above is the same as the method used in the inventory of greenhouse gases described in the National Inventory Report 2017 (NIR 2017). In the absence of prognostic data necessary for updating the emission factors, extrapolated values have been used on the basis of available data from the years 1990–2015, a similar approach was used for missing data about activities.

5.2. Results of emission projection

The projected greenhouse gas emissions, primarily of CO_2, are expected to decline until 2035, and then slightly increase by 2040 (Table 5.15), which is in line with the forecast for fuel and energy demand. Carbon dioxide will continue to be the main emission driver, with a reduction from over 82% in 1988 to less than 77% by 2040. In turn, the share of methane and nitrous oxide will increase to approximately 13.5 and 6.2% by 2040 (Table 5.17). Approximately 3% of the emissions will be industrial gases. No NF_3 emissions have been reported in Poland yet, and this assumption has remained.

Table 5.15. Aggregated results of GHG emission projections, by gases, in the years 2020–2040, as compared to emissions in 1988 and 2015

Greenhouse gases*	Emissions in years [kt CO_2 eq.]						
	1988	2015	2020	2025	2030	2035	2040
CO_2	470 886.43	310 638.59	314 091.83	304 566.17	286 338.15	252 005.49	253 072.98
CH_4	70 015.17	47 176.03	45 427.52	45 381.54	44 641.04	44 310.15	44 219.10
N_2O	29 322.01	18 989.19	20 319.87	20 799.54	20 928.79	20 598.86	20 428.46
HFCs	0.00	8 948.85	8 095.06	8 565,51	8 962.32	9 305.46	9 607.75
PFCs	147.26	13.21	11.53	10.74	10.10	9.55	9.08
SF_6	0.00	77.03	47.44	50.25	52.63	54.71	56.55
Total	**570 370.88**	**385 842.89**	**387 993.26**	**379 373.75**	**360 933.03**	**326 284.21**	**327 393.91**

* The values do not include emissions and removals from Sector 4. *Land use, land-use change and forestry*

Source: IOŚ–PIB, KOBiZE

The projected summary value of greenhouse gases emission is largely affected by Sector 1. *Energy* (Table 5.16), with the forecast, that by 2035, emissions from this sector will gradually decrease and then rise slightly in 2040. In turn, emissions from *Industrial processes and product use* show a slight upward trend. The projected greenhouse gas emissions from *Agriculture* will be slightly increasing until 2030 and then stabilizing, while emissions from *Waste* sector, after a rise in 2020, will systematically decrease over the forecast period.

In the years 1988–2040, the total forecasted emission from international aviation and shipping is growing, compared to the base year emission (1988), by approximately 48%, with a three fold increase in emissions from the aviation bunker over this time.

Table 5.16. Greenhouse gas emissions projections for the years 2020–2040, as compared to emissions in 1988 and 2015

Source categories	Sector emissions in years [kt CO_2 eq.]						
	1988	2015	2020	2025	2030	2035	2040
1. Energy	474 968.03	316 109.87	315 861.06	304 519.50	284 906.63	249 882.69	250 268.44
2. Industrial processes and product use	31 198.21	28 525.12	29 180.59	30 880.64	31 903.33	32 572.93	33 360.15
3. Agriculture	47 835.68	29 649.89	31 029.39	32 027.68	32 320.47	32 140.06	32 158.36
4. Land use, land-use change and forestry	-16 806.83	-28 844.99	-21 820.22	-18 446.49	-13 796.38	-11 804.84	-9 500.20
5. Waste	16 368.96	11 558.01	11 922.22	11 945.93	11 802.59	11 688.53	11 606.97
Total*	**570 370.88**	**385 842.89**	**387 993.26**	**379 373.75**	**360 933.03**	**326 284.21**	**327 393.91**
International fuel bunker - total	**2 784.99**	**2 481.21**	**2 753.18**	**3 147.43**	**3 518.05**	**3 953.69**	**4 136.97**
Aviation	1 016.15	1 889.96	2 102.81	2 420.19	2 737.61	3 054.99	3 054.99
Maritime	1 768.83	591.25	650.37	727.23	780.44	898.69	1 081.98

* The total emission does not include emissions and removals from sector 4. *Land use, land-use change and forestry*

Source: IOŚ–PIB, KOBiZE

Comparison of the total forecasted emission from all sectors, for the years 2020–2040, with that for the base year 1988, has shown a reduction by 32% in 2020, by 36.7% in 2030 and by 42.6% in 2040. The largest projected reduction occurred in *Energy* sector (by 47% between the years 1988–2040) and in *Agriculture* (by 33% between the years 1988–2040). On the other hand, the forecasted emission from *Industrial processes and product use* is higher in 2040 than in the base year by about 7% (Table 5.16) (Figure 5.1).

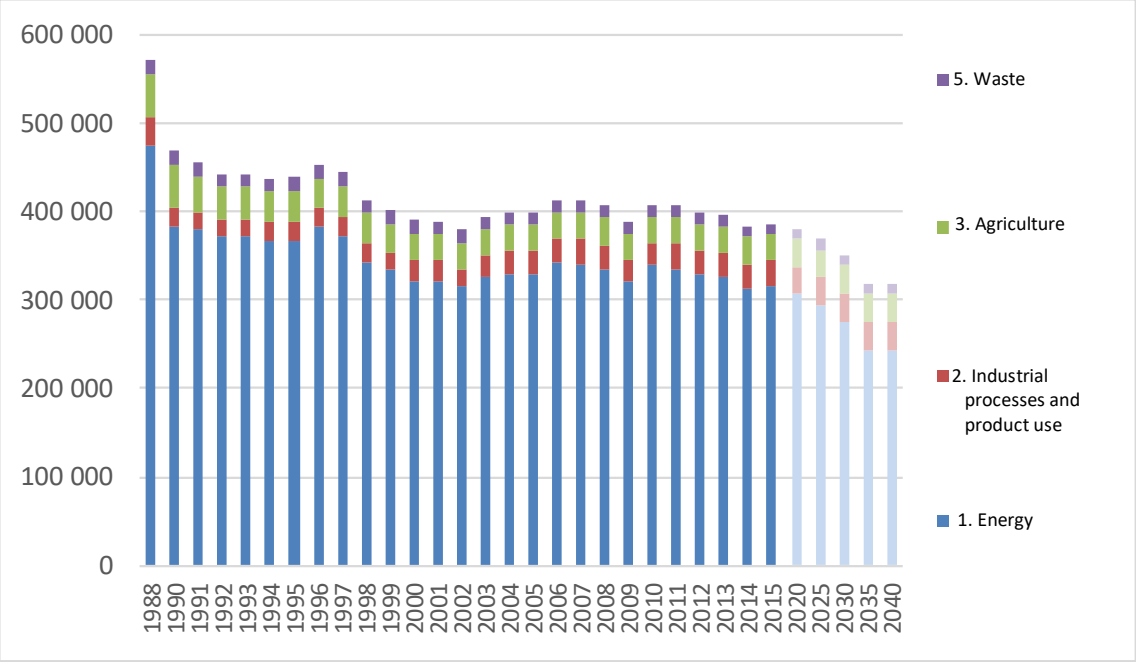


Fig. 5.1. Current (1988–2015) and projected (2020–2040) greenhouse gases emission in Poland, expressed in CO_2 equivalent. Source: IOŚ–PIB, KOBiZE

Data on changes in greenhouse gases emissions from the respective IPCC source categories in the years 1988–2040 (Table 5.17) show that the share of *Energy* sector will decline from over 83% to about 76%, while the share of other sectors, in particular the industrial ones, will increase.

Table 5.17. GHG emission structure in 1988, 2015, 2030 and 2040

Source categories	Structure of GHG emission [%]			
	1988	2015	2030	2040
1. Energy	83.27	81.93	78.94	76.44
2. Industrial processes and product use	5.47	7.39	8.84	10.19
3. Agriculture	8.39	7.68	8.95	9.82
5. Waste	2.87	3.00	3.27	3.55
Greenhouse gases	**1988**	**2015**	**2030**	**2040**
CO_2	82.56	80.51	79.33	77.30
CH_4	12.28	12.23	12.37	13.51
N_2O	5.14	4.92	5.80	6.24
HFCs	0.00	2.32	2.48	2.93
PFCs	0.03	0.00	0.00	0.00
SF_6	0.00	0.02	0.01	0.02

Source: IOŚ–PIB, KOBiZE

Table 5.18. provides the detailed results of carbon dioxide emissions projection by respective categories of IPCC sources. Based on the existing data, it can be concluded that CO_2 emissions will gradually decrease by 2040, reaching the level of 314 million tonnes by 2020, and extra around 253 million tonnes by 2040. Compared to 1988, there will be a significant decline in emissions: by 33% in 2020, by 39% in 2030 and by 46% in 2040. The largest impact on emission fluctuations has sector 1. *Energy* and related forecasted changes in the structure and amount of fuel consumed.

Table 5.18. CO_2 emissions by detailed categories of IPCC sources in 1988 and 2015, and in the forecast years 2020, 2025, 2030 and 2040.

Source categories	CO_2 emissions [kt] in years					
	1988	2015	2020	2025	2030	2040
1. Energy	**441 908.41**	**290 841.09**	**291 451.18**	**280 785.71**	**261 910.49**	**227 843.80**
A. Fuel combustion	438 753.54	287 305.83	287 944.54	277 279.07	258 403.85	224 337.16
1. Energy industries	256 963.48	162 689.57	158 030.59	146 045.05	130 571.22	102 168.64
2. Manufacturing industries and construction	55 067.83	27 827.37	27 482.32	29 708.89	29 966.43	32 053.03
3. Transport	23 597.10	460 33.81	53 128.58	56 243.78	56 010.42	54 374.69
4. Other sectors	103 125.14	507 55.08	49 303.05	45 281.35	41 855.78	35 740.81
B. Fugitive emissions from fuels	31 54.87	35 35.26	3 506.64	3 506.64	3 506.64	3 506.64
1. Solid fuels	31 15.68	1 678.68	1 761.15	1 761.15	1 761.15	1 761.1526
2. Oil and natural gas and anoter emissions from energy products	39.19	1 856.58	1 745.49	1 745.49	1 745.49	1 745.4867
2. Industrial processes and product use	**26 061.44**	**185 39.33**	**19 985.74**	**21 045.91**	**21 675.10**	**22 483.64**
A. Mineral industry	11 605.22	100 88.56	10 554.14	11 061.04	11 569.50	12 393.28
B. Chemical industry	5 757.60	5 141.13	5 473.54	5 894.83	5 872.39	5 872.39
C. Metal industry	7 729.51	2 592.10	3 261.14	3 393.12	3 536.29	3 521.05
D. Non-energy products from fuels and solvent use	969.11	717.54	696.92	696.92	696.92	696.92
3. Agriculture	**2 468.52**	**770.57**	**843.84**	**870.87**	**888.89**	**888.89**
G. Liming	1 950.86	373.84	420.43	420.43	420.43	420.43
H. Urea application	517.66	396.73	423.41	450.44	468.46	468.46
4. Land use, land-use change and forestry	**-1 7021.25**	**-299 72.75**	**-22 359.70**	**-19 048.41**	**-14 460.69**	**-10 289.43**
5. Waste	**448.05**	**487.60**	**1 811.08**	**1 863.68**	**1 863.68**	**1 856.65**
C. Incineration and open burning of waste	448.05	487.60	1 811.1	1 863.7	1 863.7	1 856.7
Total CO_2 emissions without sector 4.	**470 886.43**	**310 638.59**	**314 091.83**	**304 566.17**	**286 338.15**	**253 072.98**
CO_2 emissions from biomass	**6 869.31**	**34 767.31**	**49 759.15**	**48 494.80**	**48 672.24**	**48 009.80**

Source: IOŚ–PIB, KOBiZE

Table 5.19. shows changes in the structure of carbon dioxide emissions from IPCC source categories in 1988, 2015 and 2020, 2025, 2030 and 2040. There is a reduction in the share of *Energy* sector in the total CO_2 emission, which is offset by a simultaneous significant increase in the share of sector *Industrial processes and product use*.

Table 5.19. Structure of CO_2 emissions in 1988, 2015, 2030 and 2040

Categories of emission sources	CO_2 emissions structure [%]			
	1988	2015	2030	2040
1. Energy	93.85	93.63	91.47	90.03
2. Industrial processes and product use	5.53	5.97	7.57	8.88
3. Agriculture	0.52	0.25	0.31	0.35
5. Waste	0.10	0.16	0.65	0.73

Source: IOŚ–PIB, KOBiZE

The projected methane emission is gradually decreasing, from about 1.82 million tonnes in 2020 to about 1.76 million tonnes of CH_4 in 2040 (Table 5.20). Future fluctuations in CH_4 emissions are not great – the decline is forecasted mainly in the *Energy* and *Waste* sectors. CH_4 emission will decrease by about 35% in 2020, by 36% in 2030, and by 37% in 2040, as compared to the level of 1988.

Table 5.20. CH_4 emission by IPCC source categories in 1988 and 2015, and forecasts for the years: 2020, 2025, 2030 and 2040

Source categories	CH_4 emission [kt] in years					
	1988	2015	2020	2025	2030	2040
1. Energy	**1219.20**	**916.95**	**874.14**	**850.94**	**826.75**	**813.68**
A. Fuel combustion	221.89	144.20	140.08	130.37	122.96	109.89
1. Energy industries	3.61	4.70	7.46	6.17	5.45	4.77
2. Manufacturing industries and construction	4.04	4.27	3.08	3.36	3.43	3.72
3. Transport	7.54	4.26	5.09	5.49	6.55	8.44
4. Other sectors	206.70	130.96	124.45	115.36	107.53	92.95
B. Fugitive emission from fuels	997.31	772.75	734.06	720.57	703.79	703.79
1. Solid fuels	951.03	675.85	656.03	642.54	625.77	625.77
2. Oil and natural gas and other emissions from energy production	46.28	96.90	78.02	78.03	78.02	78.02
2. Industrial processes and product use	**2.81**	**2.62**	**2.72**	**3.68**	**3.65**	**3.65**
B. Chemical industry	1.74	2.02	1.97	2.93	2.91	2.91
C. Metal industry	1.07	0.60	0.75	0.75	0.75	0.75
3. Agriculture	**972.35**	**562.50**	**574.33**	**596.02**	**595.92**	**598.51**
A. Enteric fermentation	878.10	496.78	499.30	492.19	482.67	481.19
B. Manure management	93.44	64.77	74.09	102.86	112.25	116.25
F. Field burning of agricultural residues	0.81	0.95	0.94	0.97	1.00	1.06
4. Land use, land-use change and forestry	**1.77**	**1.36**	**1.67**	**1.65**	**1.62**	**1.57**
5. Waste	**606.25**	**404.97**	**365.92**	**364.62**	**359.31**	**352.92**
A. Solid waste disposal	440.49	364.47	329.58	329.88	327.66	329.58
B. Biological treatment of solid waste	0.13	7.34	7.73	8.34	8.34	8.34
C. Incineration and open burning of waste	NO, NA	0.00001	0.00062	0.00065	0.00065	0.00065
D. Waste water treatment and dischrge	165.63	33.16	28.61	26.40	23.31	15.01
Total CO_2 emission without sector 4	**2 800.61**	**1 887.04**	**1 817.10**	**1 815.26**	**1 785.64**	**1 768.76**

Source: IOŚ–PIB, KOBiZE

Methane emissions by IPCC source categories for the years: 1988, 2015, 2030 and 2040 are given in Table 5.21. Trends in all sectors show some slight changes.

Table 5.21. Structure of CH_4 emission in the years:1988, 2015, 2030 and 2040

CATEGORIES OF EMISSION SOURCES	CH_4 emission structure [%]			
	1988	2015	2030	2040
1. Energy	43.53	48.59	46.30	46.00
2. Industrial processes and product use	0.10	0.14	0.20	0.21
3. Agriculture	34.72	29.81	33.37	33.84
5. Waste	21.65	21.46	20.12	19.95

Source: IOŚ–PIB, KOBiZE

Table 5.22. shows the results of projection of nitrous oxide emission. N_2O emissions will increase to the level of nearly 68 thousand tonnes in 2020, and to over 70,000 tonnes in 2030, which will be followed by a slight decrease in emissions by 2040. The forecasts predict a decline in the emission, in relation to the base year 1988, by about 31%, 29% and 30%, respectively, in the years: 2020, 2030 and 2040. The largest reduction in N_2O emissions, compared to the base year, was recorded in sector 3. *Agriculture,* driven by a decline in livestock population and acreage of arable land.

Table 5.22. N_2O emissions by IPCC source categories in 1988 and 2015 and in the forecast years 2020, 2025, 2030 and 2040.

Source categories	N_2O emissions [kt] in years					
	1988	2015	2020	2025	2030	2040
1. Energy	**8.66**	**7.87**	**8.58**	**8.26**	**7.81**	**6.99**
A. Fuel combustion	8.66	7.87	8.58	8.25	7.81	6.99
1. Energy industries	3.71	2.60	2.91	2.58	2.28	1.80
2. Manufacturing industries and construction	0.59	0.60	0.43	0.47	0.48	0.52
3. Transport	1.35	1.67	1.97	2.10	2.07	1.97
4. Other sectors	3.00	3.01	3.26	3.11	2.97	2.69
B. Fugitive emission from fuels	0.0008	0.0017	0.0014	0.0014	0.0014	0.0014
2. Oil and natural gas andother emissions	0.0008	0.0017	0.0014	0.0014	0.0014	0.0014
2. Industrial processes and product use	**16.51**	**2.96**	**3.26**	**3.75**	**3.73**	**3.73**
A. Mineral industry	16.11	2.51	2.82	3.30	3.29	3.29
G. Other products manufacture and use	0.40	0.44	0.44	0.44	0.44	0.44
3. Agriculture	**70.67**	**49.72**	**53.11**	**54.55**	**55.48**	**54.72**
B. Manure management	10.50	7.01	6.96	7.01	7.02	6.81
D. Agricultural soils	60.13	42.68	46.12	47.50	48.43	47.87
F. Field burning of agricultural residues	0.04	0.04	0.04	0.04	0.04	0.04
4. Land use, land-use change and forestry	**0.57**	**3.67**	**1.67**	**1.88**	**2.09**	**2.52**
5. Waste	**2.57**	**3.17**	**3.23**	**3.24**	**3.21**	**3.11**
B. Biological treatment of solid waste	0.01	0.44	0.46	0.50	0.50	0.50
C. Incineration and open burning of waste	0.03	0.18	0.21	0.21	0.21	0.21
D. Waste water treatment and discharge	2.53	2.55	2.56	2.54	2.50	2.40
Total N_2O emissions excluding sector 4	**98.40**	**63.72**	**68.19**	**69.80**	**70.23**	**68.55**

Source: IOŚ–PIB, KOBiZE

Table 5.23 provides data on changes in the structure of nitrous oxide emissions from individual IPCC sectors in the years 1988, 2015 as well as in 2030 and 2040. A decline is noticeable in the share of industrial processes to the advantage of other IPCC source categories.

Table 5.23. Structure of N_2O emissions in the years 1988, 2015, 2030 and 2040

CATEGORIES OF EMISSION SOURCES	N_2O emissions structure [%]			
	1988	2015	2030	2040
1. Energy	8.80	12.35	11.12	10.20
2. Industrial processes and products use	16.78	4.64	5.31	5.44
3. Agriculture	71.82	78.03	79.00	79.82
5. Waste	2.61	4.98	4.57	4.54

Source: IOŚ–PIB, KOBiZE

Table 5.24 presents greenhouse gas emission projections expressed in CO_2 equivalent. Total emission reductions are mainly due to a significant drop in emissions in category 1.A.1. *Energy industries*

Table 5.24. Total greenhouse gases emissions expressed in CO_2 equivalent by IPCC source categories in the years 1988 and 2015 and in the forecast years 2020, 2025, 2030 and 2040

Source categories	Emissions [kt CO_2 eq.] in years					
	1988	2015	2020	2025	2030	2040
1. Energy	**474 968.03**	**316 109.87**	**315 861.06**	**304 519.50**	**284 906.63**	**250 268.44**
A. Fuel combustion	446 880.19	293 255.24	294 002.59	282 998.27	263 804.83	229 166.63
1. Energy industries	258 160.25	163 580.80	159 085.59	146 967.30	131 388.28	102 825.71
2. Manufacturing and construction	55 344.59	28 111.77	27 687.79	29 932.85	30 195.04	32 300.91
3. Transport	24 189.07	46 637.99	53 842.65	57 006.06	56 792.16	55 173.38
4. Other sectors	109 186.27	54 924.68	53 386.57	49 092.06	45 429.36	38 866.63
B. Fugitivee emission from fuels	28 087.84	22 854.63	21 858.47	21 521.22	21 101.80	21 101.80
1. Solid fuels	26 891.48	18 574.95	18 161.97	17 824.68	17 405.34	17 405.34
2. Oil and natural gas and other emission from energy production	1 196.36	4 279.69	3 696.50	3 696.55	3 696.46	3 696.46
2. Industrial processes and product use	**31 198.21**	**28 525.12**	**29 180.59**	**30 880.64**	**31 903.33**	**33 360.15**
A. Mineral industry	11 605.22	10 088.56	10 554.14	11 061.04	11 569.50	12 393.28
B. Chemical industry	10 601.17	5 940.96	6 364.17	6 952.87	6 925.36	6 925.36
C. Metal industry	7 903.51	2 611.18	3 283.96	3 415.95	3 559.14	3 543.85
D. Non-energy products from fuels and solvent use	969.11	717.54	696.92	696.92	696.92	696.92
F. Product use as ODS substitutes	0.00	8 962.06	8 102.45	8 572.11	8 968.27	9 612.68
G. Other product manufacture and use	119.20	204.84	178.94	181.75	184.14	188.05
3. Agriculture	**47 835.68**	**29 649.89**	**31 029.39**	**32 027.68**	**32 320.47**	**32 158.36**
A. Enteric fermentation	21 952.45	12 419.47	12 482.59	12 304.68	12 066.76	12 029.85
B. Manure management	5 464.26	3 706.80	3 926.07	4 661.48	4 897.49	4 936.18
D. Agricultural soils	17 919.06	12 718.46	13 743.04	14 155.53	14 431.25	14 265.04
F. Field burning of agricultural residue	31.38	34.59	33.85	35.12	36.09	38.41
G. Liming	1 950.86	373.84	420.43	420.43	420.43	420.43
H. Urea ppplication	517.66	396.73	423.41	450.44	468.46	468.46
4. Land use, land-use change and forestry	**-16 806.83**	**-28 844.99**	**-21 820.22**	**-18 446.49**	**-13 796.38**	**-9 500.20**
5. Waste	**16 368.96**	**11 558.01**	**11 922.22**	**11 945.93**	**11 802.59**	**11 606.97**
A. Solid waste disposal	11 012.22	9 111.69	8 239.42	8 246.96	8 191.58	8 239.42
B. Biological treatment of solid waste	5.49	314.84	331.66	357.61	357.61	357.61
C. Incineration and open burning of waste	457.71	542.25	1 872.53	1 925.46	1 925.46	1 918.43
D. Waste water treatment and discharge	4 893.53	1 589.22	1 478.60	1 415.90	1 327.94	1 091.51
Total CO_2 emission without category 4	**570 370.88**	**385 842.89**	**387 993.26**	**379 373.75**	**360 933.03**	**327 393.91**

Source: IOŚ–PIB, KOBiZE

Balances of GHG emissions and removals in the period 2011–2030, by activity related to sector *Land use, land-use change and forestry* (LULUCF) under Article 3.3. and 3.4. of the Kyoto

Protocol are compiled in Table 5.25. These balances are negative for activities such as afforestation of non-forest land and forest management, what in the final calculation means CO_2 sequestration. The prognostic values presented here are the result of sustainable forest management, implemented consistently by mainly the State Forests in recent decades (in particular, after 1991).

Table 5.25. GHG emissions and absorption balance for LULUCF activity under the Kyoto Protocol

Range of activity	Activity	GHG emission and absorption balance [kt CO_2 equivalent]				
		2020	2025	2030	2035	2040
Kyoto Protocol Art. 3.3	Afforestation/reforestation	-2.48	-2.05	-1.85	-1.80	-1.76
	Deforestation	0.26	0.26	0.26	0.26	0.26
Kyoto Protocol Art. 3.4	Forest management	-20.63	-17.64	-13.15	-11.17	-8.86
	Cropland management	not applicable	not applicable	not applicable	not applicable	not applicable
	Grazing land management	not applicable	not applicable	not applicable	not applicable	not applicable
	Revegetation	not applicable	not applicable	not applicable	not applicable	not applicable

Source: IOŚ–PIB, KOBiZE

5.3. Comparison of current emission projections with projections covered by the BR2

In Tables 5.26 and 5.27, the results are compared of the current projections for greenhouse gas emissions with data from the Second Biennial Report for the years 2020, 2025 and 2030. Both scenarios are the so-called senarios "with measures".

The projections of total greenhouse gas emissions in the current report are higher for all forecasted years than in the Second Biennial Report. The difference amounted to 1.6 million tonnes of CO_2 eq. in 2020, 5.7 million tonnes of CO_2 eq. in 2025, and 2.1 million tonnes of CO_2 eq. in 2030. Thus, the increase in the currently forecasted emission in relation to those presented in the Second Biennial Report was 0.4%, 1.5% and 0.6%, respectively, in the 2020, 2025 and 2030. In general, in the Second Biennial Report, lower emission levels were forecasted for CO_2 and CH_4, and higher for industrial gases.

Table 5.26. Comparison of current projections of greenhouse gas emissions with those predicted in Second Biennial Report, by greenhouse gases

Greenhouse gases	7. National Communication and Third Biennial Report			Second Biennial Report		
	2020	2025	2030	2020	2025	2030
	CO_2 eq. kt					
CO_2	314 091.83	304 566.17	286 338.15	311 662.90	299 099.18	284 508.55
CH_4	45 427.52	45 381.54	44 641.04	43 747.99	42 792.51	41 950.66
N_2O	20 319.87	20 799.54	20 928.79	20 424.27	20 719.26	20 879.32
HFCs	8 095.06	8 565.51	8 962.32	10 512.43	11 036.55	11 448.18
PFCs	11.53	10.74	10.10	13.75	13.08	12.57
SF_6	47.44	50.25	52.63	46.32	48.18	49.65
Total emission without category 4	**387 993.26**	**379 373.75**	**360 933.03**	**386 407.67**	**373 708.75**	**358 848.93**

Source: IOŚ–PIB, KOBiZE

Table 5.27. Comparison of current projections of greenhouse gas emissions with those predicated in Second Biennial Report, by main source categories

CATEGORIES OF EMISSION SOURCES	7. National Communication and Third Biennial Report			Second Biennial Report		
	2020	2025	2030	2020	2025	2030
	kt CO_2 eq.					
1. Energy	315 861.06	304 519.50	284 906.63	308 600.31	294 340.19	278 818.45
2. Industrial processes and product use	29 180.59	30 880.64	31 903.33	34 335.00	35 245.11	35 527.90
3. Agriculture	31 029.39	32 027.68	32 320.47	33 292.97	34 234.20	34 828.12
4. Land use, land-use change and forestry	-21 820.22	-18 446.49	-13 796.38	-22 316.20	-16 755.25	-12 963.63
5. Waste	11 922.22	11 945.93	11 802.59	10 179.39	9 889.25	9 674.45
Total emission without category 4	**387 993.26**	**379 373.75**	**360 933.03**	**386 407.67**	**373 708.75**	**358 848.93**

Source: IOŚ–PIB, KOBiZE

Key assumptions for sector 1. *Energy,* concerning fuel consumption in stationary sources, were based on the *Forecast of fuel and energy demand until 2050* (National Agency for Energy Conservation 2013) and the related study: *Analysis for assessing the effect of EU climate and energy policy on Poland's energy policy* (National Agency for Energy Conservation, 2014), are the same in both the abovementioned Reports. New assumptions for the *Poland's Energy Policy until 2050*, including the update of the forecasted demand for fuels and energy, are in the course of preparation at the Ministry of Energy.

For the purpose of this Report, the values of fuel consumption were updated in the road transport sector based on a new study of 2017, which resulted in a slight increase in the forecasted greenhouse gas emissions in this sector. In addition, updates have been made of forecasted values of industrial and agricultural production as well as of the national waste management plan. This Report also updates projections for international aviation and sector 4. *Land use, land-use change and forestry* (LULUCF), as well as projections for LULUCF activities under Articles 3.3 and 3.4 of the Kyoto Protocol.

5.4. Assessment of aggregate effects of policies and measures

In line with the "with measures" scenario, the aggregate effects of policies and measures to reduce greenhouse gas emissions, aiming primarily at improving energy efficiency, increasing the use of renewable sources, diversifying fuel structure in the energy sector, and implementing modern technologies, are shown in Figure 5.2. The diagram shows reduction in emissions achieved until and following the year 2010, as compared to the forecasted emissions.

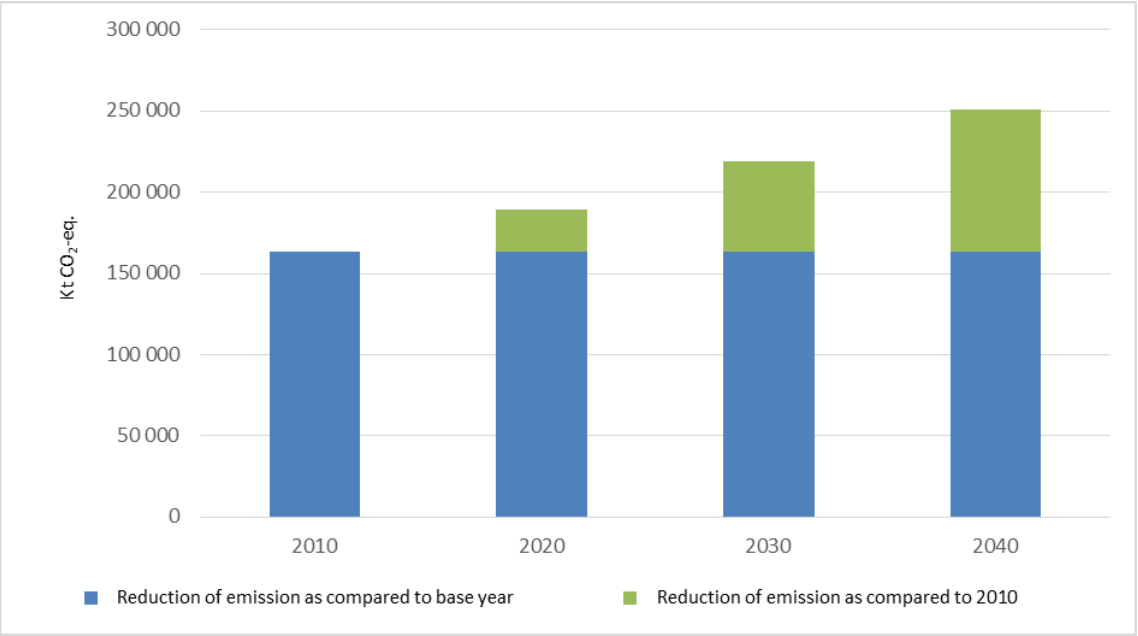


Fig. 5.2. Aggregate effects of policies and actions implemented according to "with measures" scenario for the years 2020, 2025, 2030 and 2040 [kt. CO_2 eq.]

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

6.1. Introduction

First steps towards development of a strategy for adaptation to climate change (Strategic Adaptation Plan) were taken in 2009. These were based on the "Government's Position", adopted on 3 July 2009 by the European Committee of the Council of Ministers, as the response to the EU'sstrategic document: COM (2009) 147/4. WHITE PAPER. Adapting to climate change: Towards a European framework for action, that set out a framework to reduce the EU's vulnerability to the impact of climate change.

Since the preparation of the 6th National Communication by Poland, further progress has been made regarding measures undertaken as to current and expected climate change. The Government's Position laid down the basis for the implementation (2011–2013) of the project entitled "The Development and Implementation of a Strategic Adaptation Plan for the Sectors and Areas Vulnerable to Climate Change" (KLIMADA; (http://ios.edu.pl/pol/aktualnosci/15.01.14/adaptacja_wrazliwych_sekt_i_obsz_Polski_do_zmian_klimatu.pdf). The results provided the basis for development of the Strategic Adaptation Plan 2020 (SAP 2020) with an Outlook until 2030. This new strategy forms part of the EU's Adaptation Framework with the objective to improve the EU's resilience to deal with the impact of climate change, with special attention paid to better preparedness for extreme weather events and to the current and future multi-annual financial framework.

6.2. Observed climate change and predicted changes in the future

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 climate data records carried out within Poland's territories. Over the period of last 30 years, the warmest years were: 2015, 2014, 2000, 2008, 2007 and 1989, with average annual temperatures (°C) in Warsaw: 9.7; 9.6; 9.5; 9.4; 9.4 and 9.2, respectively (figure 6.1). In all the seasons of the year, the air temperature raise has been observed – first of all, in the winter and spring, and then - in the summer and autumn. The same strong trend has been observed in the case of maximum and minimum temperatures, however, the minimum temperature rise rate has been noticeably higher when compared with the maximum temperature. This asymmetric trend cause changes in air temperature amplitudes. Since 1981, a distinct increase of extreme temperatures has been recorded.

In the period discussed, the temperature all through the country regions shows an upward trend, even though temperature rise rate has varied. In the years 1981–2010, the annual average temperature rised at a rate of about 0.3 °C/10 years in western and and easter parts of the country to about 0.1 °C in the central parts. Significant long-term changes also occur as to several other characteristics of thermal conditions, e.g. the number of days with specified thermal threshold values (thermally characteristic days). The number of days with the temperature > 25°C increases annually at a rate of approximately 6 days/10 years, and that of days with temperatures below 0°C decreases at a rate of approximately 2–3 days/10 years, depending on the region of the country.

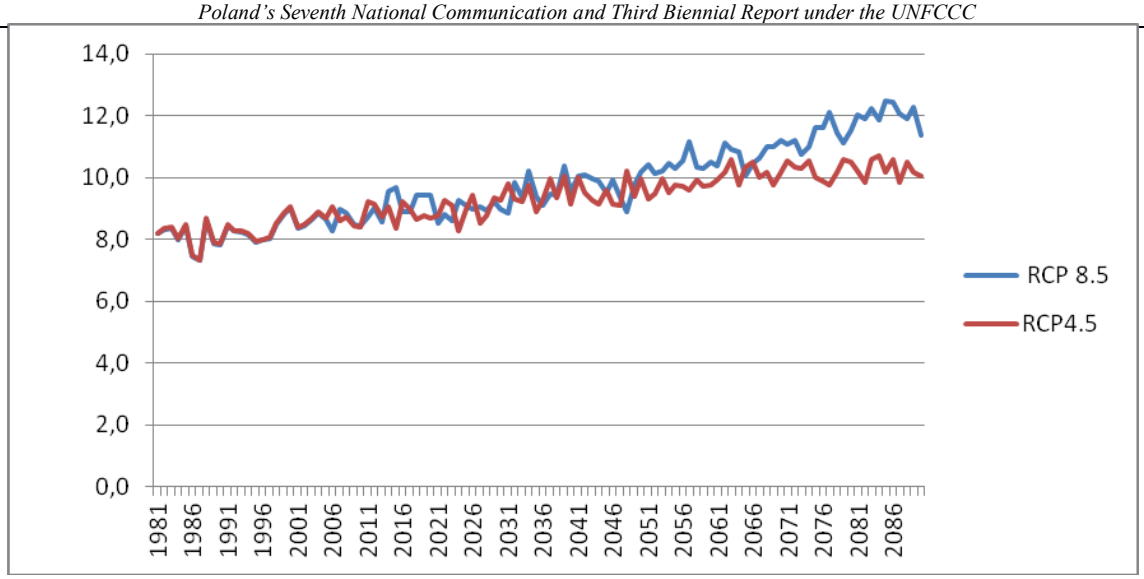


Fig. 6.1. Changes in average annual air temperature in Warsaw in the historical period (until 2010; RCP scenarios 8.5 and 4.5).

6.2.2. Expected climate change

The comparison of current trends with those expected in mid-21st century indicates that the future climate changes in Poland the will show the same tendency, however, the process will be more intense. This particularly concerns summer and winter warming (figures 6.2 and 6.3). In the summer, the number of hot periods, with temperatures above 25°C, will considerably increase (fig.6.4)

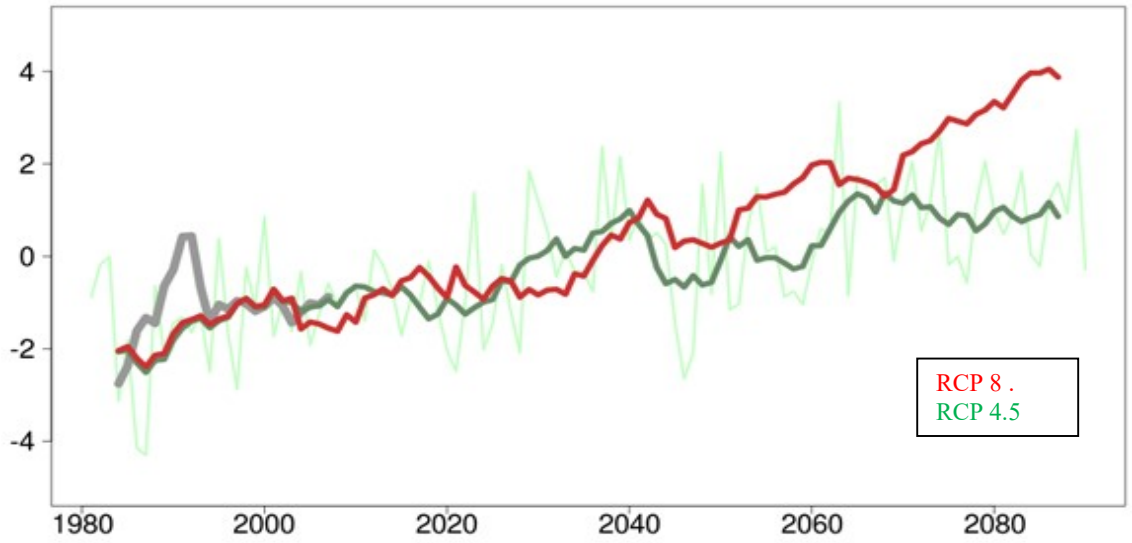


Fig. 6.2. Average winter (December–February) temperature [°C] in Warsaw for the years 1981–2090 (*Source*: ICM UW) (gray line- the observed temperature; light-green line–model simulation variation)

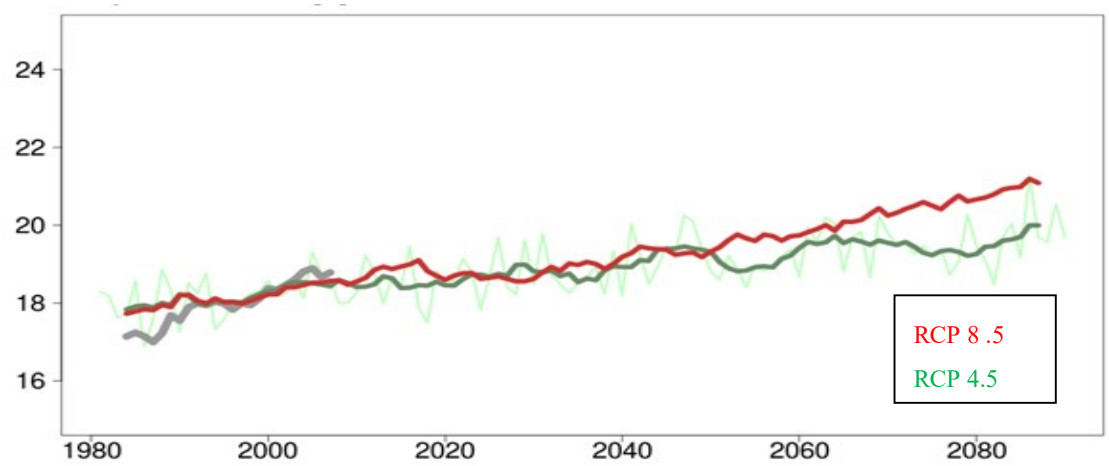


Fig. 6.3. Average summer (June-August) temperature of [°C] in Warsaw for 1980-2080 (*Source*: ICM UW) (Explanations: see above)

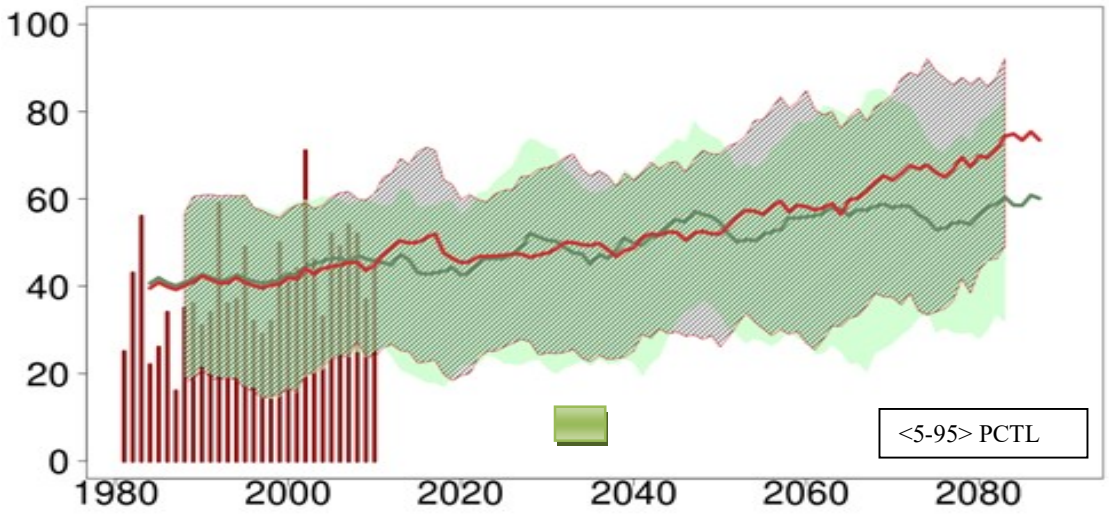


Fig. 6.4. Number of days with maximum temperature > 25 °C in Warsaw for 1980–2080 (*Source*: ICM UW)

In most Poland's regions, there has been observed a downward trend in the number of days with temperatures below 0 °C, as illustrated in Figure 6.5.

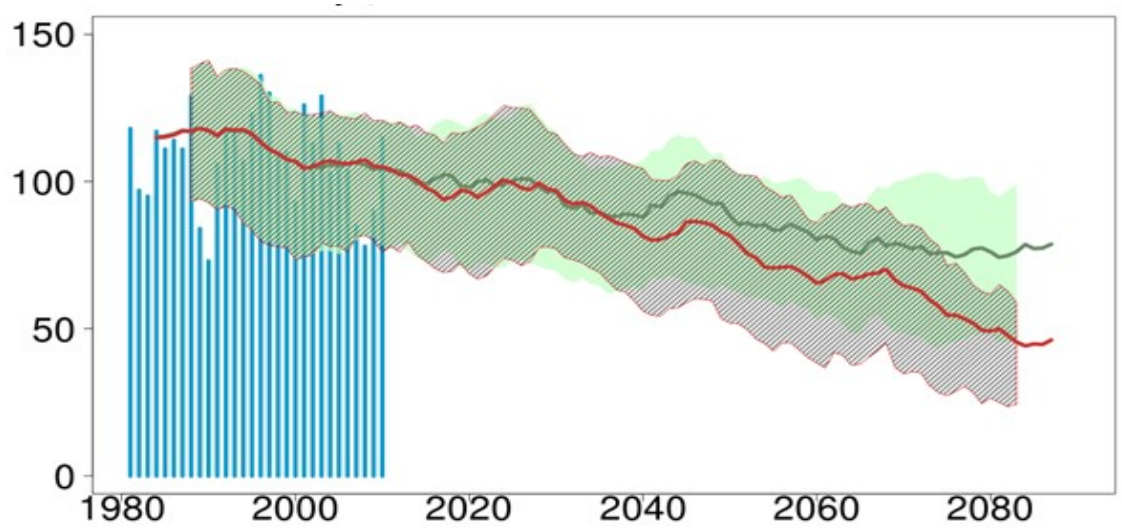


Fig. 6.5. Number of days with minimum temperature <0 °C in Warsaw for 1980–2080 (*Source*: ICM UW)

The rising temperature trend is increasing in the second half of the century, with the annual variation of about 13%.

The second basic climatic parameter - precipitation, has shown less intense changes, however, it is more diversified in terms of spatial distribution. In the period 1981–2010, the annual precipitation increased moderately, from a dozen to a few tens of millimeters per decade. During the summer season, the increase in precipitation amounts to 60 mm/10 years. Precipitation observed in the last 30 years had most significant effects on this trend. The number of days with precipitation > 1 mm slightly increased to 5 days/10 years (days/decade). Contrary to expectations, the number of precipitation-free periods longer than 5 days shows no change. On the other hand, the number of days without precipitation varies widely depending on the western and eastern parts of the country, whereas in the ceentral parts, it has decreased. Nonetheless, there should be taken into consideration that the above tendencies were determined based on a linear trend and must be interpreted as changes of statistical nature. Heavy rainfall of more than 5 mm/min, with seasonal (May–September) probability ≥ 10% is observed most frequently in southern Poland. The highest daily precipitation levels show no significant changes (fig. 6.6).

Annual and seasonal precipitation will continue to increase to a small extent. However, precipitation intensity will considerably increase, and heavy rains and thunderstorms will be more repeatedly observed.

In most Poland's regions, there has changed the structure of precipitation, which is expressed by a substantial increase in the number of days with heavy rainfall, e.g.: in the case of daily precipitation 30 mm an increase by more than 3 days/decade; daily precipitation ≥ 50 mm - an increase by 2 days/decade (fig.6.7).

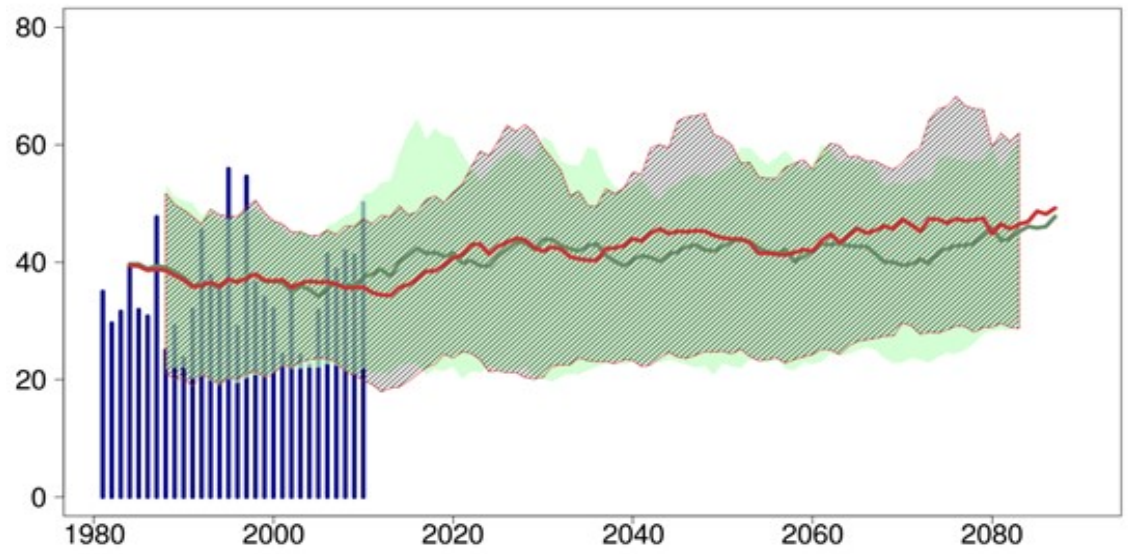


Fig. 6.6. Maximum daily precipitation [mm] in Warsaw for the years 1981–2090 (*Source*: ICM UW)

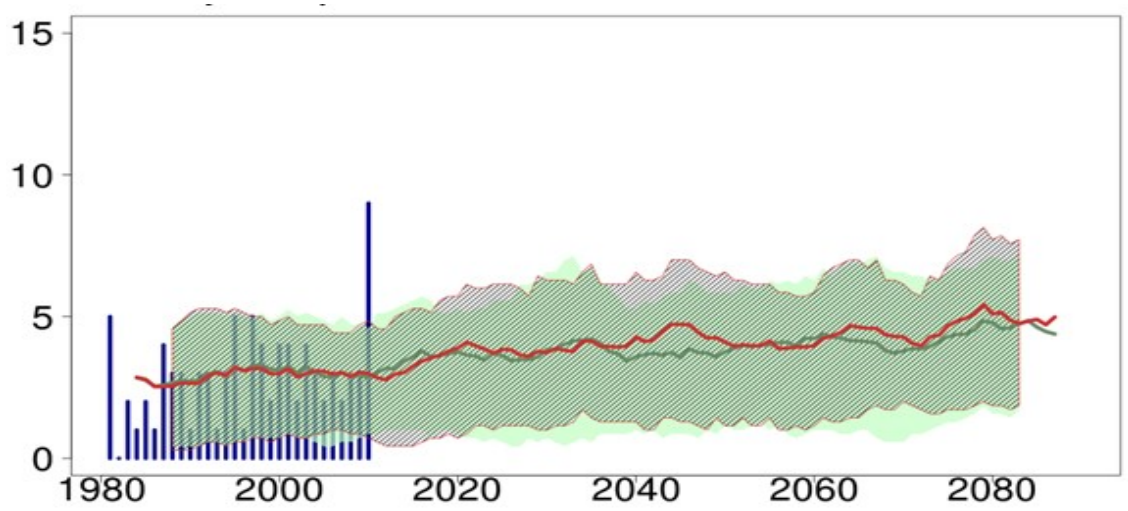


Fig. 6.7. Number of days with precipitation ≥ 20 mm in Warsaw for 1981–2090 (*Source*: ICM UW)

In the whole period referred to in the present report (1981–2090), the mean annual temperature rises on average by about 0.4°C/decade. There are observed changes in the frequency of dangerous and disruptive events, especially in the absence of snow cover in winter, i.e. frost wave and spring frost incidents, low river water levels, soil droughts, rainstorms and floods, heat waves, hurricanes and tornados. The observed temperature rise contributes to prolongation of the vegetation season, nevertheless, water deficiency has become limitation for agricultural production.

Summary of changes of selected climate characteristics, in Central Poland until the end of 21st century, is presented in table 6.1.

Summary

– Poland's climate indicates a systematic trend of increasing air temperature, starting from the late 19th century. A considerable rise in temperature has been observed since 1989.

- Air temperature pasterns show a marked upward trend across the country: temperature changes are of regional and seasonal nature, and higher temperatures are expected at the end of the century. In the last 30 years, the highest temperature rise rates – above 4.5°C – are evident in winter (low temperature range), in the northeastern part of the country and in the summer (high temperature range) - in southeastern Poland.
- With the increase in temperature, changes have been observed in the associated climate parameters, e.g.: prolonged duration of the thermal vegetation period due to its earlier beginning, there decreases the number of days with minimum temperatures below 0°C, whereas the number of days with maximum temperatures above of 25°C increases. The values of these characteristics are differentiated regionally. Precipitation shows unidirectional tendencies, and there are recorded periods with more or less humidity. On the other hand, the precipitation structure has changed, mainly in the warm season of the year; there have been increasingly observed rapid, short-lived and destructive rainstorms leading to frequent flooding.
- Climate warming has triggered extreme weather events which are becoming more frequent.

Table 6.1. Changes in selected climate characteristics until 2070

Charakteristics	Mean value			
	2010	**2030**	**2050**	**2070**
number of days per year with T_{min} <0°C	101.70	96.82	81.93	72.15
number of days per year with T_{min} <-10°C	13.39	11.12	7.56	6.38
number of days per year with T_{min} <-20°C	0.7	0.68	0.34	0.3
number of degree-days per year, $T_{threshold}$ <17°C	3379	3236	3005	2803
number of days per year with snow cover	75.37	63.43	51.16	43.6
maximum daily precipitation [mm/d]	28.59	31.11	32.17	32.93
length of the longest period with precipitation greater than 1 mm/d [days]	8.72	8.77	8.84	8.66
number of periods with precipitation greater than 1 mm/d, longer than 5 days [-]	2.77	2.99	3.11	2.91
number of days with precipitation greater than 10 mm	9.96	9.76	10.35	10.53
number of days with precipitation greater than 20 mm	1.76	2	2.2	2.24
average daily wind velocity v [m/s]	4.22	4.22	4.22	4.21
number of days per year with wind velocity v_{max}> 10 m/s]	43.1	42.88	42.66	42.51
number of days in a year with wind with v_{max}> 15 m/s	6.58	6.34	6.37	6.33
number of days in a year with wind with v_{max}> 20 m/s	0.76	0.74	0.78	0.77
average daily temperature T [ºC]	8.11	8.63	9.33	10.10
number of days per year with temperature T_{max}> 25°C	29.80	35.56	37.49	46.28

Source: ICM UW

6.3. Extreme events

Extraordinary risks are associated with hardly ever occurring extreme events – most often of local nature, such as e.g. cloudburst, hurricane, heat wave, and also landslide, avalanche or forest fire. The common feature of these events is their unpredictability and relatively short duration, whereas the small-scale occurrence makes them not sufficiently recognized in prognostic models. Large-scale extreme events, different from the above in terms of time, spatial distribution and losses caused include floods and droughts.

Extreme events occur with different frequencies and in different seasons of the year, as illustrated in Table 6.2.

Table 6.2. Extreme events and their occurrence in the year

Risk/month	I	II	III	IV	V	VI	VII	VII	IX	X	XI	XII
Snowmelt flooding												
Snowmelt-rainfall flooding												
Flooding due to ice jam												
Rainfall flooding												
Storm flooding												
Landslides												
Strong winds, hurricanes												
Tornados												
Severe frosts, blizzards												
Forest fires												
Drought												
Snow avalanches												
Heat												

Source – RCB 2013

Description: very high financial loss (red), high financial risk (orange), low financial risk (green)

6.3.1. Floods

Floods and inundations are the most frequent and most hazardous events related to climate conditions. Rapid flooding events, including flash floods, happen all over Poland posing an increased threat to all kinds of environments (fig. 6.8).

Floodings caused by rainstorm/cloudburst are extremely hazardous and cause substantial damage, nevertheless, they are of local character (fig. 6.9). Since the frequency of very intensive rainfalls increases along with climate change, the frequency of such floods also increases. Floods of this type are particularly risky in the mountain and submontane areas, where they substantially damage soil (slope erosion), tree-stands, and lead to landslides, also in urban areas which are threatened by inundations and floodings.

River floods (e.g. Odra, Vistula and their major tributaries) are caused by many interconnected natural factors and processes. Generally, river floods are mainly driven by rainfalls, their rates, spatial distribution and intensity. The characteristics such as: terrain, riverbed, river network structure, forest cover and the status of the flood protection system are of large importance. The analyses carried out for the Upper Odra River show increasing frequency the maximum flows.

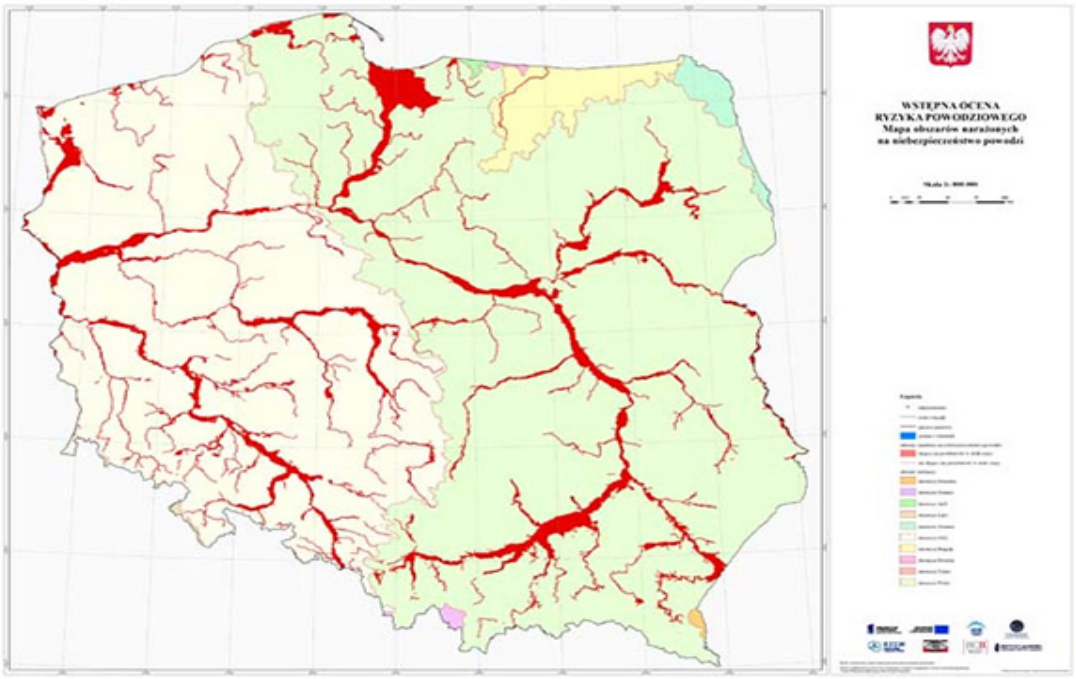


Fig. 6.8. Flood hazard in Poland *Source*: KPZK 2030

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 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.

It can be expected that winter and snowmelt floodings will continue to show a decreasing incidence, as they depend on climatic conditions and currently the temperature increases and the thickness of snow cover decreases.

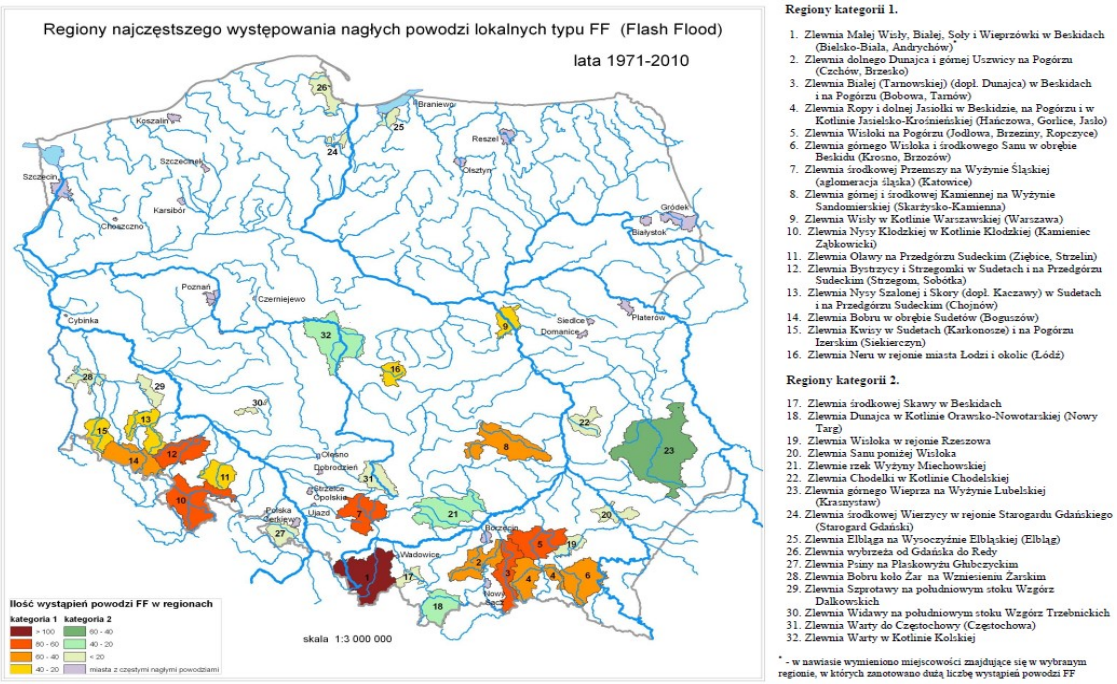


Fig. 6.9. Regions of the most frequent flah floods in the years 1971–2010, *Source*: Ostrowski et al. 2012[9]

6.3.2. 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.

Landslides, the frequency of which is increasing mainly in mountainous and sub-mountainous areas (Fig. 6.10), are particularly hazardous 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.

[9] Ostrowski J. i in. 2012 Nagłe powodzie lokalne (flush flood) w Polsce i skala ich zagrożeń w: Projekt KLIMAT t.3 IMGW-PIB

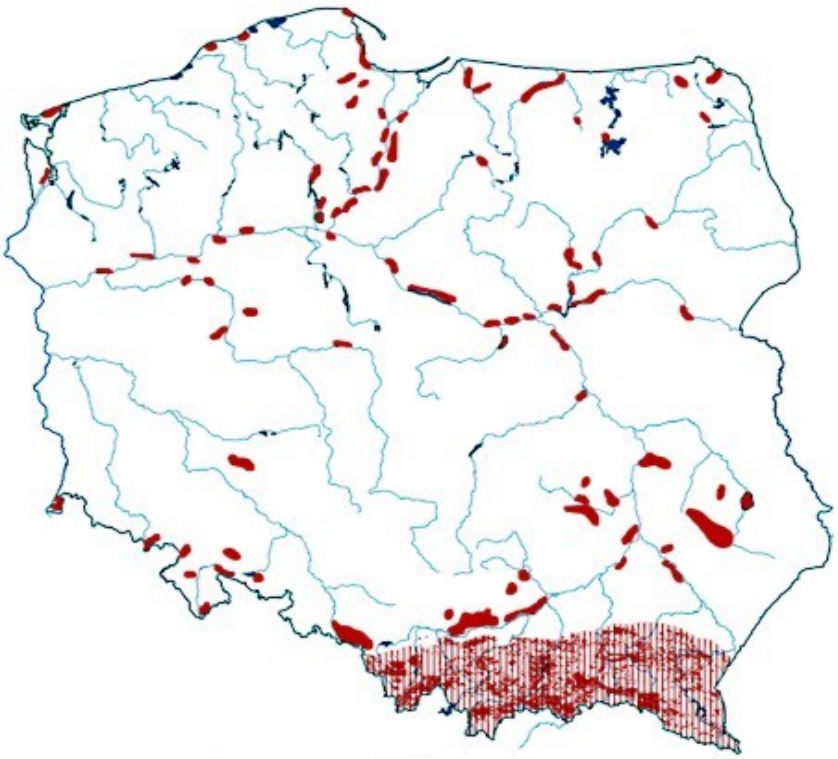


Fig. 6.10. Map of landslides in Poland, Source: PIG–PIB

6.3.3. Strong winds

Since 2005, there have been recorded 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 events 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). In the cold season of the year (October – April), there grows the share of wind gusts with speed ≥ 17 m/s, posing substantial threat, while in the summer (June – July) hurricane wind speeds occur. In the structure of the duration of the maximum speeds, more and more often winds with high speeds are observed (for many hours or even several days).

From June to August, in the different regions of the country, there occur tornados. Usually, tornados occur 6 times a year, but in the last 3 years their frequency has increased to 7–20. Changes in the frequency of the occurrence of tornados are shown in fig. 6.11.

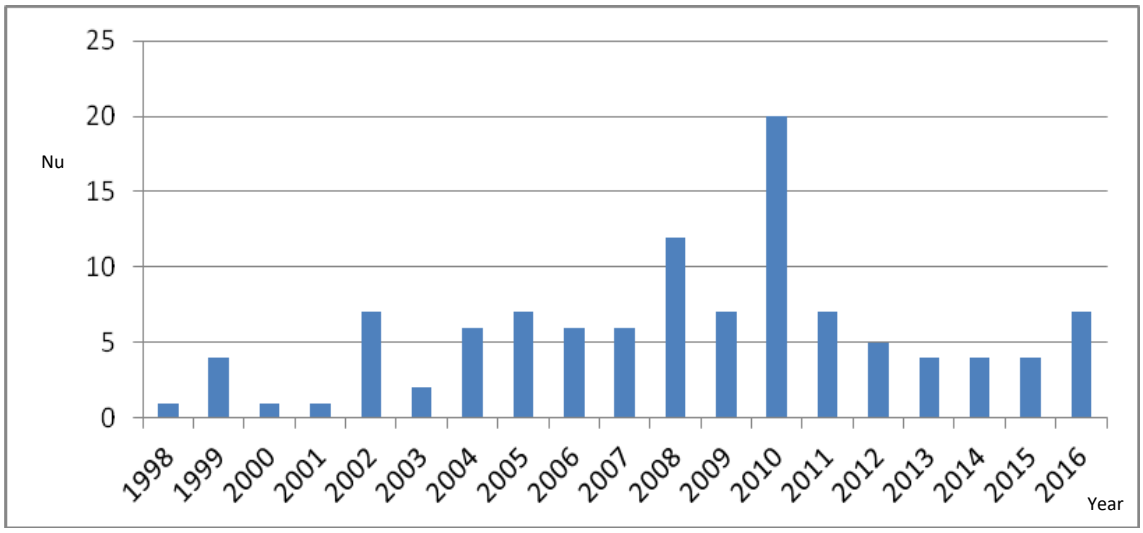


Fig. 6.11. Frequency of occurrence of tornados in Poland, Source: IMGW–PIB, Chmielewski et al. 2016

6.3.4. Hail

Hail occurs most often in May and June. In 2000–2010, the number of days with hail decreased when compared with the period from 1971 to 1980. The annual average number of days with hail (in the period from 1960 to 1978) was 0.14 per 100 km². Values exceeding this 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 storms and heavy rains. Given the expected increase of hail frequency and intensity, the occurrence of hail eventswill increase.

Other events (icing, fires) are incidental in Poland.

6.4. Drought and water deficit

The periodical occurrence of droughts is a characteristic for Poland's climate conditions. Over the last 60 years, the frequency of droughts has increased, e.g. in Poland's territory droughts occurred 6 times in 1951–1981 and 19 times in 1982–2015. In the latter period, droughts occurred almost incessantly in Almost all regions of the country. Since the beginning of the 21st century, until 2015, droughts occurred 10 times in the different seasons of the year.

As shown in the example in figure 6.12, the drought expressed as 3-month SPI (standardized precipitation index is the basic parameter for determining atmospheric drought) for Warsaw shows that in the last 30 years, drought incidence has decreased. However, the SPI point values cannot be representative of the whole country.

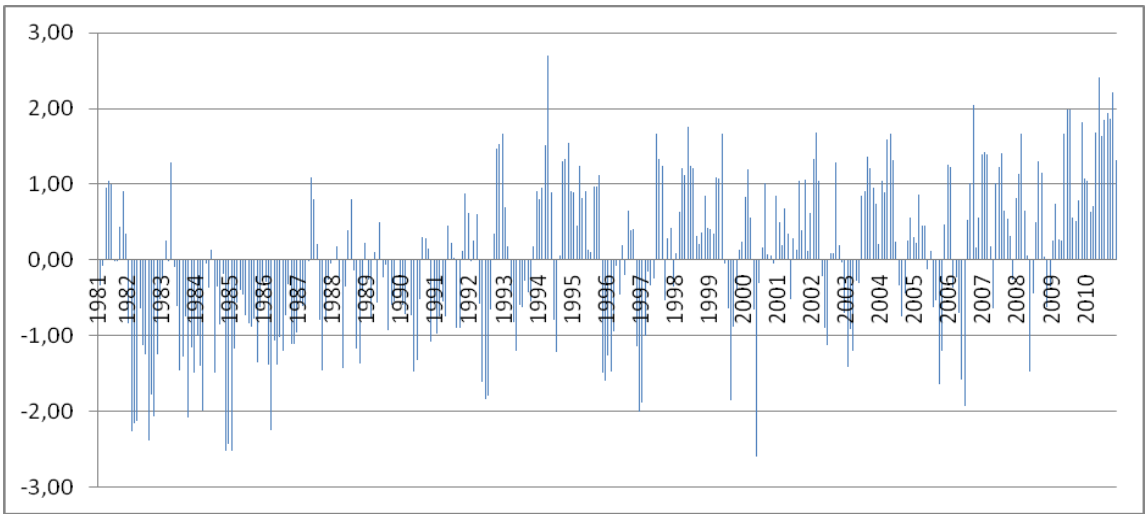


Fig. 6.12. Changes of SPI in Warsaw, source: ICM UW

The analysis of drought risk will be recommended to be included Drought Prevention Strategies. The results of the analysis shall include maps of hierarchical areas threatened with each type of drought, as well as the map of the total risk due to droughts in the areas seriously threatened by 4 types of droughts. In addition, graphical representations will be prepared for e.g. % of areas in a given river basin threatened by drought.

Water shortages in Poland differ spatially and temporally. The highest water deficits are observed in the belt central Poland Ieast to the south west) and these are hazardous to the majority of Poland's crops (fig.6.13).

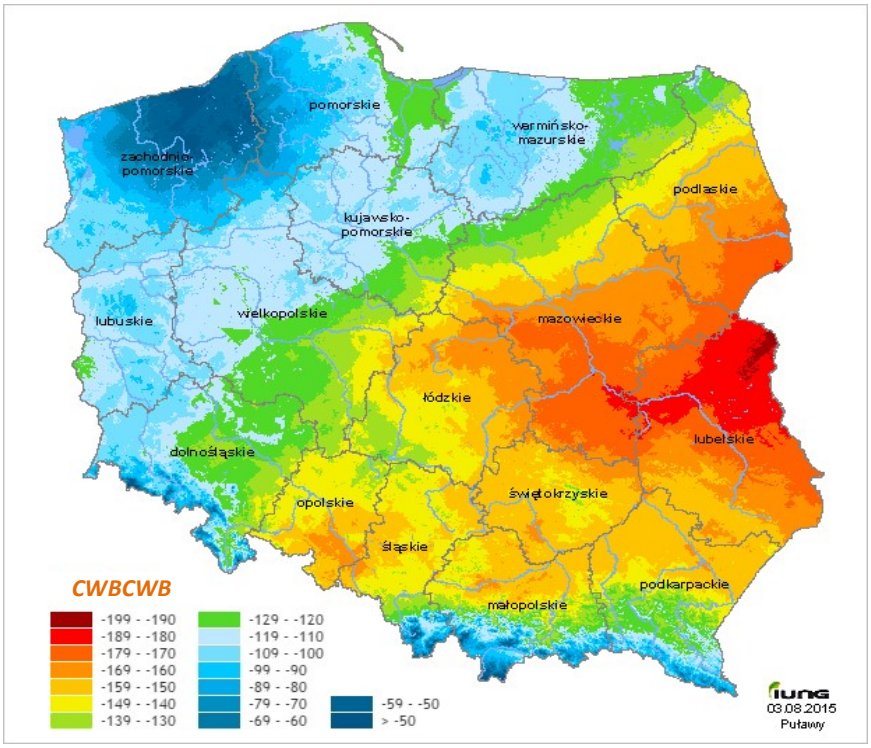


Fig. 6.13. Anomalies of total precipitation (millimeters below long-term norm) until August 31, source: IUNG–PIB Pulawy

Spatial diversification of water scarcity, as well as that of agricultural droughts (CDI quantified) indicates the need for irrigation so as to obtain high yields. This requires adequate water resources, such as e.g. current flows in waterways, water retention in lakes and/or artificial water reservoirs.

The results of projections indicate an increasing tendency with respect to yield reduction in some cultivated plants, as a result of increased drought risk in the years 2021–2050 and 2071–2100. In crops, the greatest possible yield losses are expected in central and south-western Poland, and the smallest - in north-eastern Poland.

6.5. Heat waves

Thermal events which are unfavourable and uncomfortable for the environment and society. These include heat waves and series of hot days ($t_{max} \geq 30$ °C). The longest heat wave, lasting for 15–20 days all over Poland, came at the turn of July and August 1994 and in August 2015.

Heat waves are most frequent in south-western Poland, whereas in the coastal and montane areas they occur comparatively rarely. The longest periods with a series of hot days are observed in southern Poland (≥ 17 days).

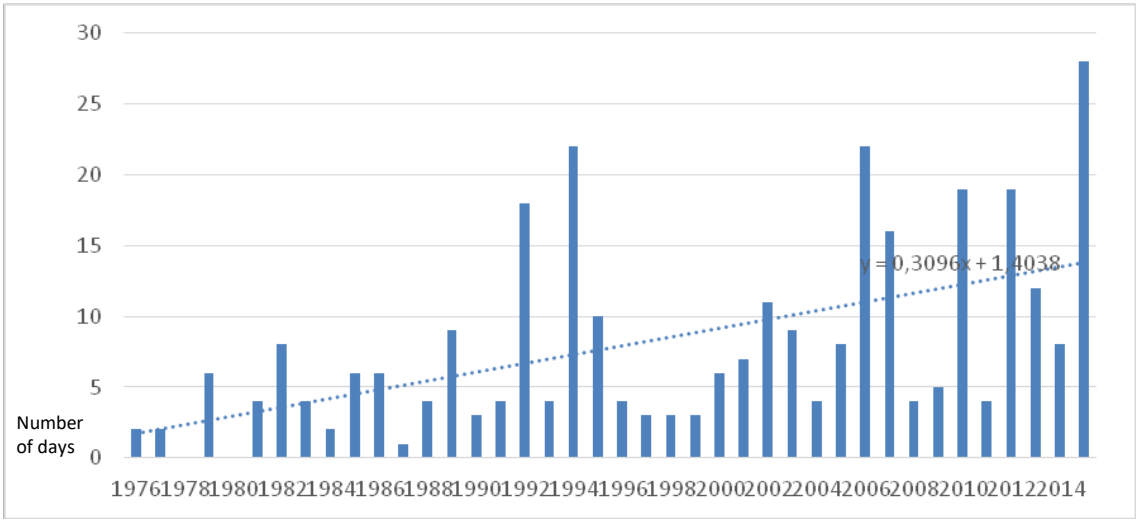


Fig. 6.14. Hot days ($t_{max} \geq 30$°C) in Poland in the period 1970–2015, Source: IMGW–PIB, NOAA

6.6. Sensitivity to climate change

The observed climate change in Poland does not yet have a significant impact on the economy. However, with further expansion of these changes, possible damages, hence increased costs of measures to reduce negative impact can be expected. Abovw all, this concerns to water supply, and especially – in agriculture.

The main threats in Poland include: changes in water balance, including increased variability of precipitation and evaporation, decrease in cereal and potato yield, increased frequency of extreme weather events including floods, droughts and hurricanes, increased forest fires, erosion of soils, bigger losses in forest stands as a result of more frequent extreme winds, as well as biodiversity loss. Additional challenges will also arise for the health system, as a consequence of increased exposure

to extreme weather events and diseases not yet present in the climate zone in which Poland is located.

The assessment of the overall vulnerability of the economy sectors to climatic events is presented in Table 6.3.

Table 6.3. Sensitivity of economic sectors to climatic phenomena

Event	Water management	Agriculture	Space management	Healthcare	Forestry	Protected areas	Coastal zone	Infrastructure	Tourism
Floods	3	3	3	3	1	3	2	3	1
Droughts	3	3	2	3	3	3	1	3	1
Heat	1	3	1	3	3	1	1	3	3
Frosts	0	3	1	3	3	1	2	2	2
Rainstorms	3	3	2	2	1	1	2	3	1
Storms	3	1	2	0	0	2	3	2	2
Sea level rise	0	1	3	1	0	3	3	3	1
Lack of snow	2	2	0	0	2	2	1	1	3
Strong winds	0	2	2	2	3	3	2	3	2

0 – invulnerable; 1 – low vulnerability 2 – moderately vulnerable; 3 – high vulnerability

Source: KLIMADA Project 2013

The results of the KLIMADA project show that the most vulnerable sectors are: water management, infrastructure (transport, construction, telecommunications and others), agriculture, health, forestry and nature protection.

More detailed analyzes have been carried out for cities under the project: Development of adaptation plans for climate change in cities with population over 100 thousand. The analyzes were conducted for 26 events divided into four categories: temperature, precipitation, air pollution, wind – with reference to 18 areas of activity. The result represents the mean value for all phenomena.

A sample analysis of one of the cities is given in Table 6.4.

The most climate change vulnerable areas in cities are: health, transport, construction and water management.

Table 6.4. Climate change vulnerability in cities

Sector/Area	Mean
Public health/sensitive groups	1.28
Transport (network – length / layout, objects – types/locations, rolling stock, traffic intensity)	1.17
Intense housing developments	0.9
Water management (network – length/layout, facilities/facilities – types/locations, size of supply/volume of consumption)	0.87
Other infrastructure	0.78
Cultural heritage	0.71
Industry including construction (as part of the economic base of the city)	0.65
Spatial management	0.6
Industrial and commercial areas	0.59
Agriculture (as part of the economic base of the city)	0.59
Power Engineering (networks – length/layout, facilities/equipment – types/locations, volume of supply / volume of consumption)	0.53
Residential areas of low intensity	0.49
Public services	0.42
Tourism (residence/sightseeing) (as part of the economic base of the city)	0.4
Biodiversity (city's natural warbler)	0.37
Free location services	0.35
Undeveloped areas	0

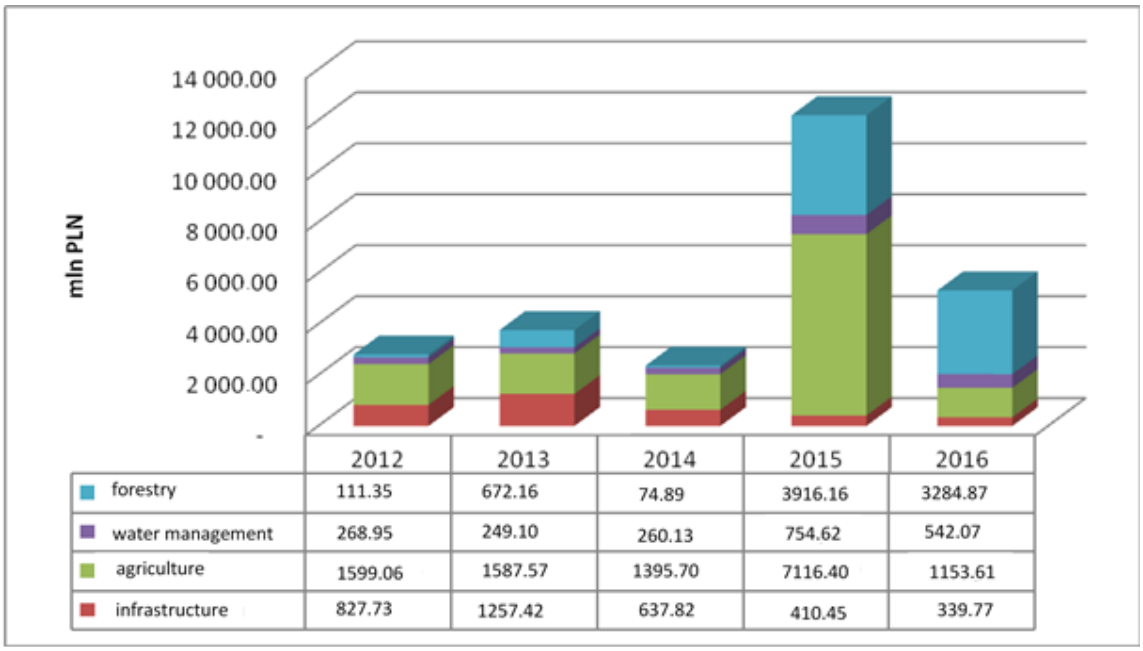
Source MPA Project

6.6.1. Climate change vulnerability across sectors

As estimated by the Institute of Environmental Protection – PIB, the total value of losses due to extreme events in 2012–2016 ammounts to around PLN 20.5 billion (2015 prices)[10]. Every year, extreme events cause losses ranging from 2 billion – 3 billion PLN. Every once in a while, over-average losses occur, as in 2015, when Poland was hit by severe drought. Long periods of drought have significant, destructive effects on many areas of life: water supply, agriculture and forestry. The elements that have caused significant damage over the last five years include storms, which cause flooding in combination with strong winds that damage the infrastructure. Stormings cause not only material damage but also endangeres human life and health.

The breakdown of the losses caused by extreme events in 2012–2016 by sector is shown in figure 6.15.

[10] According to the methodology developed by the Institute of Environmental Protection – PIB, based on data provided by the Ministry of the Environment



	2012	2013	2014	2015	2016
forestry	111.35	672.16	74.89	3916.16	3284.87
water management	268.95	249.10	260.13	754.62	542.07
agriculture	1599.06	1587.57	1395.70	7116.40	1153.61
infrastructure	827.73	1257.42	637.82	410.45	339.77

Fig. 6.15. Losses due to extreme events in Poland 2015 prices, *prepared by: Siwiec E., Institute of Environmental Protection – PIB*

The Strategic Adaptation Plan for sectors and areas sensitive to climate change (SPA 2020) states that floods are one of the major catastrophic threats to Poland. With predicted climate change, the damage is expected to increase. There were no severe floods in the reporting period (comparable to 2010 or 2001). According to the Central Statistical Office, the losses resulting from small floods estimated in the infrastructure of local government units amounted to PLN 563 million, which accounted for about 19% of the total estimated losses due to the impact of extreme events in the local government infrastructure.

Extensive information on this sector vulnerability has been provided in the 6th Report of the Government. Therefore, only the conclusions of this analysis are presented in this report.

6.6.1.1. Water resources

The surface water resources in Poland are particularly vulnerable to climate, especially to variations in precipitation and evaporation. Groundwater supply is of marginal importance.

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.

The variability of the transformations in the spatial arrangement is much higher than in the seasonal system, which may indicate that the observed changes in the studied outflow characteristics are, to date, mainly the result of anthropogenic transformations in catchment areas and changes in water management in this part of Poland. 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 has been observed a growing trend in water temperature of most rivers. The highest increase, even by as much as 4°C, is predicted for the spring months (April and May) and December.

6.6.1.2. Water management

Poland has limited water resources, which increases this sector susceptibility to droughts and floods. Particularly susceptible to drought are eastern and central provinces, and in the southern provinces floods (where 146 out of 180 communes are in danger of flooding). Analysis of the area covered by the flood in Poland with the occurrence of a flood with a probability of 1% refers to 1301 gminas.

Water intake from the beginning of the 21st century is characterized by a systematic decline. The largest amount of water in the year (in %) was used by industry – 74.3, agriculture was only 9.9 and water supply was 15.9 (fig. 6.16).

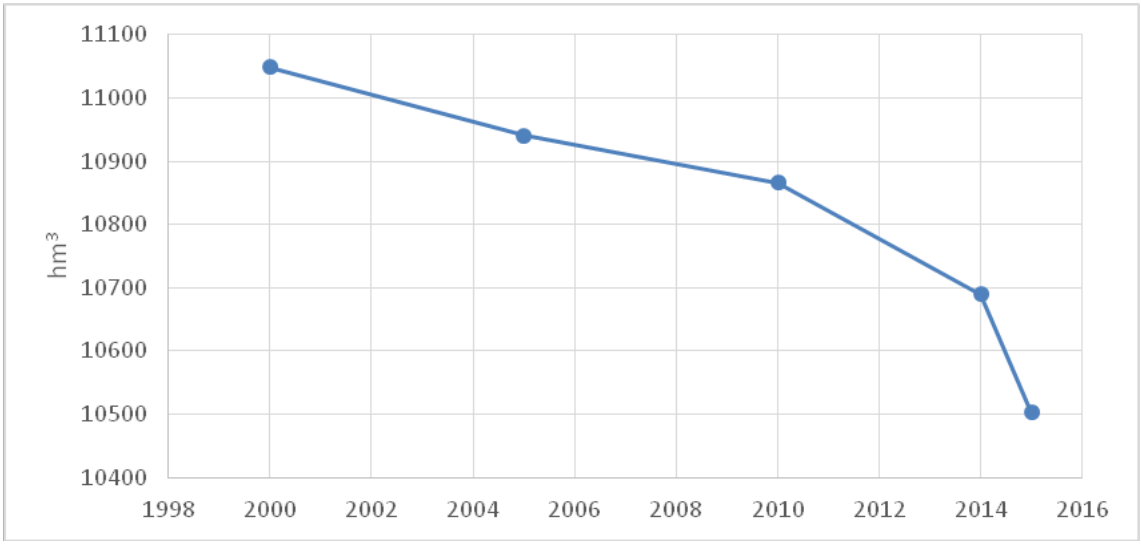


Fig. 6.16. Water consumption for the needs of the national economy and population in the reference period 2000–2015, source: GUS

The dynamics of changes in water needs of the country shows a slight downward trend until the end of the first forecasting period. In the second forecasting period (years 2071–2100) these needs slightly increase (figure 6.17).

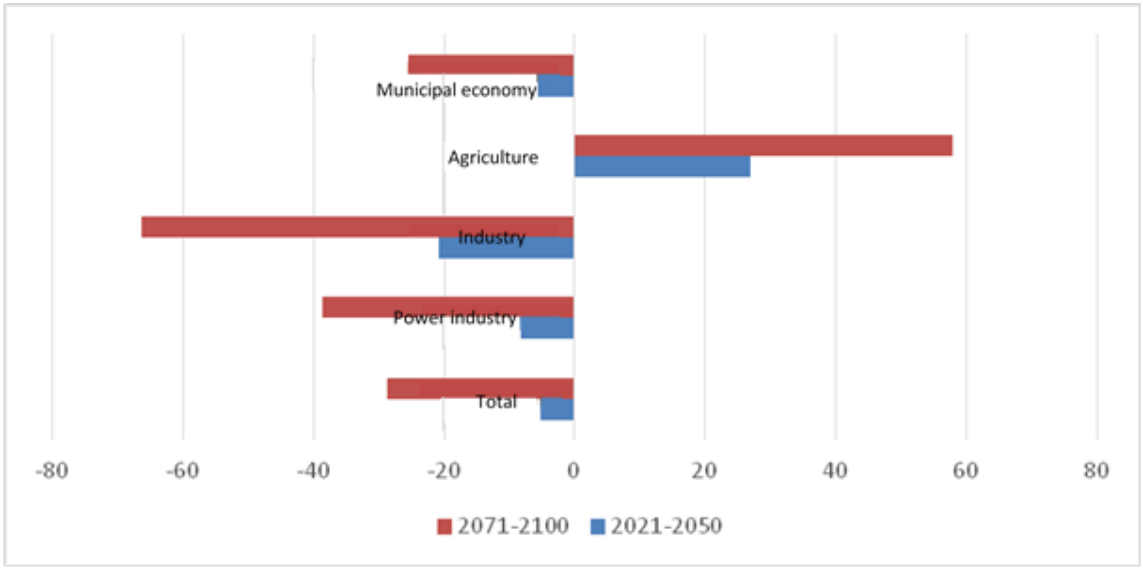


Fig. 6.17. Changes (in %) of water demand of the sectors in the periods 2021–2050 and 2071–2100, source: KLIMADA Project

A steady decline in water demand will take place in industry, power and municipal economy, despite a significant increase in the volume of industrial production, which is primarily due to improved water consumption. Agriculture is the only sector in which average annual water needs show a steady upward trend. Climate change, resulting in changes in precipitation patterns and the increase in precipitation and evaporation, necessitates the intensification of artificial irrigation, which is particularly evident in the second forecasting period (the trend of increasing water needs, from 30% in the first period to about 40–125% in the end of 21st century).

Water needs are differentiated regionally, and are the result of development strategies. The greatest increase in needs compared to the current situation, in the first period will be in the central and eastern voivodeships and lubuskiem, and in the second tendency will remain, with the exception of central provinces, where water demand will be at the level of 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.

6.6.1.3. Agriculture

As temperatures rises, the climate conditions for the cultivation of thermophilous plants has been 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/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 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, 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).

6.6.1.4. Forestry

The observed and predicted changes involve a shift of the ecological optimum to the north-eastern areas. 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, spruce, European larch, beech, common oak and broad-leaf lime. 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.

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. picking up the oak. As the climate changes, there are more frequent, more dangerous and unpredictable outbreaks of folivores and cambiophages. Climate change contributes to an increase in the threat posed by invasive species.

Climate change favours the enhancement of threats posed by invasive species. Under the effect of climate change, threats emerge and biological structures transform at the different levels of organization, the conditions and sustainability of forest production change, and so do the economic relations and social functions of forests.

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 weakened spruce stands and contributed to a rapid growth of threats.

The most effective undertakings in view of adaptation of forests to climate change are:

- promoting species that are less susceptible and better adapted to climate change
- breeding of mixed stands;
- planting of species resistant to climate change in specified regions;
- anticipate threats and promote effective pest control.

6.6.1.5. Biodiversity and ecosystems

In Poland, there are 23 national parks and 122 landscape parks, which, along with Natura 2000 sites, protected landscape areas 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.

Species and habitat vulnerability is not only due to changes in temperature or precipitation, but also to changes in range, population size, reproduction parameters, and so on. Biodiversity changes also result from the frequency and amplitude of extreme events such as floods, storms and torrential rains.

From the point of the protection of habitats, the threats related to the mainatnce 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 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. 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.

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 situated in the Polish Lowland Belt can, in general, be considered strongly vulnerable as a result of the lowering of the groundwater level.

6.6.1.6. Health

The increase in the risk of death and/or disease is associated with periods of high temperature - > 23% deaths as compared to thermo-neutral conditions and > 24% as compared to cardiovascular death. 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%. Increasing the risk of death in days with a very high thermal sensitivity is more than 10%. The elderly and small children can easily be disturbed and persons with specific diseases are the groups which are particularly vulnerable to the impact of high temperature. With a maximum temperature increase of 1°C, the risk of death among people above the age of 70 increases from 0.9% to 1.5%. By the end of the century, the number of deaths due to cardiovascular dysfunctions is expected to increase by an average of around 20–30%.

Cold waves in temperate climates also lead to an increase in mortality, but with a greater delay than heat waves. The most dangerous for the body are large, sudden drops in air temperature, which can cause sudden death, especially of the elderly with arterial disease or ischemic heart disease. Under conditions of changing climate and increased variability of phenomena such situations will intensify. Across the whole of Poland, the increase in the number of deaths from all causes and due to cardiovascular disease in cold waves is 8%. As a result of progressive warming, it is expected to reduce the incidence of influenza and death from these causes by 10–12%. At the end of the 21st century the number of deaths from the body's cooling may decrease by 45–80%.

In Poland, the number of cases of tick-borne encephalopathy is increasing, as before 1993 there were reported 4-27 cases of this disease every year, and now 200–300 cases/year are currently reported. Also, there is predicted an increase of Lyme borreliosis incidence, from 20% to 50%. Areas threatened by Lyme disease include north-eastern Poland, the lagoon belt as well as south-western and southern Poland.

Weather conditions, especially excessive precipitation and high air temperatures, are factors that facilitate the development of certain pathogenic microbes and bacteria in the water. In Poland, the most common foodborne illness is salmonellosis. The incidence of salmonellosis is estimated at 8% at 1°C. For the years under discussion, the increase in air temperature and the increase in hot days are forecast by 12–32%, which will lead to an increase in salmonella poisoning by approximately 85% at the end of the century.

6.6.1.7. Coastal zone

Climate change and related physical processes (sea level rise, ice sheet loss, wave height and storm gusts) will have a negative impact on the coastal area. Floods on the sea side threaten an area of 2200 km^2, more than 20% of which is land with unique natural values on a European or national scale, and over 7% are highly urbanized and industrialized.

The rising of the groundwater levels in low-lying areas will limit the future use of many areas for housing and industrial purposes.

As a result of coastal erosion, about 120 km^2 of coastal areas are threatened. About 300 thousand. People will be exposed to the immediate risks of climate change and around 1.7 million people will be exposed to the indirect effects of climate change (including job losses).

There are areas of Słowiński National Park and Woliński National Park and the Nadmorski Landscape Park. Climate change will greatly disturb the functioning of ecosystems in their areas and enhance the costs of maintaining the functions related to nature protection.

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).

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.

6.6.1.8. Construction industry

The vulnerability of the construction sector is differentiated depending on the elements considered, such as the localisation of a building site, building foundations, 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.

Outstanding temperature sensitivity is observed in: hospitals, hospices, nursing homes and kindergartens, which in the summer must be equipped with air conditioning due to thermal stress. Also the objects such as: ski jumps and ski lifts, mountain huts are considered climate change vulnerable. Floods and winds are hazardous for boat/yacht construction.

Residential buildings in urban and rural areas are the most exposed to climate change impacts. The industrial and public buildings are considered less vurnelabele to climate change.

Historical conditions make the cities situated in river valleys, exposed to floods associated with river flow. Poland's cities are exposed to flooding, as a result of strong rainfall and terrain preventing fast outflow of rain water. The cities distrcts, where buildings are currently located were not previously developed (considered as poorly-grounded or floodplains). This threat is not taken into account by developers.

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, 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.

Traditional housing is susceptible to temperature changes and does not provide thermal comfort under low or high temperatures. The most climate sensitive buildings are: water and sewage installations, heating and ventilation and air conditioning systems.

Rural buildings include residential buildings, which as a rule have one or two storeys, and the production buildings of the farms. 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,
- 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. 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.

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. 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.

6.6.1.9. 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 transport infrastructure, which is built for a long operation period (e.g. 100 years). 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.

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 temperatures contribute to increased equipment failure, reduced mobility, reduced travel comfort, damage to the road surface (winter break) and hamper handling, increasing loading and unloading times.

Due to the anticipated climate warming, fog has become another for traffic on Polish roads. This climatic factor causes traffic congestion. Above all, fog occurs in common in the autumn and winter, at near-zero temperatures.

In air transport, weather conditions during take off and landing are most critical. For grounded planes the basic risk is the strong wind (gusts) and icing. Other events, 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.

6.6.1.10. Power engineering/The energy sector

The energy sector is relatively almost not vulnerable to climate change. Higher temperatures are favourable in terms of the demand for electricity and heat, reduces the need primarily for room heating, compensates for load changes.

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 $0^{o}C$ and wind cause on mass-scale breakdowns of low voltage networks and even blackouts lasting for several days, mainly in rural areas.

Power stations, CHP plants and heat and power generating plants are not very dependent on the predicted climate change. On the other hand, the availability of water for cooling and refilling is a major problem.

6.6.1.11. Spatial management

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.

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.

6.6.1.12. Cities and towns

Climate change is not a direct environmental problem concerning cities, however, other events related to climate change, such as e.g. air pollution, inundations or floods, constitute serious problems for many cities. Global urbanization is affected by the effects of urbanization and intense economic activity, which deepens the negative impact of the climate. 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 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°C in a city with up to 600,000 inhabitants, the intensity of UHIE may reach 8°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°C. The predicted increase in the frequency and intensity of heat waves may aggravate the effects associated with MWC and its effects on living conditions and on human health, including increased mortality.

The intensity of UHIE is clearly dependent on the share of biologically active sites in the housing and ventilation system, while the intensity of the development intensity and the function of distance from the city center are slightly less important. The area of the biologically active area should not be less than 45–50%.

The threats related to water surplus in towns and cities basically relate to two issues, i.e. floods and inundations. 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. 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.

Hurricanes and tornadoes pose a threat to a city or town, primarily due to breaking up roofs, releasing large surface advertising objects, signs, and especially trees that destroy infrastructure and make communication impossible.

6.7. Adaptation policy for climate change in Poland

The main goal of adaptation policy is to ensure the sustainable development and effective functioning of the economy and society in changing climate. Adaptation policy for climate change is coordinated by the Ministry of Environment.

Issues related to adaptation to climate change were included in the Responsible Development Strategy adopted by the Council of Ministers on 14 February 2017. The need for adaptation measures are addressed in the chapters on Environment, Small and Medium Enterprises and Territorial Sustainability.

Environment

- Measure: *Increasing available water resources and achieving high quality of water*
  - Implementation of Flood Risk Management Plans for river basin districts, plan updates;
  - Development and implementation of drought mitigation plans;
  - Pro-ecological management of local water resources, including the development of landscapes that support water retention;
  - Development of flood protection infrastructure based on investments of high efficiency and economic rationality and appropriate spatial planning;
  - Rainwater management in urbanized areas through various forms of retention and development of green infrastructure.

Two strategic projects were established :

- **Comprehensive project to adapt forests and forestry to climate change by 2020**. The project aims to prevent the occurrence or minimization of negative effects of natural phenomena (droughts and fires), destructive floods, floods and floods through the development of small retention systems, prevention of excessive soil erosion , strengthening the resilience of forest ecosystems threatened with progressive climate change.
- **Water for agriculture** – support programme for family farms and improvement of water management in agriculture under conditions of periodic shortages and surplus water. Management of local water resources includes the retention of precipitation water in the soil, the protection of water quality, protection of the living conditions of protected water-dependent species and the creation of landscapes that support the retention of natural water and the prevention of floods and droughts.

- Measure: *Management of natural heritage resources*
  - Develop green and blue urban areas in order to preserve spatial connectivity within these areas and with open areas and support adaptation processes to climate change;
  - To maintain and, if land is available, increase the overall forest cover of the country and the compactness of forest areas.

Small and medium-sized enterprises

- Measure: *Competitive farms and agri-food producers* strategic projects are indicated:
  - Programme for support of plant breeding in Poland – the programme will include strategic, in view of Polish agriculture, directions of plant breeding with regard to climate change, resistance to harmful organisms and market requirements.
  - Modern agricultural insurance – use the potential of the Postal Mutual Insurance Company to create an offer dedicated to agricultural production insurance against the risk of unfavorable weather conditions.

Territorial Sustainable Development

- Measure: *Active and economically active residents of the city*
  - Implementing low-carbon urban strategies and improving air quality and adapting to urban climate change.
  - Reducing air pollution and greenhouse gas emissions and adaptation of urbanized areas to climate change.

A chapter on climate change (in the field of mitigation and adaptation) is planned in the document "State Ecological Policy" (PEP) prepared by the Ministry of Environment. In 2017; the scope of the document is set within the Interdepartmental Team for Preparation of PEP and the work on the preparation of the first chapter – the diagnosis is ongoing.

The SPA 2020 paper outlines the priorities for adaptation measures to be taken by 2020 in the areas most sensitive to climate change such as water management, agriculture, forestry, biodiversity, health, energy, construction and spatial management, urban areas, transport , mountain areas and coastal areas. These actions, undertaken both by public and private entities, are accomplished through policy implementation, infrastructure investment, and technology development. These include technical ventures such as the construction of the necessary flood and coastal protection infrastructure as well as regulatory changes.

In 2016, a project was launched to develop City Adaptation Plans for 44 cities with a population of over 100,000 (MPA). The project will be continued until 2019. The project is financed by the EU Infrastructure and Environment Operational Program. At the same time, several other projects related to this issue were launched, including the Polish-Norwegian project CLIMCITIES, implemented by IOŚ–PIB, preparing adaptation strategies for five cities with populations over 50 thousand. residents.

In 2015 the Working Group on Adaptation to Climate Change was set up within the framework of the national network "Partnership: Environment for Development".

The Working Group on Adaptation to Climate Change addresses:

- implementation of Strategic Adaptation Plan for sectors and areas sensitive to climate change by 2020 with a vision to 2030 (SPA 2020);
- support for the monitoring and reporting process of regional and local adaptation measures,
- establishment of forum for cooperation and exchange of experience between national and regional units and international cooperation,
- support for a project on adaptation to climate change in cities above 100 thousand inhabitatts (planned to be implemented within POIiŚ 2014–2020).

Among other projects aimed at increasing climate change resilience, there are launched:

- ADAPTCITY Project – "Preparation of a strategy for adaptation to climate change of the city of Warsaw with the use of city climate mapping and with public participation". The aim of the project is to reduce the negative effects of climate change on the ecosystem of Warsaw.
- RADOMKLIMA – "Adaptation to climate change through sustainable management of water of the urban area in Radom City". The project aims to develop blue-green infrastructure by increasing the retention and management of rainwater in the city and the renaturalization of watercourses.
- LCAgri – "Support for low carbon agriculture able to adapt to observed climate change in the perspective of 2030 and 2050" financed by the NCBR. Its aim is to increase the efficiency of implementing innovative low carbon practices and to promote the sustainable use of mineral fertilizers in agricultural holdings in Poland.

A project focused on the scientific assessment of the city's vulnerability to climate change was the project entitled "Sensitivity to climate change in the city of Kalisz – case study", which defined the basic threats of the city and assessed its vulnerability.

The National Fund for Environmental Protection and Water Management (NFOŚiGW) proposes, as part of its financial offer, support for adaptation actions in Poland. The part of the financial offer that relates to this issue is included in the priority program: Counteracting environmental threats with the elimination of their effects.

In the first section of above programme "Adaptation to climate change", it is possible to finance preventive measures to adapt to climate change, in line with the Strategic adaptation plan for sectors and areas sensitive to climate change until 2020, with an outlook until 2030, in particular:

- infrastructural activities (flood embankments, water reservoirs, polders, rainwater retention systems – including in urban areas);
- activities to develop and implement a threat monitoring and early warning system, including the development of monitoring and warning systems for extreme climatic events;
- implementation of measures and methods for analyzing threats caused by climate change, including local and regional adaptation plans and strategies;
- financing of projects implemented from the Operational Programme Infrastructure and Environment 2014–2020 and the next financial perspective of the EEA FM and NMF – support of the NFOŚiGW in the form of a loan.

The second part of the programme: "Preventing and eliminating the effects of emergency threats" is meant for financing of undertakings focused on eliminating the effects of environmental hazards, natural events (floods, fires, droughts) and accidents (events resulting from human activities), and the purchase of equipment used in rescue operations. as well as the development of methods and tools for analyzing the abovementioned threats:

- mitigation of effects of environmental accidents and hazards on environmental and water management facilities, coastal areas and natural bodies;
- purchase of specialized equipment necessary for effective rescue operations
- and forecast, prevent, reduce and eliminate the effects of natural hazards and major accidents;
- implementation of measures and methods to analyze failures and threats to the environment.

6.8. Examples of adaptation measures undertaken

Adaptation to climate change is of regional and local nature. Local communities are extremely sensitive to climate change, especially to extraordinary risks. Then again, adaptation effectiveness depends, to a great extent, on the involvement of communities and local authorities in their implementation. The awareness of the need for preventive measures is gradually increasing, especially in the areas often hit by extraordinary phenomena. Examples may include initiatives undertaken by some non-governmental organizations, such as the Sendzimir Foundation, the Green Roofs Association, and jointly with local governments and groups supported by government agencies and EU funds.

6.8.1. Protection of water resources

The protection of water resources in the aspect of adaptation concerns above all the flood risk management. It is a special area of adaptation, as the measures undertaken are most often of a technical and non technical nature. Technical measures are undertaken to reduce the flood wave volume and its spatial extent by means of retention reservoirs, relief channels, polders and embankments. The second type of measures is to educate local societies about risk of flooding, as well as the use of early warning systems and special types of insurance.

State and local government administration, compliant with the provisions of the Water Law act, is obliged to carry out tasks related to flood protection. This applies in particular to the implementation of planning and programme documentation as well as documents of the nature of programs and strategies that constitute the basis for the implementation of investment or non-investment activities, including in the field of flood protection.

According to the Water Law Act, flood risk management plans are implemented for river basin districts and for water regions, including areas exposed to flood danger (ONPP) determined in the preliminary flood risk assessment, based on risk maps and flood risk maps prepared for these areas.

Flood hazard maps are prepared and show, among others, the areas with a defined probability of flood occurrence:

- low once every 500 years (Q 0.2%),
- medium once every 100 years (Q 1%),
- high once every 10 years (Q 10%).

The purpose of flood risk management plans is to reduce the potential negative effects of floods on human life and health, the environment, cultural heritage and economic activity, through the implementation of selected measures to minimize the identified threats.

Another area of water management activities is enhancement of small retention, both in agricultural and forest areas and in urban areas.

In the majority of voivodeships, the "small" voivodeship programs are being implemented, which are aimed at intensifying actions aimed at protecting and improving the use of precipitation waters. For instance, in the small retention programme for the Śląskie Voivodeship, 66 projects are being implemented. The programme for the Mazowieckie Voivodeship was selected for implementation until 2030 over 1000 objects, in the Zachodniopomiorskie Voivodeship, about 100 projects are implemented in the first stage.

Under the programme of small retention in forests on the initiative of the State Forests in the years 1998–2005, 2216 dams were built, including 1124 reservoirs. In the years 2007–2015 the State Forests implemented 2 large "small retention" projects co-financed by the European Union Cohesion Fund, which covered the whole country. As part of the project, "Increasing retention capacities and preventing floods and droughts in forest ecosystems in lowland areas", 3644 small retention facilities have been constructed to collect approximately 43 million m^3 of water.

3553 facilities and complex tasks were carried out in the framework of the project "Counteracting the effects of rainwater runoff in mountainous areas", including 299 tasks related to the realization of the reservoirs where about 1.5 million m^3 of water were collected. Presently, under the Operational Programme Infrastructure and Environment for the years 2014–2020, the State Forests are implementing 3 comprehensive adaptation projects for climate change, 2 of which cover small retention and water erosion prevention and are redeployed into lowland and mountainous areas, due to the specific nature of these areas. Both projects are planned to carry out by the end of 2022 a total of approximately 2220 objects damaging or exiting the drainage system and re-allocating approximately 2.5 million m^3 of water in the reservoirs.

There is also implemented the project to increase water retention in mountain areas, during which 1100 objects were modernized/built. In cities, the scale of activities aimed at increasing the water retention in open water is lower. In Cracow under the Małopolska Region's Little Retirement Programme 15 projects are being implemented to set up systems for the collection and economic exploitation of rainwater. In Katowice, a project worth ca. PLN 63 million is implemented, aimed at the management of rain water in the city, among others. to maintain urban greenery. Other examples include the construction of an intercepting system for pollution from the street to the reservoirs in Arturówko in Łódź and the rehabilitation programme Sokołówka, under which five retention reservoirs were built and the river section was adjusted.

Other examples of adaptation measures carried out in Poland include the use of the potential of existing drainage facilities (e.g. construction of dams on drainage ditches, small retention reservoirs at the estuaries of wetland drainage systems), use of wetland meadows and pasture retention capacity, arable field – watercourse, as well as striving for the banks of watercourses and ditches.

6.8.2. Green infrastructure

Increasing numbers of adaptation measures are undertaken under the framework of greening in cities, among others: greening of roofs, walls of buildings, courtyards and compensatory planting and creation of retention gardens.

Current information on urban greening is provided in table 6.5.

Table 6.5. Ranking of the most and least green cities (in%)

City	Share of parks and other green areas in the city area in 2015 [%]	City	Share of forests in the city area – 2015 [%]
Cities with the highest value of the analyzed indicator			
Chorzów	21	Zielona Góra	53
Siemianowice Śląskie	9	Sopot	52
Bydgoszcz	8	Gdynia	44
Zamość	7	Katowice	40
Sopot	6	Jaworzno	37
Cities with the lowest value of the analyzed indicator			
Mysłowice	1	Rzeszów	3
Piotrków Trybunalski	1	Zamość	2
Biała Podlaska	1	Siemianowice Śląskie	1
Zielona Góra	1	Łomża	1
Świnoujście	1	Krosno	1

Source: Rynekpierwotny.pl

Investments are carried out by building owners in cooperation with local governments and non-governmental organizations. The primary goal of such activities is to reduce the urban heat island and improve the comfort of the residents, as well as increase the retention of precipitation water. Greenhouses are encouraged by the city authorities (e.g. Wrocław) to apply tax reliefs on real estate. Significant support for such initiatives is the Participatory Budgeting, where residents themselves indicate what should go from a portion of the city budget and often choose to green the city.

Greening roofs is widespread and in all cities more or less such objects exist. Large areas of shopping centers and public utilities, as well as private homes. Among the most famous are: Supreme Court Building, University Library in Warsaw (cost 80 million dollars), Leroy Merlin Shopping Center and Zielone Torowisko in Poznań, Złote Tarasy Shopping Center in Warsaw, housing estates in Bydgoszcz, Sky Tower in Wrocław, Shopping Center Arkadia in Warsaw, the Faculty of Management at the University of Łódź, the Podlasie Opera in Białystok and many others. It is estimated that in the country the total area of green roofs is about 215 thousand m^2.

Another initiative is the greening of courtyards and the creation of gardens in old housing estates. Such programs have Municipal Offices in most cities in Poland. Such initiatives are in Nysa, Tychy, Katowice, Szczecin and Cracow, where local governments finance the purchase of trees or shrubs. In Łódź in the years 2014–2016 green-blue projects were implemented for the total amount of ca. PLN 25.5 million.

In Olsztyn there is a compensation programme that covers not only areas where trees are cut but also where there are opportunities such as: in the schools and in the training, on the streets and sidewalks.

Rain gardens are installed at homes, often in conjunction with ponds.

6.8.3. Protection of the sea shore

Coast protection measures are part of the adaptation of coastal zones to climate change. The authorities responsible for the implementation of these activities are the competent maritime authorities. In the years 2012–2015, the maritime authorities carried out the tasks emphasized in the Programme for the Protection of the Seashore, on sections of the coast – most vulnerable to erosion and sea floods. In order to implement the Program, undertakings were carried out in the scope of construction, development and maintenance of the marine shore protection system. Coastal security measures have reduced the existing and future sea level flood risk in some sea shore sections.

The measures included, in particular, technical operations (boundary bands, anti-storm shafts) and artificial shore supply. In addition to the technical protection measures, biotechnological treatment was carried out, including the maintenance of protective vegetation. Artificial power is the most commonly used method of protection. Artificial power is supported by other methods of securing the shoreline (shore spurs, shorebreaks, underwater thresholds).

As commissioned by the maritime administration, the cyclical monitoring of the sea shore has been carried out to identify necessary measuresfor its protection. The analysis of research results allows for real-time adjustment of action plans and expenditures on investments. The assessment of coastal zone dynamics allows for effective planning of activities and the application of optimal methods of marine shore protection, taking into account local conditions and environmental aspects.

One of the challenges for the protection of the sea coast in recent years, has been to increase the investment pressure in the coastal zone. Increased recreation on the beach and pedestrian traffic through dunes lead to negative consequences for natural forms of nature conservation.

6.8.4. Fire protection in forests

Between 2016 and 2019, the State Forests National Forest Holding will implement the "Comprehensive project to adapt forests and forestry to climate change – prevention, counteracting and reducing the risks of forest fires". The main aim of the project is to reduce the negative impact of forest fires and to efficiently locate the source of the threat and to minimize losses and, in the longer term, to reduce the average surface area of the fires and extend the observation of forest areas, especially in forest districts classified as fire hazard category 1. The most important investments implemented in the project are:

- development and modernization of early warning and forecasting systems, including the construction and modernization of 70 fire detectors, purchase of state-of-the-art fire detection and identification equipment (114 units), alarm and disarming points (PAD) (16 units), construction of meteorological stations (11 units).
- technical assistance for the rescue and firefighting system in case of forest fires, including the purchase of patrol and fire-fighting vehicles (67 units).

The implementation of the project will contribute, among other things, to the resilience of forests to natural disasters such as fires, the threat of which increases with climate change; to improve the effectiveness of the early warning system for forest fires and to limit the extent of fires and the negative effects associated with them.

6.9. Promotional and informational measures

In 2014, on the commission of the Ministry of the Environment comisiomed the expertise "Guidelines for preparation of urban adaptation strategy". This document was the basis for the guide "Urban Adaptation Handbook – Guidelines for Preparing the Urban Adaptation Plan for Climate Change", which aims to promote sustainable urban development and adaptation to climate change (https://www.mos.gov.pl /fileadmin/user_upload/Podrecznik-adaptacji-dla-miast.pdf).

In 2013, as authorized by the Maritime Office in Szczecin, the Maritime Institute in Gdańsk prepared an expert opinion "Monitoring and research on the current state of the seashore – assessment of the effectiveness of marine protection systems implemented during the multiannual "Coastal Protection Program". Expertise has shown that shoreline protection systems have a significant impact on safety and the stable development of the coastal belt (http://www.ums.gov.pl/Pracowania%20naukowe/2016/opracowanie13102016.pdf).

Also in 2014, as part of the implementation of SPA 2020, an expert opinion "Assessment of the impact of current and future climate change on the Polish coast and the Baltic Sea ecosystem" was prepared. The aim of the work was to identify the existing climate change in the coastal environment was prepared and to identify which of them are the greatest threat to the Polish Coast. Guidelines for adaptation strategy have been developed in the most important sectors of human activity: agriculture, tourism and settlement, maritime economy – fisheries and shipping.

In 2015 the Ministry of the Environment in cooperation with the Ministry of Infrastructure and Development has prepared a "Guide to preparing investments with regard to climate change". The purpose of the Guide is to present guidelines and methodologies for calculating climatic parameters in the preparation of investments (projects and projects), including those projects co-financed by EU funds under the financial perspective 2014–2020. The guide also includes guidance on how to incorporate issues related to adaptation to climate change and mitigating climate impacts at the Strategic Environmental Assessment stage.

Within the framework of implementation of adaptation policy for climate change, a number of informational and promotional materials and expert papers have been prepared. The promotional materials have been made available on the internet platform http://klimada.mos.gov.pl/ and are used to promote the activities of the Ministry of the Environment. The Ministry of Agriculture and Rural Development is also carrying out information campaigns on agri-technical measures to increase water retention, the beneficial effects of plantings and protection of green belts along waterways, as well as the need to protect water reservoirs and ponds.

Another guide "Greening", prepared by the Agency for Restructuring and Modernisation of Agriculture was addressed to all farmers applying for a single area payment, from European funds, for the implementation of agricultural practices beneficial to the climate and the environment, (http://www.arimr.gov.pl/fileadmin/pliki/Kalkulator/Zazielenianie_guide. pdf).

In addition, a number of original practical guides were prepared for various adaptation activities for the public, such as the construction of green roofs, vertical walls and rain gardens, construction in flood areas, and so on.

CHAPTER 7. DEVELOPMENT COOPERATION AND TRANSFER OF TECHNOLOGIES COMPLIANT WITH ARTICLES 43, 4.4, 4.5. of the CLIMATE CONVENTION

7.1. Obligations under articles 4.3., 4.4., 4.5 of the Climate Convention

Article 4.3. of the Convention sets that the developed country Parties and other developed Parties included in Annex II shall provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in complying with their obligations under Article 12, paragraph 1. They shall also provide such financial resources, including for the transfer of technology, needed by the developing country Parties to meet the agreed full incremental costs of implementing measures that are covered by paragraph 1 of this Article and that are agreed between a developing country Party and the international entity or entities referred to in Article 11, in accordance with that Article. The implementation of these commitments shall take into account the need for adequacy and predictability in the flow of funds and the importance of appropriate burden sharing among the developed country Parties.

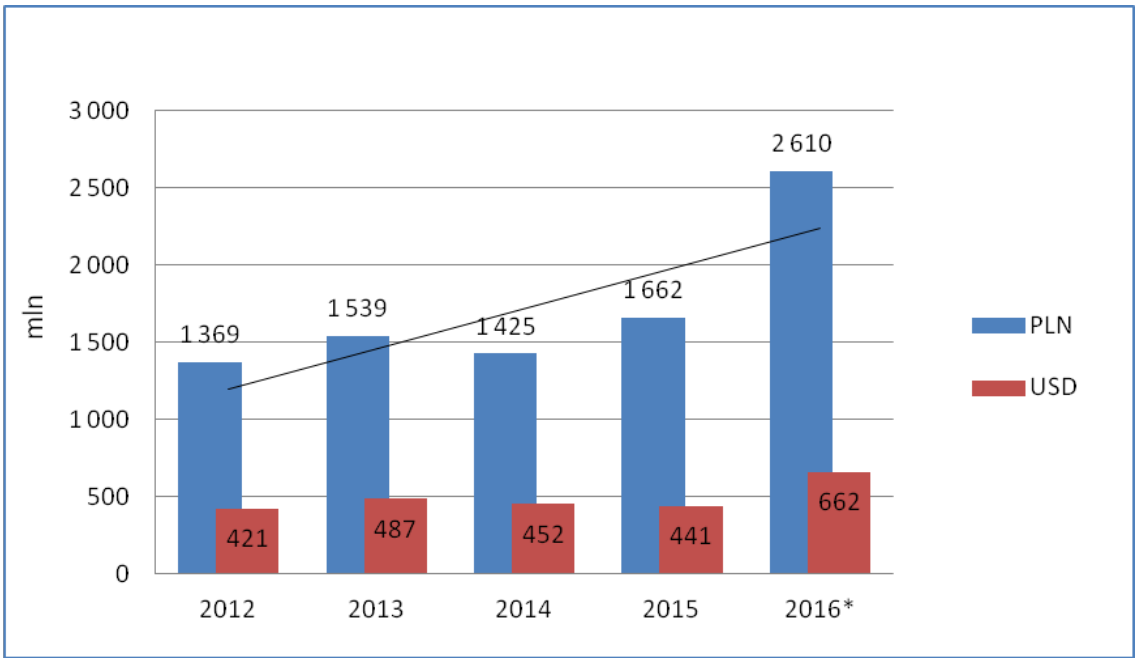
Moreover, Article 4.4. commits country Parties and other developed Parties included in Annex II to assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects.

In accordance with Article 4.5, the developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies.

The Republic of Poland is not one of the Parties listed in Annex II to the Climate Convention; therefore, it is not obliged to fulfill 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.

7.2. Development cooperation

Poland has 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. By implementing international aid commitments, the funds provided by Poland under Official Development Assistance (ODA) in 2012–2016 increased figure 7.1), ranging from PLN 1369 to PLN 2610 million (USD 421–662).



* data is subject to verification

Fig. 7.1. Total Official Development Assistance in the years 2012–2016, source: IOŚ–PIB on the basis of data provided by the Ministry of Foreign Affairs

About 77% of Polish Official Development Assistance was granted by multilateral channels in 2012–2016, mainly through contributions to the EU budget. Funds distributed through the European institutions are invested in activities selected through the programming process in line with relevant EU legislation. Multilateral assistance is also provided to entities operating in the United Nations.

Approximately 23% of Polish aid was provided through bilateral assistance provided through public finance sector institutions, Polish diplomatic missions and non-governmental organizations. Bilateral assistance is disbursed according to the priorities set by the Ministry of Foreign Affairs (MSZ) based on the needs assessment of individual countries or regions of the world. In the years 2013–2015 development cooperation was based on the Multiannual Development Cooperation Programme 2012–2015, while in 2016 funding was based on the Multiannual Development Cooperation Programe2016–2020.

It should be noted that the burden on the Polish budget also resulted from the significantly changing exchange rates of the Polish zloty against other currencies. The total amount of bilateral and multilateral aid provided by Poland in the years covered by the report is presented in Table 7.1.

Table 7.1. Bilateral and multilateral aid provided in 2012–2016

Bilateral and multilateral aid in 2012–2016						
in millions		**2012**	**2013**	**2014**	**2015**	**2016**
Bilateral aid	PLN	362.74	401.62	259.54	377.74	589.84
	USD	111.55	127.11	82.28	100.19	149.55
Multilateral aid	PLN	1 006.46	1 137.49	1 165.73	1 284.54	2 027.11
	USD	309.51	360.01	369.57	340.71	513.96

Source: Ministry of Foreign Affairs

7.3. Information on minimizing adverse effects of climate change compliant with Article 3.14. of the Kyoto Protocol

In 2012–2015, the main beneficiaries of bilateral assistance were Belarus, Ukraine, Afghanistan, Georgia, Moldova, Ethiopia, Angola, Syria, Kazakhstan, Kenya, Palestine, Cambodia. In turn, bilateral assistance was firstly directed to Ethiopia, Syria, Ukraine, Tanzania, Belarus, Kenya, Angola, Moldova, Georgia and Iraq in 2016. Priorities of Polish development aid during the period covered by the report include, among others: environmental actions in developing countries, including actions to prevent the effects of natural disasters and combat climate change.

Poland's aid to climate change activities steadily increased over the period covered by the report. Climate change contributions, environmental protection and energy are included in the Climate Action category. The bilateral assistance provided in 2013 included Armenia, Azerbaijan, Ethiopia, Guinea, Moldova, North Korea, Palestine and Ukraine. Beneficiaries of aid in 2014 were Moldova, Belarus, Peru, Uganda, Kenya, Armenia, Ukraine and Georgia. Funds of more than PLN 6.2 million (EUR 1.4 million) were transferred to projects related to: with the support of science and technology facilities of developing countries through the exchange of knowledge and the provision of specialized equipment for research purposes. Assistance was also provided for projects aimed at building of resilience to natural disasters, popularization of innovative energy efficiency technologies, development of renewable energy sources.

In 2015, the value of bilateral climate aid increased by about 56% compared to 2014. The list of countries to which funding was allocated for climate projects, including those targeting technology transfer. Eastern Partnership countries and selected African, Asian and Middle Eastern countries, i.e. Georgia, Ukraine, Moldova, Tajikistan, Kyrgyzstan, Kenya, Ethiopia, Uganda, Tanzania, Lao People's Democratic Republic, Armenia and Myanmar. Adaptation to climate change accounted for 56%, 37% for climate change, and the rest for horizontal actions. By 2016, the total amount of climate aid donated was more than PLN 23 million (€ 5.6 million), as was the case in 2015, and included countries such as Ethiopia, Belarus, Georgia, Indonesia, Iraq, Kenya, Moldova, Nigeria, Tanzania, the West Bank and the Gaza Strip. Approximately 20% of the climate aid provided by the bilateral channel concerned adaptation projects, 20% of activities related to emission reduction. The remaining part was devoted to the implementation of horizontal projects. The level of Polish bilateral and multilateral aid related to climate projects in the particular years covered by the report is presented in Table 7.2.

Table 7.2. Polish climate aid in 2013–2016

Year	Total climate aid		including:	PLN	EUR*
	PLN	EUR*			
2013	1 099 022.7	261 990.07	Mulitilateral	15 719.02	3 747.17
			Bilateral	1 083 303.68	258 242.9
2014	15 380 394.29	3 675 036.28	Mulitilateral	9 139 127.84	2 183 729.87
			Bilateral	6 241 266.45	1 491 306.41
2015	23 739 162.79	5 673 931.69	Mulitilateral	12 653 895.95	3 024 426.00
			Bilateral	11 085 266.84	2 649 505.69
2016	23 465 950.21	5 379 014.37	Mulitilateral	14 217 145.08	3 258 944.43
			Bilateral	9 248 805.13	2 120 069.94
Total (current prices)	63 684 529.99	14 727 982.34	Mulitilateral	36 025 887.89	8 470 847.47
			Bilateral	27 658 642.10	6 519 124.94

* according to the rates indicated in the EIONET reports

Source: IOŚ–PIB based on EIONET reports

Poland allocates funds to promote technological development in developing countries. The Ministry of Environment in the framework of the UN Climate Conference, which took place in Poland in December 2008, has prepared the GreenEvo – Green Technology Accelerator project. The programme aimed to create favorable conditions for the dissemination of environmental protection technologies in Poland and abroad offered by Polish entrepreneurs. GreenEvo supports the identification of the technological needs of developing countries and assesses the ability of these suppliers to meet these needs. In the years 2013–2016, 54 commercially-oriented technological projects in Poland have been selected to promote the rational use of energy and renewable energy sources. A detailed breakdown of the number of projects implemented under the programme in each of the years covered by the report is indicated in Table 7.3.

A list of projects in developing countries is provided in Table 8 of the Third Biennial Report.

Table 7.3. Number of GreenEvo projects implemented in 2013–2016

Year	Number of GreenEvo AZT projects	including number of projects targeted at developing countries (developing countries)
2013	16	4 (China, Moldova, Ukraine, Serbia)
2014	12	4 (Chile, Kazakhstan, Moldova, Ukraine)
2015	14	7 (Chile, Kazakhstan, Nigeria, Morocco, Ukraine, Republic of South Africa)
2016	12	5 (Bosnia and Herzegovina, Kazakhstan, Costa Rica, Senegal, Ukraine)
Total	54	20

Source: IOŚ–PIB (based on data provided by the Ministry of Environment)

The Ministry of the Environment, seeing the potential of Polish companies in the market of environmentally friendly technologies, strives to support the development and promotion of green entrepreneurs in the most efficient way possible. Almost 40% of GreenEvo's projects have been deployed to developing countries. During the project the companies had the opportunity to participate in meetings with potential partners in countries such as China, Moldova, Serbia, Chile, Kazakhstan, Ukraine, Nigeria, Morocco, South Africa, Bosnia and Herzegovina, Costa Rica and Senegal.

CHAPTER 8. RESEARCH AND SYSTEMATIC OBSERVATIONS

8.1. Research and systematic observation policy and the funding system

8.1.1. Climate research in the nationl science policy

On 22 September 2005, the National Framework Programme was adopted and set out the priorities for research and development. It was the basis for establishing projects commissioned by the minister responsible for science and announced in tender-process-driven contests. One of the 9 strategic areas of research was the environment with priority given to the area "Economy and climate change". The aim of the project was to determine means to reduce greenhouse gas emissions in Poland, enhance GHG removal, to limit non-renewable energy consumption in favour of renewable energy sources and to counteract adverse impacts of GHG emissions on economy and natural environment.

On 30 October 2008, the National Research and Development Programme (KPBNiPR) was endorsed**,** as the instrument for facilitating the implementation of the state's science and technology policy, at the level of European and world standards. The issue of countermeasures and adaptation to climate change was included in 2 of 5 priority research areas:

- Energy and infrastructure. Research directions: efficient use of domestic fossil resources ensuring ecological security; alternative energy sources, such as renewable nuclear and hydrogen-based sources; new technologies leading to increased reliability and efficiency of generation, processing, storage and transmission of energy;
- Environment and agriculture. Research directions: environmental diagnostic methods and technologies to mitigate climate, air, soil and water threats; improvermnt of technology for acquiring satellite information on the environment and precise positioning system.

On 1 October 2010, a package of 6 reform laws was set, including the Act of 30 April 2010 on Science Financing. The reform of science allowed the Ministry of Science and Higher Education to assume the role of a leading center for scientific policy development and coordination of activities in this field in Poland. The National Science Centre (NCN) and National Center for Research and Development (NCBR) have taken over the task of creating programs and funding research projects.

Consistent with Art. 4 par. 1 of the Act on the Principles of Financing Science, in 2011, the Council of Ministers adopted the National Research Programme (KPB), which formulates strategic directions of research and development work and defines the objectives and tasks of the state's scientific, technical and innovative policy. These guidelines are the foundation for grounding strategic research and development programs by the National Center for Research and Development (NCBR).

The issue of climate change and adaptation to climate change is addressed in 3 of 7 strategic, interdisciplinary fields of research and development:

- new technologies in energy,
- modern materials technology,
- environment, agriculture and forestry.

Among others, under Programme and NCBR framework, the following strategic research and development programmes were launched:

Strategic Programme: Advanced power generation technologies

The aim of the program, completed in 2015, was to develop technological solutions whose implementation contributes to reducing the negative impact of the energy sector on the environment. These solutions help to reduce emissions and to achieve the EU targets set out in the Strategy 3 x 20 (enhancing energy efficiency), i.e. increasing the share of renewable energy to 20% and reducing CO_2 emissions.

The Programme comprised four research tasks implemented in the years 2010–2015:

1. Development of technology for high-efficiency "zero-emission" carbon blocks integrated with CO_2 capture from exhaust gases;

2. Development of aerobic combustion technology for dust and fluidized bed boilers integrated with CO_2 capture;

3. Development of coal gasification technology for high efficiency fuel and electricity production;

4. Development of integrated technologies for the production of fuels and energy from biomass, agricultural waste and others.

Environment, agriculture and forestry – BIOSTRATEG

The main goal of BIOSTRATEG is to stimulate innovation and competitiveness of Poland's economy, sustainable development of the agricultural, forestry and food sectors as well as of timber industry, taking into account environmentally-friendly solutions and the reduction of the negative impacts of civilization and climate change.

BIOSTRATEG consists of 5 research tasks, of which the task 3 is directly related to mitigation and adaptation to climate change (see p. 8.2.5):

1. food safety;

2. rational management of natural resources with a special focus on water management;

3. mitigation of and adaptation to climate change, with particular emphasis on agriculture;

4. protection of biodiversity and sustainable development of agricultural production;

5. forestry and timber industry.

Other major projects and projects related to the subject of climate change include:

Integrated system for reducing building energy consumption

The aim of this research project is to develop technical and organizational solutions for the design, construction and operation of residential and public buildings, towards reduction of their energy intensity and the increase in the share of renewable energy in the building energy balance.

The project, completed in 2014, consisted of 7 research tasks:

1. analysis of socio-economic effects of enhancement of energy efficiency in the construction sector;

2. development of optimal energy-efficient solutions as regards the structure, material and installation of buildings;

3. increasing the use of energy from renewable energy sources in the construction industry;

4. development of thermal diagnostics of buildings;

5. optimizing electricity consumption in buildings;

6. analysis of technical and operational requirements for buildings when powered from centralized heat sources;

7. the conditions and possibilities of energy saving by means of urban policy instruments.

Generator of Ecological Concepts GEKON

Joint project of NCBR and Fund for the Environmental Protection and Water Management (NFOŚiGW), realized from 2013 to 2018, aims at developing low-carbon environmental technologies (including co-financing of scientific research, development and implementation). Funds are received by scientific and industrial consortia. PLN 400 million is planned for the project implementation (PLN 200 million each – NFOSiGW and NCBR). Projects are implemented with regard to 5 areas:

1. Environmental aspects of unconventional gas acquisition,

2. Energy efficiency and storage,

3. Protection and sustainable use of water,

4. Acquiring energy from clean sources,

5. Innovative methods of obtaining fuels, energy and materials from waste and waste recycling.

In addition, as part of the Smart Growth Operational Programme (POIR), sectoral programs have been implemented by entrepreneurs. This enables the implementation of large R&D projects in selected industries that are part of the National Intelligent Specializations. The sectoral programs related to the widely-understood climate protection, include PBSE and IUSER (energy, including renewable energy and energy efficiency), WOOD-INN (forestry and furniture sector), INNOVATIVE RECYCLING.

The science budget 1991–2016 is shown in figure 8.1. Until 2005, a gradual decrease in expenditure on science was visible, resulting primarily from a declining share of the state budget in research financing. After the adoption of the National Framework Programme in 2005, funding gradually increased, with a constant share of budgeted expenditure on science in GDP. Currently, the science budget comprises, among others, the statutory activity of scientific units (including subsidies for the maintenance of research potential, scholarships, Minister's programs, targeted subsidies), as well as funds for NCBR, NCN, scientific cooperation with foreign countries, knowkedge dissemination, and other relevant European activities (including POIR, POWER, Horizon 2020).

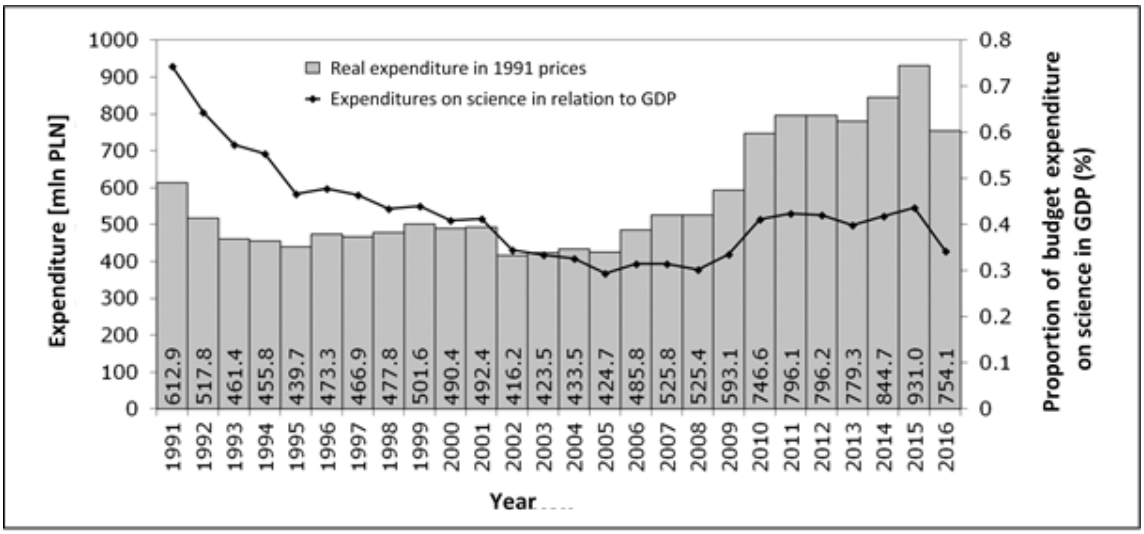


Fig. 8.1. Expenditures on science in the years 1991–2016, data sources: Ministry of Science and Higher Education, Central Statistical Office

8.1.2. Directions of national research on climate change

In Poland, research in the field of climatology covers a wide spectrum, which practically has not changed for many years. The major directions of research include: physical climatology, climatology of areas exposed to anthropopressures, dynamic climatology, regional climatology, applied climatology and broadly understood 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,
- climate change impacts on the natural environment, economy and society,
- impacts of human activities on the climate,
- social and political aspects of climate change.

A detailed description of the research related to climate change is provided in Chapter 8.2.

8.1.3. Participation in international programs

In July 2013, as a follow-up and extension of the tasks of the 7th EU Framework Programme, the Horizon 2020 – EU Framework Programme for Research and Innovation 2014–2020 was adopted. The key objective of Horizon 2020 is to integrate research and innovation by creating a single and coherent funding system. The third pillar of the "Social Challenges" programme addresses adaptation to climate change: health; demographic change; human wellbeing; food security; sustainable agriculture and forestry; maritime issues; inland waterways and bio-economy; safe, clean and efficient energy; intelligent, green and integrated development; climate; the environment; the efficient use of resources and raw materials.

Polish research centres have actively participated in projects related to broadly understood climate change issues, carried out within the framework of the Horizon 2000 programme for research and technological development.

Future Earth Program

The international Future Earth (FE) programme, launched in 2015, is a continuation and extension of the International Geosphere-Biosphere Programme (IGBP), implemented in 1986–2015. Future Earth brings together international efforts to promote sustainable development on the ground and covers activities across many disciplines, as well as social and political activities. the Polish National Committee of IGBP/FE plays the important role as the programme coordinator. The Committee also conducts activities to expand research on global geosphere and biosphere changes and to disseminate the results of these studies in Poland. The participation of Polish scientific institutions in IGBP and Future Earth subprograms is discussed below.

Biosphere Aspects of the Hydrological Cycle (BAHC)*:** Research projects carried out with regard to the objectives of ***BAHC focus on the effects of geophysical processes on Poland's water resources, with particular attention paid to extreme hydrological events (floods and droughts). The detailed study covered selected areas of the country, mainly lake districts, mudflats and floodplains. Works are carried out on the water and heat balance of selected areas (Wielkopolska, Kaszuby). There has been developed methodology for assessing the risk of negative processes in the Baltic coastal zone, especially in the areas of large agglomerations, as well as the Vistula delta and Żuławy.

***Global Land Project, Global Change and Terrestrial Ecosytems (GCTE)*:** Research under this programme addresses climate change impacts on the carbon cycle in selected water ecosystems (Wielkopolskie Lakeland, north-eastern Poland) and forest ecosystems (Wielkopolska). In collaboration with European and American research centers, extensive research is conducted on the impact of climate warming on changes in the range of pine forests across Europe (from Lapland to the Carpathian Mountains). In the Polish in mountainous regions, there was carried out a study on changes of altitudinal zonation due to the increase of air temperature. There has been also continued research on climate change impact on plant production and forestry in Poland.

International Global Atmospheric Chemistry (IGAC): As part of the program, there is carried out monitoring of GHG concentrations in the atmosphere, isotopic composition of carbon (isotopes ^{12}C, ^{13}C and ^{14}C radio carbon) in atmospheric carbon dioxide and methane, including their changes due to the CO_2 and methane anthropogenic emissions into the atmosphere. Monitoring of the concentration and chemical composition of aerosols in the coastal areas and in urban agglomerations, is also carried out. There are undertaken studies on the height of the atmosphere boundary layer in cities (sodar and remote sensing methods) and on variability of atmospheric ozone content and UV-B radiation. Some of the studies are related to the impact assesments as regards effects of various sectors on climate and the establishment of factors and insicators for greenhouse gas emission. At the same time, there are carried out works on improvement of methodology with regard to climate change mitigation.

Past Global Changes (PAGES): Research on environmental variability in the past focuses on historical climate change mechanisms, especially during the last glacial period and the holocene. As for the glacial period, particular attention is paid to the changes recorded in loess sediments, the course of deglaciation and the recession of permafrost. The research on the sediments of Gościąż Lake (the Kujawsko-Pomorskie Voivodship) is continued, as well as research with regard to reconstructing past climatic conditions – based on biological traces in sediment samples, collected from water reservoirs located in Pomerania.

Surface Ocean Lower Atmosphere Study (SOLAS): As part of the continuation of the IGBP *Joint Global Ocean Flux Study* (JGOFS) programme concluded in 2003, studies on aerosol optical properties were conducted in the North Atlantic areas. Polish polar research is an important contribution to understanding the impact of global warming on ocean ecosystems.

Future Earth Coasts (former Land-Ocean Interactions in the Coastal Zone – LOICZ). Particular attention has been paid to the coastal zone in view of global warming effect, leading to the sea level rise and increasing storm frequency and intensity, as well as the associated frequent flooding of coastal areas. Research continues on the dynamics of coastal areas (shoreline change and sediment transport) and marine sediments, the evolution of the southern coast of the Baltic Sea in the long run, the modeling of river basins, the exchange of salt and CO_2 in marine contact areas, and the chemistry and pollution of coastal waters.

World Climate Programme (WCP)

Polish scientists and experts take active part in the work of the World Meteorological Organization (WMO) in both Commissions and Programmes. Research is ongoing in the framework of the World Climate Programme – Water on marine climatology. A programme for the recovery of historical observation data from Poland has been conducted since 2005 by the Institute of Meteorology and Water Management (IMGW–PIB). Research on climate change in Poland has been carried out on the basis of long-term climatic data. There have been continued activities covered by the programme and by the Global Climate Observing System (GCOS), established under WMO. Detailed information on current work and monitoring systems in the framework of the WMO programmes is provided in Chapter 8.3.

Intergovernmental Panel on Climate Change (IPCC)

IMGW–PIB in Warsaw is the focal point for the Intergovernmental Panel on Climate Change (IPCC), as established by the Minister of Environment in 1990. This institution coordinatas Poland's activities with regard IPCC works, issues IPCC documents, and nominates experts (e.g. working/expert group meetings). Polish scientists have been involved in the drafting and review of documents, including the Fifth IPCC Report issued in 2014.

European Global Ocean Observing System (EuroGOOS)

Polish research institutes (Institute of Oceanology of the Polish Academy of Sciences, Maritime Istitute, Institute of Meteorology and Water Management – National Research Institute) are members of EuroGOOS. They are involved in the development of European operational oceanography, which geatly contributes to the Global Ocean Observing System (GOOS). The key element of EuroGOOS's work is the construction and development of a stable surveillance system and oceanographic measurements within the Baltic Sea.

Global Flux Monitoring Network (FLUXNET)

Seven research stations in Poland, affiliated to the FLUXNET network, observe the exchange of open and latent heat and greenhouse gases (CO_2, CH_4) between atmospheric and natural ecosystems: forest, marshes, and agriculture. Particular attention has been paid to changes in the characteristics of greenhouse gas flows (temporal and spatial variability as well as absolute values of the stream) under the influence of external stimuli: agricultural activity, deforestation as a result of the tornado.

Aerosol Robotic Network (AERONET)

AERONET is a network for the measurement of the quantity and type of suspended particulates (aerosols) and the amount of water vapor in the air. It consists of over 600 solar photometers all over the world. Four of them are located in Poland. Aerosol optical measurements have been also performed during cruises in the Baltic, Norwegian and Greenland (Institute of Oceanology of the Polish Academy of Sciences).

Earth System Science for the Baltic Sea Region (Baltic Earth)

Polish scientific institutions (Institute of Oceanology of the Polish Academy of Sciences, University of Łódź) take part in Baltic Earth subprograms (formerly BALTEX) on biogeochemical interactions between land and the sea and the dynamics of sea level changes in different time and space scales (for meteorological, hydrological and geological reasons).

Science for a Better Future of the Baltic Sea (BONUS)

The BONUS programme is a continuation/development of previous activities related to the protection of the marine ecosystem and sustainable management of the Baltic Sea. All the Baltic countries participate in the program. The project includes, among others, evaluation of the extent of retention of biogenic elements (nitrogen and phosphorus) between sources of pollutants and their receptor – the Baltic Sea; development of radar detection methods on the surface of the sea such as ice, oil stains, waves and observations on biodiversity change of the marine ecosystem.

International Network for Terrestrial Research and Monitoring in the Arctic (INTERACT)

INTERACT is a network of 79 research stations located in the arctic and alpine regions of the northern hemisphere, including Polish polar stations (Svalbard; Institute of Oceanology, Polish Academy of Sciences) and those in the Tatra Mountains (Institute of Geography and Spatial Organization, Polish Academy of Sciences). The network constitutes a platform for coordinating research, monitoring and logistics, sharing experiences and creating networks of infrastructures for environmental researchers. As part of the program, observation and research activities will be continued, focusing on environmental research to identify, understand, predict and respond to the impacts of diverse environmental conditions.

8.2. Research studies

8.2.1. Studies on the climate system and processes

Research on climate change in the past

The studies on past climate change in Poland mainly concern the period when instrumental measurements were conducted (1800s/1900s) and are done at the country, regional and local (city) levels. The analyses have been carried out as regards the variability of thermal and pluvial characteristics. The oldest records of temperature and total precipitation come from the city of Gdańsk (systematic records since 1739), the city of Warsaw (systematic records since 1779) and the city of Kracow (systematic records since 1792). At the present time, the elements that make up the weather and climate are observed/recorded by the State Hydrological and Meteorological Service (PSHM) under the framework of IMGW–PIB. Within the framework of the KLIMAT project, coordinated by IMGW–PIB and implemented in 2008–2012, there were carried out studies

concerning the risk of occurrence of extreme meteorological and hydrological events in Poland, such as : hail, drought, black ice, fog, strong wind, intense rain, storm surge, extremely low and extremely high air temperature. Under the ISOK project, implemented in 2012–2016, detailed maps of meteorological hazards were developed by IMGW–PIB.

Works on the reconstruction of climate conditions in the historical period are aimed at searching for trends in past climate change and possible periodicity of these changes. In general, the results obtained confirm those reported in neighboring countries. Research has continued with respect to the attribution of causes of climate change observed in Poland, and new scientific facts prove the association of climate change in Poland with regional and global processes (changes in regional atmospheric circulation, North Atlantic Oscillation, Arctic Oscillation, surface temperature change in the North Atlantic).

Relevant projects financed at a national level (NCN, NCBR), as well as those supported by international funds (operational programmes of the European Union and other forms of international cooperation) are specified below:

- Model of geological structure, regional key horizons and Middle-Late Pleistocene climate in the southern part of the Polish-Belarusian cross-border area. Polish Geological Institute – National Research Institute (PIG–PIB), OPUS 2014–2017.
- The Štramberk-type limestone Crinoids as a valuable source of paleobiological and paleo-environmental data. University of Silesia (UŚ) in Katowice, PRELUDIUM 2014–2017.
- Devonian deep-water marine realm as a key to elucidate global ecosystem perturbations. University of Silesia in Katowice, MAESTRO 2013–2018.
- South Shetland neoglacjal dynamics (Western Antarctica) from the perspective of microscale and isotopic studies. Polish Geological Institute – National Research Institute (PIG–PIB), PRELUDIUM 2015–2017.
- Reconstruction of palaeontological conditions based on cave infiltration for the northern and southern Carpathians for the Eemal interglacial and early Vistulian. nstitute of Geological Sciences, Polish Academy of Sciences, SONATA 2016–2019.
- Recording the environmental response to climate change over the last 15 000 years on the European W–E transect line based on new, integrated high resolution analysis pf sediments from the Lake Gościąż. Institute of Geography and Spatial Organization, Polish Academy of Sciences, OPUS 2016–2019.
- Causes of Arctic climate warming in the first half of the 20th century. Nicolaus Copernicus University, OPUS 2016–2019.
- The occurrence of the heat waves in Europe and their circulation and synoptic conditions. Adam Mickiewicz University in Poznań, PRELUDIUM 2015–2018.
- The problem of synchronicity of droughts and fires along the continental gradient in northern Poland over the last 4000 years: high-resolution, multi-proxy studies of peatlands. Adam Mickiewicz University in Poznań, OPUS 2016–2019.

- Tracking climate signals preserved in lake sediments from integrated process studies and ultra high-resolution analysis of annually laminated sediments. University of Gdańsk, SONATA BIS, 2016–2021.
- Air temperature variability in northern Poland during the past two millennia – quantitative reconstruction based on annually laminated sediments of Lake Żabińskie (CLIMPOL–2k). University of Gdańsk, OPUS 2015–2018.
- The use of blue light reflectance intensity analysis as a new data source in dendrochronological research on climate change in Europe. University of Silesia in Katowice, OPUS 2014–2017.
- Climate conditions in the southern Baltic in the second half of the 15th and 16th centuries and their consequences for social, economic and cultural life. Nicolaus Copernicus University, OPUS 2014–2017.
- Perigacial transformation of the relief and sediments of northern Podlasie in the upper Pleistocene. University of Warsaw (UW), OPUS 2014–2017.
- Reconstruction of climate change over the last 200,000 years and their impact on the aquatic ecosystem on the basis of subfossil Cladocera analysis deposited in the sediments of Lake Peten Itza (northern Guatemala). Institute of Geological Sciences, Polish Academy of Sciences, OPUS 2015–2018.
- Reconstruction of geomorphological processes in glacial environment after the end of the "Little Ice Age" – Sedimentological and morphological record of glacial systems reaction to changes in natural environment. Adam Mickiewicz University in Poznań, SONATA 2011–2017.
- Comparison of thermal variability in the last millennium in mountains of Central Asia and Central Europe. University of Silesia in Katowice, OPUS 2014–2017.
- Precipitation extremes in different spatial and temporal scales – identification of factors favorable to the occurrence of precipitation extremes. University of Łódź, OPUS 2013–2017.
- Characteristics of the variability of thermodynamic, kinematic and composite parameters associated with the occurrence of extreme convective phenomena in Central Europe over the past 40 years. Adam Mickiewicz University in Poznań, PRELUDIUM 2015–2018.
- Dust flux record and palaeohydrology of peatlands during the last 1000 years studied by nuclear and related analytical techniques. Uniwersytet im. Adam Mickiewicz, Joint Institute for Nuclear Research, 2017–2018.
- Climate of northern Poland during the last 1000 years: Conflicting the future with the past (CLIMPOL). University of Gdańsk, Polish-Swiss Research Programme, 2011–2015.
- Reconstruction of climatic conditions in Gdańsk in the period of instrumental measurements, 1739–2010. University of Gdańsk, OPUS 2013–2016.

Research on climatology of air pollutants and greenhouse gases

In Poland, research is conducted as regards: climatology of air pollutants (Silesia, Cracow, Tri-City); evolution of the urban boundary layer (Kraków, Łódź, Wrocław); atmospheric ozone and

UV radiation (Belsk, Legionowo); changes in GHG and halogen concentrations (Kraków, Kasprowy Wierch), as well as aerosols and optical properties of the atmosphere. These studies, using relatively short but contemporary data series, provide important input to knowledge about Poland's climate (see Section 8.3.5).

Since 2015, under the Horizon 2020 programme, there has been carried out the project "Aerosols, Clouds, and Trace Gases Research Infrastructure Network" (ACTRIS-2). It aims to integrate European ground stations equipped in advanced equipment for surveying aerosols, clouds and trace gases. The participants of the project are: the Institute of Geophysics of the Polish Academy of Sciences, Institute of Environmental Engineering of the Polish Academy of Sciences, IMGW–PIB, Institute of Oceanography of the Polish Academy of Sciences, University of Warsaw, Warsaw University of Technology. Archieving of the full operational capability of the project, i.e. establishing an independent research infrastructure, providing publicly available observation data, is planned for the year 2025.

In 2011, a consortium of Polish national research institutes, Poland-AOD, was set up to integrate research on impacts of aerosols on the climate system, through monitoring aerosol optical and microphysical features, the measurements of radiation balance components, as well as developing measurement techniques of pollutant transfer and numerical modeling methods for evaluation of aerosol effects on the energy balance. The consortium embraces: the University of Wrocław (UWr), University of Gdańsk (UG), Nicolaus Copernicus University (UMK), Adam Mickiewicz University in Poznan (UMK) and institutions of the Polish Academy of Sciences (Institute of Oceanography, Institute of Geophysics) The consortium studies are carried out with the help of NCN, NCBR, the Polish Science and Technology Fund and the Ministry of Science and Higher Education.

Relevant research projects financed at a national level (NCN, NCBR), as well as those supported by international funds (operational programmes of the European Union and other forms of international cooperation) are specified below:

- Features of daily and annual variability of urban area – atmosphere turbulent exchange of methane on the example of the City of Łódź. University of Łódź, SONATA 2011–2017.
- Horizontal variability of optical properties of aerosols in the European Arctic. Institute of Oceanology, Polish Academy of Sciences, ETIUDA 2016–2018.
- Interannual and seasonal variability of net greenhouse gas (CO_2, CH_4, H_2O) streams in wetlands (Biebrza National Park) and their determinants. University of Łódź, OPUS 2016–2019.
- Integrated studies of climate processes involving absorbing aerosols. University of Warsaw, SONATA 2013–2018.
- Influence of internal sources of emission of gaseous and particulate pollutants on the change of atmospheric aerosol structure migrating to selected non-production rooms. Institute of Environmental Engineering, Polish Academy of Sciences, PRELUDIUM 2014–2017.
- Teledetection research of optical properties variability of aerosols during transportation over Poland. Institute of Geophysics, Polish Academy of Sciences, OPUS 2014–2017.

- Seasonal changes in greenhouse gas emissions (methane, carbon dioxide and nitrous oxide) depending on the technological stage of the wastewater treatment process in the SBR plant model laboratory. Institute of Agrophysics, Polish Academy of Sciences, PRELUDIUM 2016–2018.
- Modeling of concentrations of suspended particulate matter and ozone for Poland using high-resolution spatial and temporal surveys. University of Wrocław, OPUS 2014-2017.
- Air Pollution and biometeorological forecast and Information System. University of Wrocław, Horizon 2020 2013–2017.
- Aerosols, Clouds, and Trace gases Research InfraStructure Network. IMGW–PIB, Horizon 2020 2015–2019.
- Integrated monitoring *system* of spatial data to improve air quality in Cracow. City of Cracow and IMGW–PIB, the Polish-Norwegian Research Programme 2014–2016.
- Integrated studies of climate processes involving absorbing aerosols. University of Warsaw, SONATA 2013–2018.
- Remote sensing investigation of optical properties of aerosols during transportation over Poland. Institute of Geophysics, Polish Academy of Sciences, OPUS 2014–2017.
- Study of the influence of vertical transport of Pb-210 and Po-210 on determination of aerosol times of presence in the atmosphere and evaluation of the anthropogenic emission of these radionuclides. Lodz University of Technology, SONATA 2013–2017.

Research on high-latitude climate

Research on areas located in high latitudes is of particular importance in Poland. Two Polish polar stations (in Hornsund, SW Spitsbergen and on the King George Island, South Shetland) have continued their regular work. In both cases, issues related to global climate change are of main interest. Particular attention has been paid to the disappearance of the ice cover in the central part of the Arctic Ocean and changes in seawater chemistry, as well as their implications to the local biosphere. Moreover, in the summer season, the Polish universities conduct in Spitsbergen various studies in the field of climatology, glaciology and geoecology. In 2013, Polish Polar Consortium was established, bringing together 12 universities and 6 scientific institutes, in order to effectively cooperate with the Polish scientific community focused on polaristics. From the very beginning, the Consortium has organized a number of workshops, conferences and seminars on polar topics. The Centre for Polar Studies of the University of Silesia in cooperation with the Institute of Geophysics of the Polish Academy of Sciences and the Institute of Oceanology of the Polish Academy of Sciences conducts didactic activities in this field (diploma and postgradual studies, workshops and internships).

Relevant scientific projects financed at a national level (NCN, NCBR), as well as those supported by international funds (operational programmes of the European Union and other forms of international cooperation) are specified below:

- Interaction of glaciers and permafrost as an environmental continuum between the glacial and periglacial areas in Tarfala, Scandinavia and the Hornsund area, Spitsbergen. University of Silesia in Katowice, OPUS 2013–2017.

  - Factors determining the process of calving of Spitsbergen glaciers on the example of Hansbreen. University of Silesia in Katowice, PRELUDIUM 2014–2017.
  - Biodiversity, structure and functioning of benthic communities in the changing ecosystems of the northern Bering Sea and the Chukchi Sea. Institute of Oceanology, Polish Academy of Sciences, HARMONIA 2013–2017.
- The wind field of the Svalbard archipelago in the light of climate change projection using dynamic downscaling. University of Wrocław. OPUS 2015–2018.
- Detection, characterization and effects of icebergs in the Amundsen Sea, Antarctica. University of Gdańsk, ETIUDA 2016–2018.
- The impact of climate change on snow cover and hydrological regime of polar non-basin catchment. Institute of Geophysics, Polish Academy of Sciences, PRELUDIUM 2014–2017.
- Role of meltwater from snow cover for supplying drainage systems of the Spitsbergen glaciers. University of Silesia in Katowice, PRELUDIUM 2013–2017.
- Predictability of Eurasian winter climate fluctuations associated with oceanic heat anomalies in the Nordic seas and North Atlantic. Institute of Oceanology, Polish Academy of Sciences, OPUS EURAKLIM 2015–2020.
- Integrated Arctic Observation System (INTAROS). Institute of Oceanology, Polish Academy of Sciences, Horizon 2020 2016–2021.
- Drifting fast or crawling slow? Advance of boreal species to Svalbard. Institute of Oceanology, Polish Academy of Sciences, Polish-Norwegian Research Programme 2017–2018.
- Future Arctic Algae Blooms and their roles in the context of climate change. Institute of Oceanology, Polish Academy of Sciences, The Research Council of Norway 2015–2019.
- The changing ocean of the Polar North (POLNOR). Institute of Oceanology of the Polish Academy of Sciences, Institute of Paleobiology of the Polish Academy of Sciences, Polish-Norwegian Research Programme, 2014–2017.
- South Shetland neoglacial dynamics (Western Antarctica) from the perspective of microscale and isotopic studies. Polish Geological Institute – National Research Institute, PRELUDIUM 2015–2017.
- The impact of climate change on snow cover and hydrological regime of polar non-basin catchment. Institute of Geophysics, Polish Academy of Sciences, PRELUDIUM 2014–2017.
- Causes of Arctic climate warming in the first half of the 20th century. Nicolaus Copernicus University, OPUS 2016–2019.
- Variability of the Russian Arcitic and Subarctic climate in the last three hundred years. Nicolaus Copernicus University, OPUS 2013–2017.

Oceanology research

Research on the subject of oceanology and studies on atmosphere physic/chemistry in coastal zones is primarily focused on the aspects such as: water circulation; transport of energy and mass in

high-latitude areas of the northern hemisphere; transport of solar energy deep into the ocean; aerosols and related changes in atmosphere optical properties, as well as ozone (tropospheric and stratospheric), changes in UVB radiation and GHG concentrations in the atmosphere. The relatively new research focus concerns the Baltic Sea ecosystem; the aim is to quantify the transport of biogenic elements (nitrogen and phosphorus) between land and the sea. This is achieved by means of a comprehensive analysis of the processes occurring in the river basins (surface runoff, the migration in porous/splitting spaces of shallow and and deeper aquifer layers, drainage, processes in water reservoirs, etc.). Research on biodiversity changes in the Baltic Sea ecosystem concern: their causes, consequences and implications to the economy. As part of the BONUS program, there have been developed the methods of extending the capabilities of radar equipment for the detection and parameterization of events on the sea surface (ice, oil stains, algae blooms, waving).

Relevant scientific projects financed at a national level (NCN, NCBR), as well as those supported by international funds (operational programmes of the European Union and other forms of international cooperation) are specified below:

- Measurement, parameterization and analysis of the properties of sea spray aerosol stream fluxes in the boundary atmosphere layer in the southern Baltic and the European Arctic. Institute of Oceanology, Polish Academy of Sciences, PRELUDIUM 2016–2019.
- Application of passive underwater acoustics in the study of sea ice in the Hornsund fjord at Spitsbergen. Institute of Geophysics, Polish Academy of Sciences, PRELUDIUM 2014–2017.
- Influence of freezing of coastal waters and the shore on wave motion and morphodynamics of the coasts in polar regions on the example of the south-western Spitsbergen: process analysis, modelling and prediction. Institute of Geophysics, Polish Academy of Sciences, OPUS 2014–2017.
- Structure and dynamics of demersal layers in the Bornholm Basin, Slupsk Furrow and Gdansk Deep. Institute of Oceanology Polish Academy of Sciences, PRELUDIUM 2014–2017.
- Development of a spectrophotometric pH measurement system for Baltic Sea monitoring – PINBAL. Institute of Oceanology, Polish Academy of Sciences, BONUS 2014–2017.
- Harnessing Coastal Radars for Environmental Monitoring Purpose – HARDCORE. IMGW-PIB, BONUS 2014–2017.
- Nutrient cocktail in coastal zones of the Baltic Sea – COCOA. University of Gdansk, BONUS 2014–2017.
- Reduction of pollutant loads of agricultural origin affecting the Baltic through groundwater and surface water (Soils2Sea). University of Science and Technology (AGH), BONUS 2014–2017.
- Mediating integrated actions for sustainable ecosystem services in a changing climate – MIRACLE. IMGW–PIB, BONUS 2015–2018

- Assessment of the groundwater discharge as a source of pharmaceuticals residues in the marine environment of the Bay of Puck (PharmSeepage). Institute of Oceanology, Polish Academy of Sciences, OPUS 2017–2020.
- Advanced research on the relationship between optical, biogeochemical and physical properties of suspended matter properties of seawater in the southern Baltic Sea (OPUS–OPTICS). Institute of Oceanology, Polish Academy of Sciences, OPUS 2017–2020.
- Holocene history of the Greenland Gyre WIR. Institute of Oceanology, Polish Academy of Sciences, OPUS 2017–2020.
- Development of a spectrophotometric pH-monitoring system in the Baltic Sea. Institute of Oceanology, Polish Academy of Sciences, BONUS 2014–2017.

8.2.2. Modeling and forecasting

Systematic studies on climate change modeling and attempts to predict future climate have been strenghtened. In the recent years, there has been observed intensive development of forecasting methods and warning systems for dangerous hydrological and meteorological events with the purpose to enhance the country's protection.

Relevant scientific projects financed at a national level (NCN, NCBR), as well as those supported by international funds (operational programmes of the European Union and other forms of international cooperation) are specified below:

- Development and implementation of an effective forecasting and monitoring of air pollution, based on AI techniques using data from an extensive metering network. AIRLY Sp. z o.o. 2017–2020, NCBR under the Smart Development Operational Programme 2014–2020.
- Modelling the influence of oil-in-water emulsion on the upwelling light field of seawater, Gdynia Maritime Academy, PRELUDIUM 2013–2017.
- Modeling of concentrations of suspended particulate matter and ozone for Poland using high-resolution spatial and temporal surveys. University of Wrocław, OPUS 2014-2017.
- Microdynamics of clouds. University of Warsaw, MAESTRO 2013–2018.
- Analysis of geophysical surficial fluids models and CMIP climate models for verification of polar motion excitation functions. Space Research Centre of the Polish Academy of Sciences, OPUS 2015–2018.
- Prognostic troposphere model based on meteorological data, GNSS products and. Numerical Weather Prediction models. Wrocław University of Environmental and Life Sciences, PRELUDIUM 2015–2017;
- Precipitable water content (PWAT) as an predictor of extremal weather events in Poland in the light of multi-sources and high resolution measurements. University of Wrocław, OPUS 2016–2019.
- Analysis of the possibility of estimating the type of precipitation based on radar, satellite and numerical data. IMGW–PIB, OPUS 2016–2019.

- Numerical modeling of cloud microphysics and microphysics-dynamics interactions in shallow boundary-layer clouds. University of Warsaw, POLONEZ 2016–2017.
- Utilization of time series of tropospheric parameters received from GNSS observation to validate climate models over Europe. University of Warmia and Mazury in Olsztyn, OPUS 2016–2019.
- GNSS observations as a numerical weather prediction data source, a way forward to enhanced forecasts quality. Wrocław University of Environmental and Life Sciences, SONATA 2014–2017.
- Development and implementation of the Polish IDF Atlas. IMGW–PIB, Smart Development Operational Programme 2016–2019.
- Numerical weather prediction for sustainable Europe. IMGW–PIB, First Team Programme 2016–2019.
- SeaDataCloud – Further developing the pan-European infrastructure for marine and ocean data management. Institute of Oceanology, Polish Academy of Sciences, Horizon 2020 2016–2020.
- Optimizing North Atlantic models to improve Arctic climate prediction. Institute of Oceanology, ERA.Net Plus 2016–2018.
- Modeling of concentrations and deposition of atmospheric pollutants and exposure of human populations and ecosystems to their detrimental effects – present condition and forecast. University of Wroclaw, OPUS 2013–2017.
- Analysis of geophysical surficial fluids models and *CMIP* climate models for verification of polar motion excitation functions. Space Research Centre, Polish Academy of Sciences, OPUS 2015–2018.
- Use of artificial neural networks and methods in the field of pattern recognition for a complex catchment analysis of the impact of anthropogenic chemical and microbiological pollution on water resources. European Regional Centre for Ecohydrology, Polish Academy of Sciences, OPUS 2016–2019.
- Discrete-element sea ice modeling – development of theoretical and *numerical* methods. University of Gdańsk, OPUS 2016–2019.
- Aerosol processing through clouds – the construction of a comprehensive object-oriented programming tool for numerical simulations. University of Warsaw, HARMONIA 2013–2017.

8.2.3. Research on climate change impacts on natural environment

Research on the impact of climate change on the natural environment is focused on a variety of ecosystems – from natural (peat, forest), through agricultural, to those in urban areas. The Laboratory of Ecology and Wetlands Monitoring (Adam Mickiewicz University in Poznań) continues its long-term activities by conducting research on paleohydrology of wetlands and peat bogs and their responses to global warming. The Geological Institute – National Research Institute continues its activities related to the evaluation of environmental sensitivity to climate change:

groundwater monitoring; forecasting threats due to prolonged droughts/excessive supply of rainwater; documentation of areas with steppe formation and continued soil erosion; the Baltic Sea coast erosion; monitoring of landslides (now observed more frequently) due to prolonged, intense rainfalls. Particular attention was paid to the assessment of climate change impacts on urban ecosystems: Warsaw Agglomeration and spa towns (IGiPZ PAN). Research is ongoing on the urban heat island and its impact on the health of urban residents (Jagiellonian University, IMGW–PIB). The "Climate and Bioclimate of Cities" conferences are organized periodically by the University of Łódź, bringing together the ecology of climate researchers in urban ecosystems.

Relevant scientific projects financed at a national level (NCN, NCBR), as well as those supported by international funds (operational programmes of the European Union and other forms of international cooperation) are specified below:

- Trees as bioindicators of industrial air pollution during implementation of pro-environmental policy in Silesia region. Silesian University of Technology, SONATA 2012–2017.
- Study on the modification of the water chemistry of the Revelva river basin (Hornsund fjord area, Spitsbergen) by anthropogenic contamination with differentiated supply by atmospheric water. Gdańsk University of Technology, PRELUDIUM 2014–2017.
- Dendroclimatic and dendroecological studies of larch (Larix decidua Mill.) in the Carpathians and Sudetes. Stanisław Staszic University of Science and Technology (AGH) in Cracow, OPUS 2015–2017.
- The impact of catastrophic deforestation on the lakes and peatlands ecosystem in Tuchola Pinewoods. Institute of Geography and Spatial Organization, Polish Academy of Sciences, OPUS 2016–2019.
- Evolutionary history of two species of Microtus in the late pleistocene and holocene. Reconstruction of population response to climate change using antique DNA and radiocarbon dating. University of Warsaw, SONATA 2016–2019.
- Shaping the cliff seashores under the influence of local and global causal processes in different time scales. University of Szczecin, SONATA 2016–2019.
- The impact of climate change (warming and drought) on the diversity of eukaryotic micro-organisms in peat bogs – next generation sequencing and field experiment. Adam Mickiewicz University in Poznań, PRELUDIUM 2016–2018.
- Reaction of the landscape to climate change and direct human impact: Quantitative analysis of gravity threats of mass processes in tropical mountain areas. Adam Mickiewicz University in Poznań, SONATA 2016–2019.
- The impact of climatic factors on reproductive strategies of birds. Jagiellonian University, SONATA 2016–2019.
- Cryosphere reactions in contrasting high-altitude conditions of Svalbard against environmental changes. Adam Mickiewicz University in Poznań, OPUS 2012–2017.
- Predicting annual dynamics of reflected radiation as consequence of smoothing of previously harrowed soils in a global scale. Adam Mickiewicz Univerisity in Poznań, OPUS 2015–2018.

- The response of the South Shetlands Antarctic fjord ecosystem to climate change in the last millennium: a record of marine sediments (Admiralty Bay, King George Island). University of Warsaw, OPUS 2013–2017.
- Eutrophication of shelf waters as a mechanism decreasing the efficiency of the biological pump. University of Gdańsk and IMGW–PIB, OPUS 2014–2017.
- Determination of the effect of climate change on the composition of phytoplankton in Western Spitsbergen fjords based on pigment in sediments (CLIP). Institute of Oceanology, Polish Academy of Sciences, PRELUDIUM 2017–2019.
- Investigation of the impact of environmental factors on phytoplankton blooms in the Baltic Sea on the basis of numerical models and existing databases. Institute of Oceanology, Polish Academy of Sciences, PRELUDIUM 2013–2017.
- Is the size so important? Comprehensive analysis of the size structure of plankton in the European Arctic at the time of climate warming. Institute of Oceanology, Polish Academy of Sciences, OPUS 2014–2017.
- Assessment of the effect of dissolved organic matter on the acid-base system in the Baltic Sea. Institute of Oceanology, Polish Academy of Sciences, SONATA 2015–2018.
- Climate change impact on ecosystem health – marine sediment indicators. Institute of Oceanology, Polish Academy of Sciences, Polish-Norwegian Research Programme 2014–2017.
- Impact of climate change on development of *Cladium mariscus* (Great Fen sedge) population in Central-East Europe in the last 2000 years. Adam Mickiewicz University in Poznań, OPUS 2014–2017.
- Impact of potential leakage from the sub-seabed CO_2 storage site on the marine environment at the relevant hydrostatic pressure (CO_2Marine). University of Gdańsk, Polish-Norwegian Research Programme.
- Declining size – a general response to climate warming in Arctic fauna? (DWARF). Institute of Oceanology, Polish-Norwegian Research Programme.
- Climate Change Manipulation Experiments in Terrestrial Ecosystems: Networking and Outreach (ClimMani). Poznań University of Life Sciences, COST Action 1308, 2013–2018.
- Rethinking the peatland carbon cycle – identifying the role of mixotrophs in the biological carbon pump (MIXOPEAT). Adam Mickiewicz University in Poznań, Agence Nationale de la Recherche, 2017–2019.
- Long-term changes in the climate system in areas with varying levels of anthropopression. Institute of Geography and Spatial Organization, Polish Academy of Sciences, 2012–2017.
- FORECOM – Forest cover changes in mountainous regions: drivers, trajectories and implications. Jagiellonian University, financed under the Polish-Swiss Research Programme, from 2012.

- Application of objective local classification of weather types in environmental studies and climate change detection. Jagiellonian University, Polish-Hungarian Executive Programme, from 2010.
- Unfavorable biometeorological conditions in the urban areas of central Europe in the context of climate change. Jagiellonian University, from 2009.

8.2.4. Socio-economic analysis

In 2016, the Public Opinion Research Center (CBOS) conducted a survey among the population of the Republic of Poland with regard to the environment and climate change. 69% of respondents had no doubt that climate was changing. On the contrary, 49% of the respondents believed that there was a consensus of science on climate change existence, however 40% of the respondents perceived the scientific community as being divided in this respect. 63% of respondents said that the increase in CO_2 concentration in the atmosphere was not a natural phenomenon. Compared to previous studies (2009 and 2014), Poles' opinion is gradually strengthened that human activity is the main cause of climate change. A marginal percentage (2%) of the respondents claimed that the climate did not change.

Since 2008, a large-scale KLIMAT project ("The impact of climate change on the environment, economy and society: changes, effects and waysof mitigation, lessons for science, engineering practice and economic planning"), financed by the Operational Programme Innovative Economy and coordinated by IMGW-PIB. One of the tasks of the project is socio-economic analysis related to climate change (Task 1: Climate change impacts on Poland's natural environment and determination of their economic consequences). The work carried out within the project focused on the forecast until 2030, based on different scenarios of future climate change developed by IPCC and adapted for Poland's conditions. Among the analyzes carried out special attention was paid to:

- Agriculture: analyzes of the impact of climate change on crop yielding in Poland enabled forecasting the impact of Poland's climate change on agricultural crops until 2030, and assessing the economic costs of abandoning adaptation measures.
- Energy Sector: analyzes of long-term weather data and electricity production indexes allowed to determine the relationship between energy consumption and climate (average air temperature and total precipitation);
- Construction sector: a model has been developed that takes into account the influence ofclimate elements, especially the sum and distribution of temporal and spatial occurrences of precipitation on this sector of the economy. The analysis of the vulnerability of various stages of the building process to changes in weather elements, allowed to assess the impact of climate change on construction;
- Tourism: the analysis allowed to determine how climate change will affect tourism by 2030: the number of foreign and domestic tourists, as well as the activities of ski resorts;
- Water management: the impact of changes in surface water availability due to climate change on the water supply and waste water sectors has been assessed, along with the necessary adaptation measures.

Current and ongoing analyzes focus on the impact of climate change on water management and public health, with particular atrtention paid to urban areas, as well as to extreme weather events and their impact on the economy.

Relevant scientific projects financed at a national level (NCN, NCBR), as well as those supported by international funds (operational programmes of the European Union and other forms of international cooperation) are specified below:

- Impact of climate change and adaptation of some sectors of national economy in Poland and Bulgaria. Institute of Geography and Spatial Organization, Polish Academy of Sciences, 2015–2018.
- The role of man and extreme events in the transformation of environment at the margin of the Eastern Himalaya and their piedmont. Institute of Geography and Spatial Organization, Polish Academy of Sciences, 2015–2017.
- Projections of climate change in EU-based sectors on bottom-up analysis (PESETAIII). Institute of Fundamental Technological Research, Polish Academy of Sciences, Horizon 2020 2014–2020.
- Socioeconomic sensitivity and resilience of regions in Poland and Slovakia. Institute of Geography and Spatial Organization, Polish Academy of Sciences, 2016–2018.

8.2.5. Research and development programs as regards approaches to mitigation and adaptation

In 2013, the Strategic Adaptation Plan for sectors and areas sensitive to climate change was adopted (SPA2020). SPA2020 aims to ensure sustainable development and effective functioning of the economy and society under changing climate. The Plan is a part of the superior research project KLIMADA, launched by the Ministry of Environment, which covers the period up to 2070. One of the partial objectives of the SPA2020 is to define necessary adaptation measures to be undertaken in various areas of the economy and social life and to estimate the necessary costs.

Research in Poland is part of an international effort to develop a scientific basis for adaptation to climate change. Extensive work is being carried out to broaden the methods for: sustainable management of surface and groundwater; soil treatment; prevention of erosion; optimization of production to improve energy efficiency, and reduction of pollutant emissions. Research on innovative techniques to reduce CO_2 emissions in agricultural production has become particularly important in view of the possibility of including this sector of the economy in the emissions trading system (ETS). On 27–28 September 2017, the conference "Contemporary Climate Change in Poland – Biodiversity – Adaptation" was organized by IMGW–PIB.

There is continued the participation of Polish scientific institutions in the INTERREG Central Europe project, which aims to increase regional capacity, among others, with regard to CO_2 emissions reduction. In general, Polish scientific institutions actively participate in 19 projects on the issues associated with: energy management; revitalization of green areas in cities and postindustrial areas; adaptation of forest trees to changing climate, air quality, and groundwater pollution.

Adaptation to climate change is also included in research and development projects related to CO_2 sequestration and storage, within the framework of the Polish-Norwegian Research Programme (area: Carbon Capture and Storage – CCS), co-financed by NCBR. The research deals with CO_2

sequestration and storage under the seabed and in shale gas deposits, in view of impacts on ecosystems, as well as focuses on innovative CO_2 capture and storage techniques. Applied research on coal capture and storage is carried out, among others. by: University of Gdańsk, Silesian University of Technology, University of Science and Technology (AGH), West Pomeranian University of Technology in Szczecin and Polish Geological Institute – National Research Institute.

Relevant scientific projects financed at a national level (NCN, NCBR), as well as those supported by international funds (operational programmes of the European Union and other forms of international cooperation) are specified below:

- Global warming effects: Adaptive capability of Daphnia longispina complex to elevated temperature. Adam Mickiewicz Univeristy in Poznań, PRELUDIUM 2016–2019.
- A Systems Approach Framework for Coastal Research and Management in the Baltic – BaltCoast. Institute of Hydroengineering, Polish Academy of Sciences, BONUS 2015–2018.
- Mediating integrated actions for sustainable ecosystems services in a changing climate – MIRACLE. IMGW–PIB, BONUS 2015–2018.
- Towards sustainable governance of Baltic Marine Space – BaltSpace. Maritime Institute, BONUS 2015–2018.
- Coherent policies and governance of the Baltic Sea Ecosystems – GO4BALTIC. University of Warsaw, BONUS 2015–2018.
- Biodiversity changes -. causes, consequences and management implications– BIO-C3. National Marine Fisheries Research Institute (MIR–PIB), BONUS 2014–2017.
- A platform to analyse and foster the use of Green Travelling Options – GREEN TRAVELLING. Silesian University of Technology, ERA-NET 2014-2017.
- Harnessing coastal radars for environmental monitoring purposes, IMGW–PIB, BONUS 2014–2017.
- Tools, methods and improved community preparation for better preparedness in the event of a crisis. IMGW–PIB, 7 Framework Programme 2014–2016.
- Information system on the impact of climate change on agriculture and adaptation methods. Multiannual program, Institute of Soil Science and Plant Cultivation – State Research Institite.
- Support for low carbon agriculture able to adapt to observed climate change in the perspective of 2030 and 2050 (LCAgri). Institute of Soil Science and Plant Cultivation – State Research Institite, Polish Academy of Sciences, Institute of Environmental protection – National Research Institute, Azoty Group; NCBR Biostrateg 1 Programme 2015–2018
- Development of Urban Adaptation Plans for cities with more than 100,000 inhabitants in Poland. Institute of Environmental Protection – National Research Institute. Ministry of the Environment 2017–2019.
- Climate change adaptation in small and medium size cities. Institute of Environmental Protection – National Research Institute, Polish-Norwegian Project 2017.

- Better prepared for crisis situations – tools, methods and training for local communities. IMGW–PIB, 7 EU Framework Programme.
- A panEuropean framework for strengthening Critical Infrastracture resilience to climate chang (EU–CIRCLE). The Maritime University of Gdynia participates in the project.
- A Comparative Study on Institutional Capacity, Governance, and Climate Change Adaptation in Poland and Norway (PolCitClim). University of Warsaw, Polish-Norwegian Research Programme, from 2014.
- Resource Management in peri-urban areas: going beyond urban metabolism (REPAiR). Institute of Geography and Spatial Organization, Polish Academy of Sciences, Horizon 2020, 2016–2020.
- Shaping the profile of the demand for electric power, while saving energy and its cost without interfering with the profile of the demand for usable energy. Euros Energy Sp. z o.o. IUSER NCBR Programme in the frame of the Smart Development Operational Programme 2014–2020.
- Modular power management system for sustainable energy management from renewable sources with storage function for household and industrial applications. Twerd Power Electronics 2017–2020. NCBR, in the frame of the Smart Development Operational Programme 2014–2020.
- Area forecasting of electricity production from Renewable Energy Sources, taking into account its impact on network node loads. GLOBEMA Sp. z o.o. 2016–2019. NCBR, in the frame of the Smart Development Operational Programme 2014–2020.
- Smart Sensor Networks in Air Protection (ISSOP). Atmoterm S.A. 2016–2020. NCBR, in the frame of the Smart Development Operational Programme 2014–2020.
- Development of an integrated system for precise control of microclimate in large facilities to meet almost zero energy requirements (nZEB). FRAPOL Sp. o. o. 2017–2019. NCBR, in the frame of the Smart Development Operational Programme 2014–2020.
- CLIMATIC TOWN – Energetic Revitalization of Cities. Marshal Office of the Dolnośląskie Voivodeship 2016–2018. NCBR, The Co-operation Programme INTERREG V-5 Poland – Saxony 2014-2020
- Friendly house – cross border network of energy-efficient demonstration buildings. Koszalin University of Technology 2016-2017. South Baltic Cross-border Co-operation Programme 2014–2020.
- Research on a modern, backup source of electricity. Energia OZE Sp. z o.o., 2017–2019. NCBR, Regional Operational Programme for the Śląskie Voivodship 2014–2020.
- Obtaining a new generation of Polish varieties of rapeseed, cereals and Fabaceae resistant to new breeds of pests, with better ability to mitigate and adapt to climate change, with appropriate technological features required by consumers and industry. Hodowla Roślin Strzelce Sp. o. o. 2017–2023. NCBR, in the frame of the Smart Development Operational Programme 2014–2020.

- Comprehensive adaptation of forests and forestry to climate changes – small retention and protection against water erosion in mountain areas. State Forests National Forest Holding 2016–2022. NCBR, in the frame of the Infrastructure and Environment Operational Programme 2014–2020.
- Comprehensive adaptation of forests and forestry to climate change – prevention, counteracting and reduction of the effects of threats related to forest fire. State Forests National Forest Holding 2016–2022. NCBR, in the frame of the Infrastructure and Environment Operational Programme 2014–2020.
- Knowledge base on climate change and adaptation to their effects and channels of dissemination in the context of increasing the resilience of the economy and the environment and society to climate change and to counteract and minimize the effects of emergency threats. Institute of Environmental Protection – National Research Institute 2017–2021. NCBR, in the frame of the Infrastructure and Environment Operational Programme 2014–2020.
- The cooperation for adaptation to climate change through small retention and protection of biodiversity. "Green Action" Ecological Foundation 2017–2019. NCBR, in the frame of the Infrastructure and Environment Operational Programme 2014–2020.
- Modernization and development of the calibration infrastructure of the National Reference and Calibration Laboratory for Atmospheric Air Research and the additional equipment of a network of air quality monitoring in Poland. Chief Inspectorate for Environmental Protection 2015–2020. NCBR, in the frame of the Infrastructure and Environment Operational Programme 2014–2020.
- Strengthening of water monitoring in the scope of procedures for ensuring and controlling the quality of measurements and assessments of surface water status and research, measurement and IT infrastructure. Chief Inspectorate for Environmental Protection 2015–2021. NCBR, in the frame of the Infrastructure and Environment Operational Programme 2014–2020.
- Elaboration of plans to counteract the effects of drought in river basin districts. National Water Management Authority 2016–2020. NCBR, in the frame of the Infrastructure and Environment Operational Programme 2014–2020.

8.3. Systematic observations

8.3.1. Meteorological observation systems

In Poland, observations and measurements under the global meteorological and climate observation system are conducted by the State Hydrological and Meteorological Service at the Institute of Meteorology and Water Management – National Research Institute (PSHM IMGW–PIB). Meteorological and hydrological measurements are performed at 1777 points situated all over the country (Table 8.1, Figure 8.2). The scope of measurements performed at PSHM stations is specified in the Regulation of the Minister of Environment of 6 November 2008 on standard procedures for collection and processing of information by PSHM and PIG (State Hydrogeological Survey). The measurement and observation programme implemented by the PSHM network are in line with the guidelines of the World Meteorological Organization (ZIIRE). The installed equipment

is subject to constant monitoring and periodic calibration at IMGW–PIB Central Laboratory of Measuring Equipment.

Table 8.1. Measurement and observation network of IMGW–PIB (as at 30 June 2017)

Type of station	Number
I level meteorological stations – high-altitude meteorological observatories	2
I and II level meteorological stations – synoptic	60
III and IV level meteorological stations	205
V level rainfall stations	626
I–IV level water gauge stations	862
V level underground water stations	1
Aerodynamic measurement stations	3
Meteorological radars	8
Atmospheric discharges locating stations	9
Satellite data receiving station	1
Total	**1777**

Meteorological stations of I level (high mountain meteorological observatories) are located in the Tatra Mountains (Kasprowy Wierch) and in the Karkonosze Mountains (Śnieżka). Meteorological observations and weather parameter measurements arecarried out. In addition, in co-operation with the University of Science and Technology (AGH) in Kraków, the Kasprowy Wierch Observatory carries out a broad programme on GHG concentrations in the atmosphere (carbon dioxide, methane, nitrogen oxides and freons).

At the meteorological stations of the I and II level, there are performed hourly measurements and observations of pressure, air temperature, air humidity, wind speed and direction, liquid precipitation and horizontal visibility. In addition, the I level stations carry out observations on the type and coverage of the cloud cover, and measurements of the the heights of cloud bases.

Weather stations of the III and IV level are climatological stations equipped with automatic devices, which perform, record and transmit hourly measurements of basic meteorological parameters.

The V level stations are rain stations, equipped with automatic measurement units and transmiting data in operating mode; perform, record and transmit hourly measurements of the amount of liquid precipitation.

There are currently three aerial survey stations located in Łeba, Legionowo near Warsaw and in Wrocław. Twenty times a day, at midnight and noon of universal time (UTC), there is launched a meteorological balloon, equipped with instruments that measure pressure, temperature, humidity, wind direction and speed. Measurement results are sent to WMO.

The state POLRAD meteorological radar network consists of eight radars, located in such a way that they cover the entire territory of the country. The visualization of data from the POLRAD network is made available the IMGW–PIB website in ten minutes. The PERUN/SAFIR discharge detection network consists of nine detectors that identify and locate atmospheric discharges, using high frequency interferometric detectors. Meteorological radars combined with a network of

lightning detectors allow to track the intensity and evolution of precipitation and intense convection phenomena in real time.

The PSHM IMGW–PIB observation network complements the actinometric network, which currently comprises 25 stations. In addition to basic meteorological measurements at these stations, there are also performed measurements as regards radiation balance (short-wave radiation and long-wave radiation taken into account). Data from 4 stations (Kołobrzeg, Warsaw, Belsk, Zakopane) are sent to the World Radiation Data Center (WRDC) sponsored by the World Meteorological Organization (WMO).

Data obtained from the IMGW–PIB network of measurement/monitoring stations is, after verification and control, collected and stored (without specifying the expiration date) in the national database as well as on paper (observation diaries - the oldest date back to the end of the 18th century), microfilms and electronic devices (digital data covers the period from 1951, and for a greater measurement range – from 1966).

Fig. 8.2. Meteorological stations of PSHM IMGW–PIB: synoptic (weather) stations (I and II level) and climate (III and III level)

8.3.2. Ocean Observation Systems

Research on the marine environment of the Polish zone of the Baltic Sea is carried out by numerous institutions. Monitoring of the coastal zone, bays and lagoons of the Baltic Sea has been carried out since 2007 by voivodeship inspectorates for environmental protection.

A dominant role plays the Oceanography and Balitc Monitoring Center of the IMGW Marine Division in Gdynia, which, under the supervision of the Chief Inspectorate for Environmental Protection, monitors the deep-sea area under the State Environmental Monitoring. In addition to

meteorological observations, measurements of the physical parameters (sea water temperature, salinity, sea currents), chemical parameters (oxygen concentration, biogenic content, heavy metals and organic compounds) and those biological as well as radionuclides of anthropogenic origin are measured (^{137}Cs, ^{90}Sr). The observation programme is tailored to the requirements of the Marine Strategy Framework Directive (MSFD).

Observation and research tasks are carried out jointly by the IMGW–PIB, the Marine Fisheries Institute in Gdynia – National Research Institute (MIR–PIB), the Institute of Oceanology Polish Academy of Sciences, the University of Gdansk and the Maritime Institute in Gdańsk. The observations are carried out with the use of the research vessel r/v Baltica, equipped with chemical laboratory and the state-of-the-art instruments for measurements of physical water features, and also - m/y Littorina, which is used in shallow-water research. The Baltic Sea monitoring data is collected in the oceanographic database, and then sent to the European Environment Agency (EEA), the Helsinki Commission (HELCOM) and the International Council for the Exploration of the Sea (ICES).

Oceanographic research conducted outside the Baltic Sea is carried out by the Institute of Oceanology of the Polish Academy of Sciences in cooperation with the Marine Fisheries Institute (MIR–PIB) from the deck of the ship Oceania. In addition to research cruises in the Baltic Sea, the unit carries out research on the European North Seas – the North Atlantic and the Arctic. During the cruise, measurements are made in the field of physics, hydrodynamics, chemistry and biochemistry, ecology and marine organisms genetics.

Since December 2008, automatic meteorological stations have been located on the Petrobaltic Beta offshore platform (about 70 km from the shore). Measurement results, among others, pressure, velocity and direction of wind, temperature and humidity are sent to IMGW–PIB (10-minute time step).

In 2015, under the Polish programme of monitoring the Baltic Sea, the automatic meteorological and oceanographic measurement system "FerryBox" was installed, on m/f Stena Spirit ferry. Measurements take place on the route Gdynia – Karlskrona, and include continuous measurements, among others, temperature, salinity and oxygen concentration.

Poland participates in the global maritime observation system under the VOS (Voluntary Observing Ships) and SOOP (Ship Of Opportunity) programmes. 82 ships from the Polish merchant fleet are included in the VOS programme (data from 2014). Most of them send data to data collection centers. In the SOOP programme, there participate two vessels, floating on the Baltic Sea. Sea level data from Władysławowo stations is transferred to the European Sea Level Network (ESEAS).

The analyses of satellite images, in the context of oceanology, have been carried out by IMGW-PIB, University of Gdańsk, Silesian University in Katowice and Institute of Oceanology PAN. They works concern, among others, winds over sea areas, sea surface temperatures, ice, and colour of sea water.

Global network of in-situ observations of the world's oceans ARGO. The ARGO global observation network consists of 4000 temperature/salinity profiling floats. Data is transmitted in real time to database management centers, where they are then processed and prepared for publication.

The ARGO network is represented by the PAN Institute of Oceanology. The Polish network consists of 13 floats (Argos) deployed in the Baltic Sea, the Greenland and the Norwegian Sea.

8.3.3. Earth Surface Observation Systems

The land observation system of important climate variables is integrated into the Global Terrestrial Network (GTN) and includes the following:

- hydrology (GTN–H, GTN–Hydrology),
- flows (GTN–R, GTN–River Discharge),
- lakes (GTN–L, GTN–Lakes),
- glaciers (GTN–G, GTN–Glaciers),
- permafrost (GTN–P, GTN–Permafrost).

As part of the GTN–H IMGW–PIB component, water levels are measured at 863 sites in the country (Table 8.1, Figure 8.3). The basic measuring range includes observations of water level, ice events, thickness of the ice cover, overgrowth of the river bed and if possible – daily course of the water level and water temperature (over 210 locations). The distribution of the hydrological network is not homogeneous: its density depends on flood risk. Therefore, there are more stations established in the south of the country.

The thickness of the snow cover is determined at meteorological stations in Poland one station in the polar regions (southwestern Spitsbergen, Hornsund station, Institute of Geophysics, Polish Academy of Sciences). In addition to daily measurements of snow cover thickness, snow cover density is determined (water equivalent; water mm/ snow cover thickness cm)

Relationships between water level and flow are assessed based on measurements carried out by water gauging stations (under the GTN–R network).

The inland hydrological network is supplemented by lithological measurements – within the GTN–L component framework. The measurements are conducted by 35 stations located in 15 lakes in the northern and western parts of the country. The observations concern: the water balance of monitored lakes: inflow and outflow. In addition, three of the stations conduct measurements of evaporation from the surface of the lake. Additionally, there are carried out measurements of surface water temperature (or in vertical cross-section) in some lakes, and also the parameters such as water transparency and quality, are periodically determined. For some lakes, the components of the water balance have been systematically determined since the early 1960s.

Polish scientific units conduct monitoring of highland inland glaciers under the GTN–G component. In the Norwegian Arctic, south-west Spitsbergen (Hornsund station), the glacier monitoring programme has been running since the 1970s, and includes studies on mass balance and glacial dynamics, snow depth measurements, and a wide range of observastions as regards meteorology, seismology, earth magnetism, ionosphere structure and physics and atmospheric chemistry. In Antarctica – periodically and to a limited extent – ice surveys have been conducted by the Polish Academy of Sciences in the vicinity of the Henryk Arctowski station (South Shetland Islands). Howewer, the results obtained allow to determine the rate of glacier retreat and the intensity of the summer outflow.

Monitoring of permafrost (GTN–P component) has been conducted since 1977 by the Institute of Geophysics of the Polish Academy of Sciences in the area of Hornsund station (south-west Spitsbergen). It includes regular measurements of the depth of summer defrosting and measurements of soil temperature up to one meter deep.

Poland is a member of the International Permafrost Association (IPA) and participates in the Circumpolar Active Layer Monitoring (CALM) programme, part of the Global Climate Observation System GTN–P (Maria Skłodowska-Curie University, Nicolaus Copernicus University, Adam Mickiewicz University in Poznań and the University of Wrocław). The measurements are passed to the CALM data center at the University of Cincinnati (USA) and to the National Snow over Ice Data Center in Boulder, Colorado.

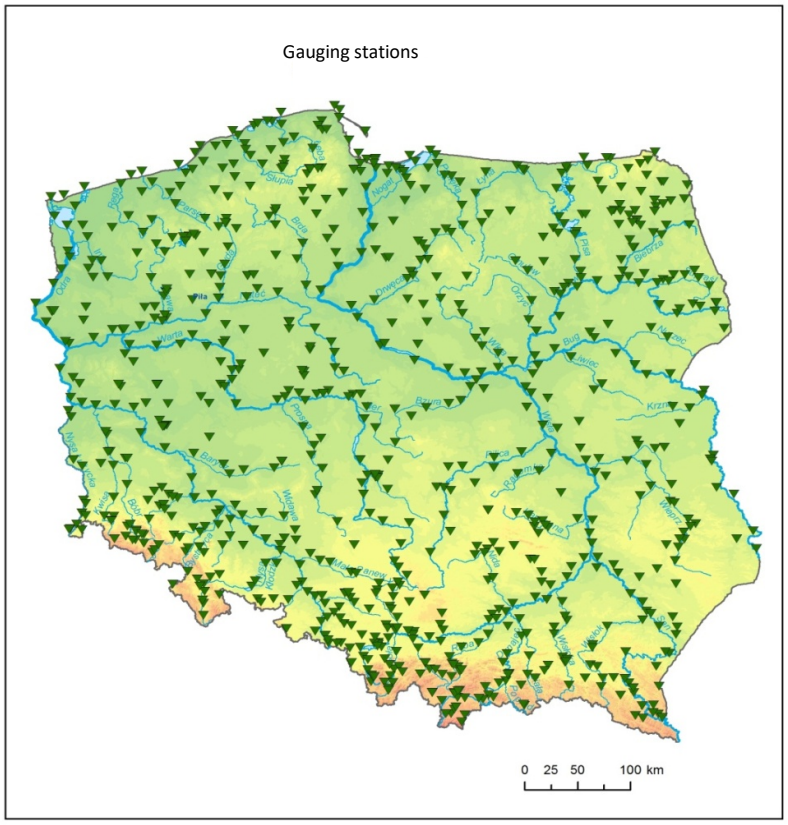


Fig. 8.3. Location of PSHM IMGW–PIB water gauging stations

The first phenological observations in Poland were made at the end of the 19th century. Observations have been systematically carried out at IMGW–PIB synoptic stations since 2005. These include ten wild plant species; phenology records include: leaf emergence, blossoming, ripening, yellowing and death. The data is available on the IMGW–PIB website and sent to the European phenological database in Vienna, managed by the Zentralanstalt für Meteorologie und Geodynamik (ZAMG). Local, regional phenological observation networks are also run by some scientific institutions (Poznan University of Life Sciences, Institute of Soil Science and Plant Cultivation – National Research Institute) and Agricultural Advisory Centers.

8.3.4. Satellite climate monitoring systems

Hydrological and meteorological forecasting (and indirectly also climatology), as well as research on the use of satellite products in meteorology, have been performed at the Satellite Remote Sensing Center of IMGW–PIB in Cracow. Since the 1960s, IMGW–PIB has had station on reception and processing of satellite data that enables collection of satellite data:

- geostationary systems: METEOSAT–8, 9 and 10 and indirectly from GOES–E (US) satellites, GOES–W (USA), Himawari (Japan) and FY3 (China);
- Polar systems: NOAA satellites (15, 18 and 19), European satellite METOP–A and B, Jason-2 and 3 oceanographic satellites, US satellite Suomi NPP and environmental satellites: TERRA and AQUA.

In addition, there is possible operational internet access to data from GCOM–W1, GPM and Sentinel-1,2 and 3 satellites. Since 1987, the satellite imagery archive has been available digitally and can be processed in any way. In operational mode, satellite images are available in spatial resolution up to 250 m (TERRA and AQUA satellites) or in time resolution up to 2.5 minutes (RapidScan mode of METEOSAT satellites), in a wide spectrum of radiation (radiation channels).

Research activities in the field of satellite observation systems focus on the use of satellite information for meteorology and hydrology in operational mode. In addition, work is being done on the use of satellite data in climatology, oceanology, agriculture and environmental studies.

8.3.5. Monitoring of greenhouse gases

Eight of the Polish meteorological observation stations are part of WMO's Global Atmosphere Watch (GAW) established in 1989, five of which continually send data to the World Meteorological Organization (WMO). Their measurements are in line with the extended programme requirements for GAW regional stations. In addition, monitoring of the background of atmospheric pollution according to the EMEP (European Monitoring and Evaluation Program) programme carried out at the request of the Chief Inspectorate of Environmental Protection under the State Environmental Monitoring is carried out on stations in Jarczewo, Śnieżka, Diabla Góra (the Borecka Forest) and Łeba. At these stations, a basic EMEP measurement programme (including sulfur and nitrogen concentration measurement, ozone in air, sulfate, nitrate, ammonium, chloride, light metals, heavy metals and precipitation). Moreover, at the station in the Borecka Forest – the additional parameters are recorded (eg: concentration of carbon dioxide, concentration and chemical composition of PM 2.5, as well as concentration of PMI O. Since 1994, the monitoring of greenhouse gases (CO_2, CH_4, N_2O) has been conducted at the Kasprowy Wierch station by the University of Science and Technology (AGH) in cooperation with IMGW–PIB.

Measurements from the GAW stations are reported to EMEP and COMBINE/HELCOM archives, and via EMEP to the WMO/GAW global system with the WDCGG (World Data Center for Greenhouse Gases, Tokyo, Japan) data center. WDCPC (Wolrd Data Center for Precipitation Chemistry, Albany, USA), WDCA (World Data Center for Aerosols, Ispra, Italy), WOUDC (World Ozone and Ultraviolet Radiation Data Center, Toronto, Canada).

Studies on the status of the ozone layer over Poland

UV radiation, carried out at the request of the Chief Inspectorate of Environmental Protection within the framework of the State Environmental Monitoring, are coordinated by IMGW–PIB and the Institute of Geophysics, Polish Academy of Sciences. Some ozone monitoring stations are have run from the 1960's. Studies on ozone layer over Poland include:

- measurement of total ozone content in the atmosphere and its vertical distribution,
- measurements of vertical ozone concentration profiles by the survey method,
- determination of the total ozone layer over Europe by satellite observation,
- measurements of the intensity of UV radiation at stations Łeba, Katowice, Legionowo, Mikołajki, Zakopane.

The data is forwarded to the Norwegian Institute for Air Research in Oslo (NILU), the World Ozone and Ultraviolet Radiation Data Centre (WOUDC) in Toronto and the Laboratory of Atmospheric Physics of the University of Thessaloniki.

Figure 8.4 shows the changes in the total ozone content in the atmosphere as measured by the Dobson spectrometer at the station in Belsk (Mazovia) in 2007–2017. Over the past decade, the ozone content in the Polish atmosphere has not been subject to a clear long-term trend, but a slight increase in the average annual value (0.35 DU per year for 2007–2017) can be noted. It confirms the observed trend of ozone layer recovery after its rapid disappearance in the second half of the 20th century. The distinctive seasonal cycle is related to the dynamics of ozone transport in the atmosphere (i.e. large-scale movements of air masses) and the production and destruction of O_3.

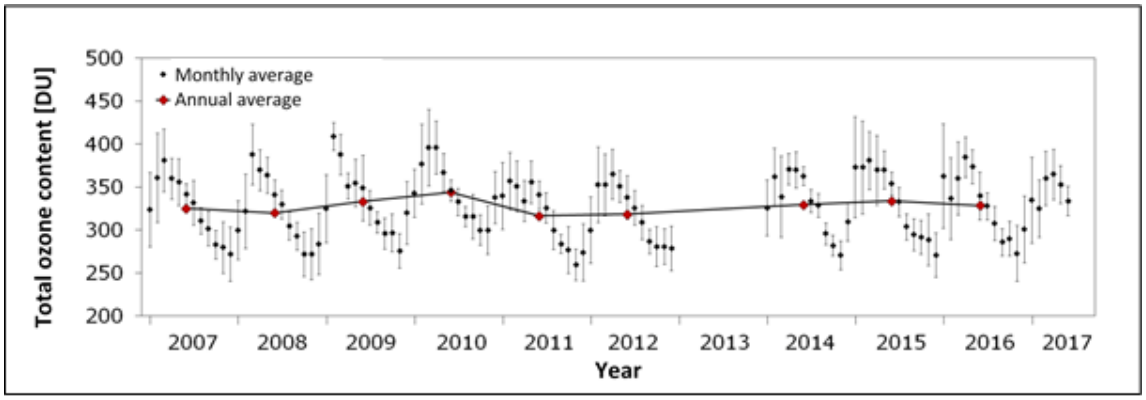


Fig. 8.4. Total ozone content (monthly averages and annual averages) in the atmosphere at Belsk station in 2007–2017, source: WOUDC

Study on carbon dioxide and methane concentrations in the atmosphere

Measurements of carbon dioxide concentrations in the ground atmosphere layer within the system of air pollution monitoring are performed at the Monitoring Base Station in the Borecka Forest (Institute of Environmental Protection – National Research Institute). Monitoring is commissioned by the Chief Inspectorate of Environmental Protection within the framework of the State Environmental Monitoring. Some universities, including the University of Science and Technology (AGH) in Cracow, the University of Lodz and the Poznan University of Life Sciences carry out their own programmes focusing on the observation and study of greenhouses gases.

Figure 8.5 shows the results of measurements of CO_2 concentration at the monitoring station in the Borecka Forest (north-eastern Poland). A systematic increase in CO_2 concentrations in the atmosphere is observed. Seasonal variability can also be observed, with the maximum values in winter and spring while the minimum values in summer. This variability is related to the photosynthetic and respiratory activity of the biosphere and the increase in CO_2 emissions during the heating season. The amplitude of seasonal variation is 24.2 ppm (μmol CO_2/mole dry air).

Measurements of carbon dioxide and methane concentrations in the atmosphere have been carried out since 1994, by the University of Science and Technology (AGH) (Environmental Physics Department, Faculty of Physics and Applied Computer Science) in cooperation with IMGW–PIB, at the Meteorological Observatory Kasprowy Wierch (the Tatra Mountains, altitude of 1987 m above sea level). The unique location of the station qualifies it for the WMO climate station reference network, and it is also part of the Network of European High-Mountain Observatories. The location of the station enables the measurement of greenhouse gases (CO_2, CH_4) at least during the night hours, devoid of the influence of anthropogenic and biogenic emissions, which in turn enables monitoring of the so-called regional background concentration of GHG (concentration in the free troposphere). The obtained concentration values confirm the global trend of CO_2 concentration: at the Kasprowy Wierch station, the rate of CO_2 concentration increase is on average 1.99 ppm annually. Figure 8.6 shows the average monthly concentrations of CO_2 in the atmosphere measured at the Kasprowy Wierch station, and the concentration of CO_2 measured at Mace Head, Ireland, which monitors the chemical composition of the marine polar air coming to Europe (according to data from the latter station, the trend of CO_2 concentration is increasing by 2.00 ppm per year).

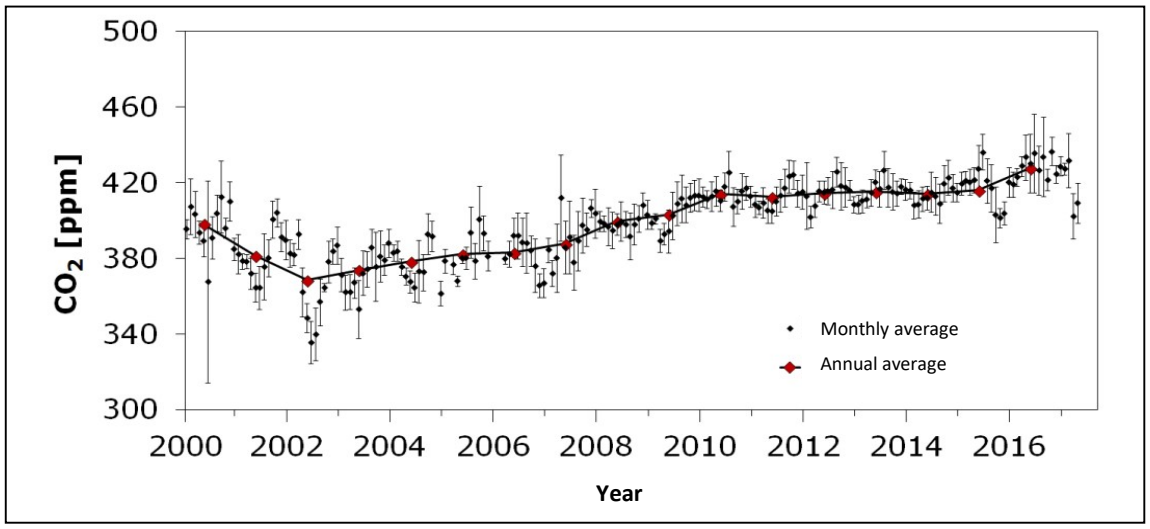


Fig. 8.5. CO_2 concentration measured in 2000–2017 at the Monitoring Base Station in the Borecka Forest: average monthly values with standard deviation and annual mean values, source: IOŚ–PIB, WDCGG

Seasonal variation in CO_2 concentration in the atmosphere, with the maximum values observed in winter and the minimum values observed in summer, is associated with the biosphere activity. The amplitude of this cycle in the analyzed period for the Kasprowy Wierch station was on average 14.3 ppm. This is nearly doubles the amplitude of the seasonal changes observed at the station situated in the Borecka Forest (Figure 8.5), where the influence of local CO_2 sources, i.e. the biosphere and anthropogenic emissions is evident.

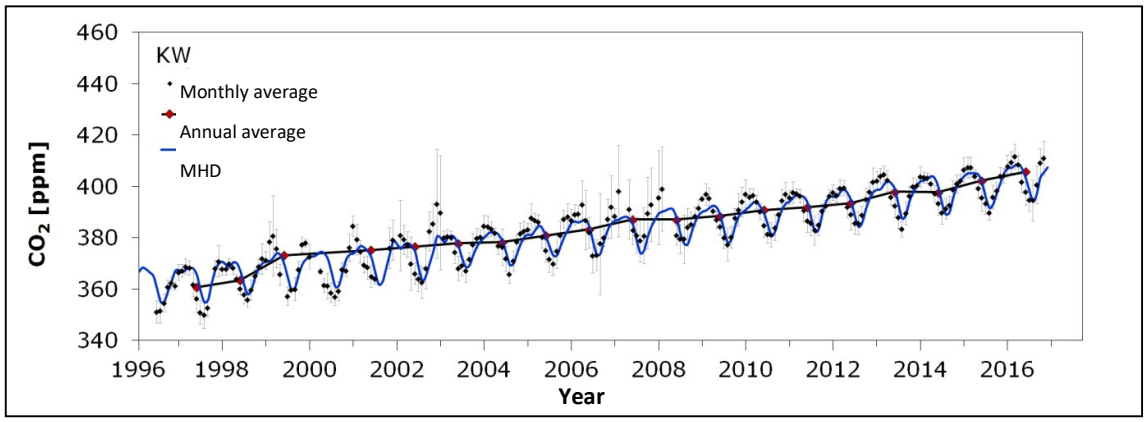


Fig 8.6. CO_2 concentration in the atmosphere measured at Kasprowy Wierch (KW), in the years 1996–2016: monthly mean values with standard deviation, mean annual values; CO_2 concentration in the atmosphere measured at the Mace Head reference station (MHD), data sources: AGH (KW), NOAA (MHD)

The atmospheric CO_2 analysis carried out using isotopic methods allows for splitting up the total CO_2 atmospheric concentration into individual components, i.e.: regional background (for Cracow represented by Kasprowy Wierch), biogenic component (CO_2 derived from autotrophic respiration and heterotrophic vegetation and other living organisms) and anthropogenic (CO_2 from fossil fuel combustion). Figure 8.7 shows seasonal variations of CO_2 concentrations in the Krakow atmosphere and its individual components in 2013. In the spring and summer season, a reduction in the amount of biogenic CO_2 is observed due to the photosynthetic assimilation process, and in the late autumn – the increase in CO_2 from fossil fuel combustion due to the start of heating season.

Research has been conducted in order to specify the CO_2 anthropogenic sources associated with fossil fuel combustion, coal combustion in industry (the so-called high emission sources), and coal and natural gas combustion in urban buildings (the so-called low-emission sources). The use of carbon isotopes in CO_2: ^{12}C, ^{13}C and ^{14}C allows for assigning to each of these sources the amount of CO_2 emission in the Cracow atmosphere.

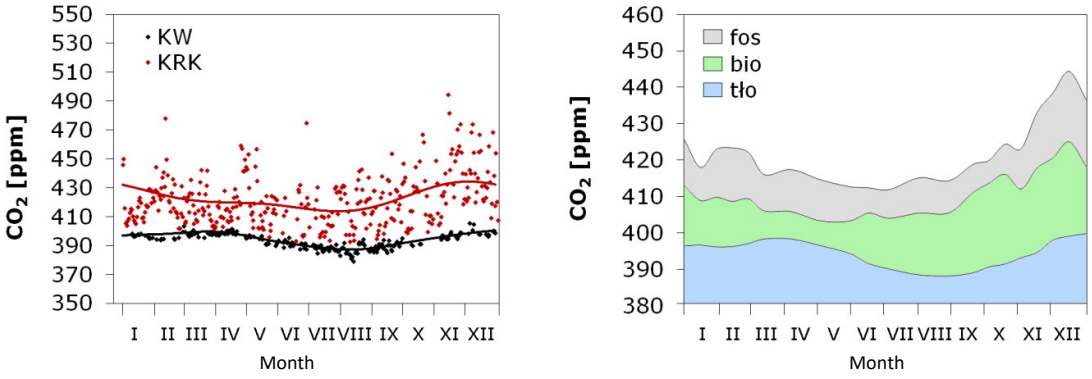


Fig. 8.7. CO_2 concentration in Cracow (KRK) and Kasprowy Wierch (KW) (left panel) measured in 2013; division of CO_2 sources in the atmosphere of Cracow: background, biogenic and fossil fuel sources, data source: AGH

Figure 8.8 shows the results of methane concentration measurements carried out at the Kasprowy Wierch station, along with the values from the Mace Head reference station. With the increase of CO_2 concentrations in the atmosphere, a regular increase in CH_4 concentration has been

observed, especially since the 2000s. Accelerating the rate of methane growth in the atmosphere is associated with the increased wetland emissions in tropical parts of South America and polar Eurasia. Methane concentrations observed at the Kasprowy Wierch station are higher than those found for the oceanic background at the Mace Head station. These differences reflect land emissions of CH_4 leading to a gradual methane concentration increase as the air mass moves inland. The most important sources of methane include wetlands (anaerobic respiration), waste landfills (anaerobic organic matter decomposition) and cattle breeding. Methane, despite its almost three orders of magnitude lower content in the atmosphere, is an equally serious threat to climate as CO_2 – its potential to create a greenhouse effect is definitely higher than that of carbon dioxide.

Satellite data and those obtained using other methods of assessment of methane emission into the atmosphere, show that Upper Silesia in Poland, is the regionally important source of this gas. Currently, multi-faceted studies on the atmosphere of this region are conducted to identify sources of methane. The first results show that methane comes from both biogenic sources and emissions from numerous coal mines, operating in this area.

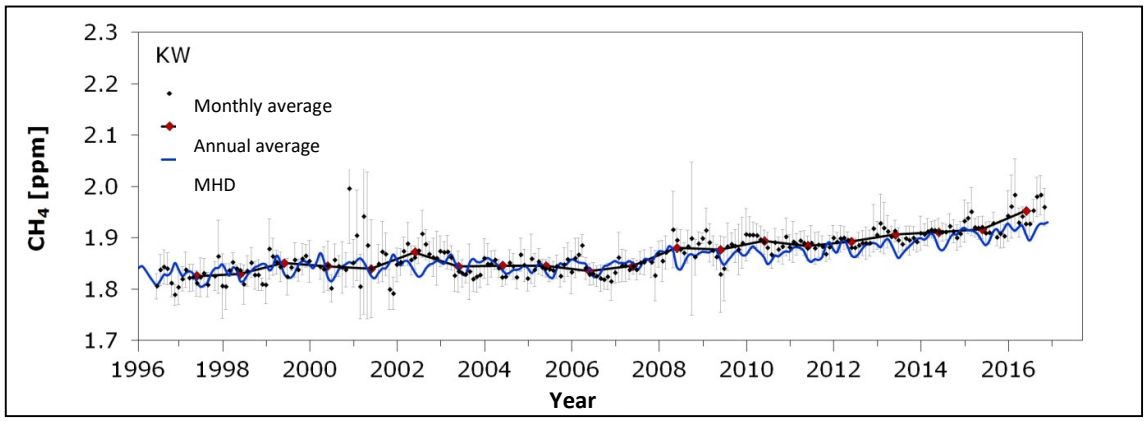


Fig. 8.8. CO_2 concentration in the atmosphere measured at Kasprowy Wierch (KW) in the years 1996–2016: monthly mean values with standard deviation, mean annual values; CO_2 concentration in the atmosphere measured at the Mace Head reference station (MHD), data sources: AGH (KW), NOAA (MHD)

Since 2009, the concentration of the third greenhouse gas, i.e. N_2O has also been measured at the Kasprowy Wierch Station. The observed increase in N_2O concentration of 0.83 ppb per year (1 ppb = 10–3 ppm) remains in line with the global trend. Short-term campaigns for the measurement of other greenhouse gases, aerosols and radon are also carried out periodically at Kasprowy Wierch.

Since 1992, measurements of CO_2 concentrations in the vertical profile of the atmosphere in the Białystok region have been performed (AeroMeteo Service in cooperation with the Max Planck Institute in Jena). The measurements have been carried out routinely from the deck of the aircraft.

Study on the dynamics of greenhouse gas transport between the ecosystem and the atmosphere

The study of greenhouse gas flows between the atmosphere and various ecosystems is a relatively new field of science in Poland. Such studies have been conducted, among others. by the University of Life Sciences in Poznań (natural ecosystems: peat bogs, forests, agricultural land), the University of Lodz and the University of Science and Technology in Cracow (AGH) – in urbanized areas.

A study of the dynamics of greenhouse gases exchange between ecosystems and the atmosphere allows to quantify the CO_2 balance for a given ecosystem, i.e. the annual amount of CO_2, CH_4 or N_2O that gets into the atmosphere. This is the key information in modelling climate change.

Research on halogens in the atmosphere

Since 1997, the team from the Department of Physicochemistry of Ecosystems (Institute of Nuclear Physics, Polish Academy of Sciences) has been conducting research/measurements of concentrations of halogen compounds in the Cracow atmosphere, which are responsible for the loss of stratospheric ozone and increase in the greenhouse effect, including: F-11, F113, chloroform $CHCl_3$), trichlorethylene (CH_3CCl_3) and carbon tetrachloride (CCl_4). Since 1999, observations on F-12 freon and sulphur hexafluoride (SF_6) have also been carried out. The purpose of the measurements is to determine the impact of the urbanized area on the concentration of these compounds, as well as to assess the amount of their emissions and determine sources of origin. The general trends in halogen emission agree with observations made at the Mace Head station, however, in Cracow, a short-term and high-intensity emissions are observed, which reflects the impacts of local sources. A methods has been developed for the assessment the age of groundwater with the use of SF_6 as well as freons F-11 and F-12.

Radiological measurements

In Poland, radiological measurements have been conducted since 1961 (detection of radioactive contamination in the environment and food). Since 2002, by decision of the Council of Ministers, the IMGW–PIB stations of Early Detection System of Radioactive Contamination have been incorporated into the network of basic stations responsible for radioactivity monitoring in the country. The results of the measurements are transmitted to the National Atomic Energy Agency. The research is carried out at on the commission of the Chief Inspectorate of Environmental Protection in the framework of the State Environmental Monitoring.

8.3.6. Support for developing countries in the development and maintenance of surveillance systems, databases and monitoring systems

In 2016, the multiannual programme was adopted to support the development cooperation for the years 2016–2020. Among the thematic priorities of support for developing countries there is the protection of the environment, with the specific objective of "Protecting natural resources and promoting sustainable development and mitigating the negative effects of climate change, including the prevention of natural disasters".

The projects, consistent with the above programme, will primarily be implemented in the African countries: Ethiopia, Tanzania, Kenya and Senegal. One of the objectives of the development cooperation in these countries is to build the prevention and response capacity in the event of natural disasters and disasters resulting from human activities. These activities are also included in the projects related to observation systems. However, over the recent years, Poland has not been directly engaged in supporting projects aimed at maintaining, developing or launching surveillance systems, databases or monitoring systems implemented in the developing countries.

CHAPTER 9. EDUCATION, TRAINING AND PUBLIC AWARENESS FOR GLOBAL CLIMATE CHANGE

9.1. Educational policy

The term "education policy in the field of climate change" is understood as a system of official documents and agreements at international, national and regional level, which indicate the need for actions to raise public awareness and outline the direction of appropriate education and implementation strategies that set out in detail the actions to be taken.

The most important document in this area, the UN Framework Convention on Climate Change, as well as all other final documents of the UN Conference on Environment and Development adopted in Rio de Janeiro in 1992, recognize that education provides foundation for creating and developing people's opportunities for solving environmental protection problems and facilitates the implementation of sustainable development.

The Convention emphasizes the obligations of Parties (and thus of Poland) to raise public awareness on climate-related issues and provides the relevant tasks in Article 6. This is an important and frequently quoted article that recommends that appropriate educational programmes should be promoted at the national level, public access to information on the environment should be ensured, the personnel should be trained and that cooperation and exchange of experiences at the international level should be implemented. The Kyoto Protocol to the Framework Convention, ratified by Poland in 2002, also urges signatories, in Article 10 point e, to cooperate internationally and use existing organizations and institutions to promote national education, training and public awareness, along with facilitatation of access to information on climate change.

The Paris Agreement under the Framework Convention, ratified on 7 October 2016, already in its preamble confirms the importance of education, training, public awareness, public participation and universal access to information and cooperation at all levels. This is particularly recommended in Article 11: Capacity building. This task relates to responsibility for ensuring that the relevant aspects of education and training are addressed to support the least developed countries. Education and awareness-raising is also one of the core goals of the SDRs by 2030, adopted by the UN in 2015.

In the European dimension, the United Nations Economic Commission for Europe (UNECE) Strategy of Education for Sustainable Development, adopted in Vilnius, in 2015, at the High-Level Meeting of Education and Environment Ministries is a valuable signpost for implementing a comprehensive climate change education. The Polish version of the document is available on the website at the Ministry of the Environment[11].

At the national level, the need to raise environmental awareness of the public is emphasised in all strategic documents concerning the broadly understood environmental protection, in force in the reporting period (i.e. 2012–2015). This was taken into account in the Second Environmental Policy, Poland 2025: The long-term strategy for sustainable development and in Poland's Climate Policy. The New National Environmental Policy in 2009–2012 with an Outlook until 2016, adopted by the Council of Ministers in December 2008, places large emphasis on consumer education,

[11] www.mos.gov.pl/g2/big/2009_04/4f3f267429420f4dfcb32b98f1ac8605.pdf

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 environmental education should be extended in the school curricula, that access to environmental information should be facilitated and that habits consistent with the principle of sustainable development should be promoted. It also recommends a closer cooperation with the media on education addressed to all social groups.

In 2001, the binding document National Strategy for Environmental Education – Through Education to Sustainable Development, which resulted from an agreement between the Minister responsible for education and the Minister of the Environment, was updated and strengthened with an executive programme. The programme laid down in this document covers respective age and vocational groups and sets out relevant tasks for the entities which carry out education and proposes ways of fund raising. According to the National Strategy, the responsibility for environmental education, including the education in the field of climate protection, is vested in the Ministry of National Education and the Ministry of the Environment, as the leading entities, with the participation of all other Ministries (particularly, the Ministry of Agriculture and Rural Deevelopment and the Ministry of National Defence) in the scope consistent with their competences. The Ministry of Foreign Affairs has also a special role to play in this respect, as it implements the development education, which addresses climate issues at global level, including Poland's responsibility for assisting in the process of capacity building to adapt to climate change in developing countries.

In addition to the system of Poland's integrated development strategies, in October 2013, the Ministry of the Environment worked out the Polish National Strategy for Adaptation to Climate Change by 2020 with the perspective by 2030 (hereinafter: SPA). This document emphasizes the need to shape social attitudes that are conducive to adaptation to climate change and to promote actions to increase knowledge about the risks associated with extreme phenomena and methods to reduce their impact (Objective 6. SPA). The necessity was also highlighted to implement educational activities in both formal and informal education that contributes to upgrading of public awareness, including understanding of climate change effects on social and economic aspects of life.

The importance of environmental education is illustrated by the content of the Act of 27 April 2001 on Environmental Protection Law, which provides that environmental and sustainability issues are included in the general education curricula for all types of schools (this includes the organizers of trainings aimed at achieving professional qualification). In addition, the law provides that mass media are obliged to shape positive attitudes of the public towards the protection of the environment and popularize the principles of environmental protection in publications and broadcasts.

The issue of access to environmental information and environmental protection should be recognized as a complementary issue. The Act of 3 October 2008 on the Provision of Information on the Environment and its Protection, Public Participation and Environmental Impact Assessments comprehensively covers the issues related to the assessment of environmental effects which may arise as a result of implementation of concrete projects and on instruments aimed at ensuring a full objectivity of the process.

The Ministry of the Environment has been for many years now undertaking and supporting ecological education activities, which aim at raising the ecological awareness of the society. The

ecological education involves promotion of environmental knowledge, practical skills and ecological motivation for habit and attidue change. In addition to the formal education system, for which the Ministry of National Education and the Ministry of Science and Higher Education is resopnsible, environmental education is implemented within the framework of extracurricular education, by specialized educational institutions, non-governmental organizations, local selfgovernments and public environmental institutions.

The environmental sector participates in the development of both teaching modules, by directly initiating or participating in already implemented projects. The implemented educational projects are linked with the priority topic areas of the Ministry of the Environment, wherein there is always the issue of counteracting and adapting to the changing climate.

An important aspect of the implemented educational policy is the issue of financing projects in this area. The National Fund for Environmental Protection and Water Management (hereinafter referred to as NFOŚiGW) together with 16 Voivodeship Environmental Protection and Water Management Funds make available financial support for environmental protection and water management in Poland.

In view of the autonomous status of each of the seventeen Funds, the Environmental Protection Law endowed them with the common strategic document. The Common Strategy of the National Fund and Voivodeship Funds is drawn up once every four years and forms a general framework for the actions of individual Funds[12]. The Common Strategy also establishes a general framework for the individual strategies of each Fund, indicating the key objectives of the activity (environmental objectives and horizontal environmental objectives), regulating and identifying the areas of co-operation (co-operation priorities) to ensure coherence and alignment of the entire Funds for 4 years.

In line with the provision of the Common Strategy[13], the overall objective of the funding system is to improve the environment and sustainably manage its resources by providing stable and effective support for environmental projects and initiatives, using the EU funds for environmental protection and water management in agreement with the rules of sustainable development.

Referring to the subject of the report, it should be emphasized that one of the horizontal environmental objectives pursued by all Funds in each of the topic areas (objectives) was to promote pro-environmental habits, actions and projects intended to preserve assets of biological diversity and adapt to climate change[14].

9.2. Education in the formal education system

Education is a process which can be implemented by institutions, as formal education at the different training levels, regulated by the relevant curricula. It can also be delivered as various forms

[12] During the reporting period the following were in force:
• Joint Strategy of the National Fund and voivodeship funds for environmental protection and water management for the years 2009–2012 (updated in 2011);
• Joint Strategy of the National Fund and Voivodeship Funds for Environmental Protection and Water Management for 2013–2016 with a perspective up to 2020 (updated in 2015).
[13] After the Joint Strategy of the National Fund and Voivodeship Funds for Environmental Protection and Water Management for 2017–2020, Warsaw, 2016.
[14] After the Joint Strategy of the National Fund and Voivodeship Funds for Environmental Protection and Water Management for 2013–2016 with a perspective up to 2020.

of informal education carried out by different scientific and public institutions outside of the education system, as well as by non-governmental and church organisations. Education gained through various campaigns, including spots and education programmes in the media, and spontaneous education through advertisements, films, entertainment programmes on television and as a result of different situations leading to exchange of experiences, also plays a vital role. Large importance is also attributed to the education gained in the family. Each of the above educational impacts should be directed in its specific manner to all the citizens in the process of lifelong education.

The education system in Poland, until September 2017, encompassed upbringing in 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 university level schools. The Act of 1966 on the education system, contained already the provision making it clear that "The education system shall ensure in particular (…) the dissemination of knowledge on the principles of sustainable development, among children and youth, and on 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 defining the compulsory content of curriculum in educational institutions is the "Curriculum for Upbringing at Kindergartens and General Education in the Individual School Types''. The curriculum of general education defines mandatory sets of learning objectives and curricular content that are included in the curricula and allow for the assessment of school assessments and exam requirements. School textbooks approved by the Minister responsible for education must also be compatible with school curricula approved for the school use. In the years 2012–2015, the school curriculum was regulated by the Ordinance of the Minister of National Education of 27 August 2012 on the core curriculum of pre-school education and general education in particular types of schools (Official Journal of the Laws of 2012, Item 977). Starting from September 1, 2017, the core curriculum will be gradually replaced by a new curricula that have been developed for primary and secondary schools as part of the education reform.

In the general education process, environmental education is taught at all instruction levels, including pre-school education, in accordance with the objectives and contents of the curriculum. The curriculum emphasizes the need for educating pupils how to live in harmony with nature and develop appropriate attitudes for effective and responsible functioning in the contemporary world.

In the years 2012–2015, children in kindergarten were taught, among others, to keep order in their immediate environment and to respect plants and animals.

In the first and third grades of the primary school, the pupils were provided with knowledge on issues concerning the topic area "education for nature", related to life in selected ecosystems, role of animals in an ecosystem and nature conservation. They learned to segregate waste, understand the importance of using ecological packaging, save water, respect plants, keep silence and help animals. They were acquainted with the damage to nature caused by humans (meadow burning, littering forests, excessive noise, poaching). At the higher education stages, the contents reated to ecological education were included into the curricula of respective subjects, including: nature, biology, geography, chemistry, physics and technical classes.

At the second stage of education (grades IV–VI), respect for nature was indicated as the objective of education on nature. The emphasis was on encouraging activities aimning at the conservation of nature and the community cultural heritage. The students carried out observations and experiments to recognize pollution in their immediate surroundings. They learned to segregate waste and indicate the possibility of waste recycling. During technical classes, the problems related to the development of the technical environment were tackled and students designed the sustainable management of secondary raw materials.

Students in gymnasium (the third stage of education) and post-gymnasium schools (the fourth stage) learned about phenomena and processes in the natural environment, discussed global and local environmental issues, including the need to segregate and reduce household waste, pointed out to the need for international cooperation to prevent threats to nature. The content of the supplementary subject – nature was intended to familiarize students with the idea of sustainable development and the principles that should be guiding the world economy.

In the curricula of vocational schools, there was also a great deal of emphasis on the effectiveness of instruction in natural sciences – in line with the priorities of the Lisbon Strategy. Apart from offering vocational qualifications, these schools were to equip graduates with a basic general knowledge.

In all types of schools, the expected performance of students was to be able to: assess changes in the natural environment as a result of human impact and its effect on the quality of life and ability to find remedies. The phrase "finding remedies" is very spacious and allows for taking into account the issues of adaptation to climate change. Since the "education for health" is an important task of the school, as it aims at shaping the students' habits of health care and the ability to create conditions conducive to maintaining health, within this framework, the students wouldl learn how to deal with health or life threatening situations. On the other hand, the subject: "education for safety" is focusing on issues of protection against the effects of various threats, ways of warning the public, behavior after the announcement of an alert and providing the first aid. Within the framework of "education for safety" the teacher is obliged to instruct the principles of rescue operations and to provide practical knowledge on first aid actions during accidents or other emergencies.

Starting from the 2017/2018 school year, a new curricula will be implemented, announced by the Official Journal of the Laws of 2017, Item 356, as part of the reform of education in the course of introduction. Students of grades I, IV, and VII will be taught in accordance with the new curriculum in 2017/2018, students of grades II, V and VIII – in the next school year, i.e. 2018/2019, and students of grades III and VI – in 2019/2020. The task of the teacher is to make a student interested in the surrounding world and help in explaining natural phenomena. The aim of instruction is to improve abilities of a student to take care of his/her surrounding and develop his/her sense of shared responsibility for the environment. These are the aims of education in the subjects of biology and geography in grades V to VIII.

The curriculum can be effectively implemented when there are well-written manuals, well-trained, competent teachers and attractive auxiliary teaching aids. Preparation and production of such aids in the education process is supported by subsidies from the National Fund for Environmental Protection and Water Management (NFOŚiGW) and the Voivodeship Funds. A good example of support for climate education in shools are teaching aids recommended by the Minister responsible for education and sponsored by the NFOŚiGW. Instruction in environmental issues and

practices of sustainable development, including issues related to climate change prevention and adaptation, is supported by non-education institutions which provide teachers training and teaching aids for upgrading teacher competences. An example are methodological conferences and workshops for teachers led by the Institute for Environmental Protection – National Research Institute in cooperation with the Masovian Self-government Teacher Training Centre, the Institute for Sustainable Development and the Institute for Ecology of Industrial Areas. The Department of Environmental Education of the Ministry of the Environment hosts websites providing useful assistance for teachers and students.

Many schools benefit from complementary educational programs and participate in competitions of knowledge and activity organized by specialized social organizations or institutions, such as the Bank for Environmental Protection Foundation. These initiatives, though directed to schools and run by educators, will be discussed in the section devoted to non-formal education. However, the scale of their impact on school education is worth emphasizing here. Three editions of the renewable energy project "Bet on the Sun" were attended by nearly 8,000 participants from among almost 1,100 student teams from all over Poland. In total, the students prepared 1,800 photovoltaic micro-installations for single-family households and organized 170 local conferences for more than 11,000 guests. As part of a parallel film competition, the students pictured nearly 150 reports documenting micro-installations of RES found in their neighbourhoods.

Honorary patronage over all editions of the competition was taken by: the Minister of Energy, the Minister of National Education and the Minister of the Environment. Technical sponsorship was provided by the University Centre for Environmental Studies and Sustainable Development of the University of Warsaw and the Centre of Photovoltaics of the Warsaw University of Technology.

Apart from the education ensuing from the implementation of the basic curriculum, a hands-on example of implementing principles of sustainable development in the practice of school management is of great importance for shaping the students' attitudes. Such good models are provided by diverse activities of the school management which ensures practical energy saving or waste segregation. These efforts are evaluated in the process of applying for certification under the evaluation system of educational institutions in terms of a holistic approach to ecological issues, on both the side of educational innovations and the care for the environment. The international school certification recognizes the Green Flag. In Poland, the role of the national coordinator of this certification procedure is the Environmental Partnership Foundation within the Schools for Sustainable Development programme. By evaluating the complex activities (e.g. thermal insulation, renewable energy sources), and assessing appropriate education in this area, the title of the Local Ecological Activity Centre is awarded. This is the first step to applying for an international Green Flag Award I and II. It is a certificate based on environmental management systems, which also takes into account actions for climate protection.

University level schools are also within the formal education system. 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 majority of public universities of diverse profiles runs faculties of environmental protection, and likewise, many non-public university level institutions. Environmental protection may also be instructed at a inter-faculty type courses, e.g. at the University of Warsaw, or even at the

inter-university courses. In order to improve the teaching process, methodological conferences: "Environmental Protection at Universities" have been organized every year in another academic centre. This initiative has continued for 25 years without interruption. The Jubilee Conference in 2017 was organized by the University of Gdańsk and the Marine Station of the University of Gdańsk at Hel, and was devoted to approaching the profile of the graduate to the needs of today's challenges in environmental management.

Taking into account the population decline, the number of students has steadily decreased since 2006. According to the data by the Ministry of Science and Higher Education, the students of environmental protection in 2010 represented 1.4% of almost 2 million persons attending Polish universities (in total 28,000 students at all the courses, while half of this number were studying at technical faculties, such as environmental engineering). In the academic year 2015/2016, only 1.4 million students were educated in all 415 university level institutions, of which 1.2% were students of environmental faculties. Unfortunately, the decreasing number of students has caused several schools to eliminate the faculty of environmental protection. However, it is noteworthy that some schools preparing staff for public administration run courses on the environmental protection management, e.g. at the Wszechnica Polska University in Warsaw. In addition to the faculty courses, many universities also offer lectures addressed to all students, enabling them to become acquainted with the most important environmental challenges related to civilization development. The series of open popular science lectures has for many years been offered by the University Centre for Environmental Studies at the Warsaw University and the Centre for the Study on Man and the Environment of the University of Silesia. For example, at the University of Warsaw, a series of open lectures in the academic year ended with the publication of Urban spatial planning and its impact on reducing the effects of climate change.

Numrous universities also carry on postgraduate studies, which increase the graduates' competences in some specific, specialized fields. A good example is here the Postgraduate School "Biofuels and Renewable Energy Sources" at the Faculty of Earth Sciences of the University of Szczecin, while the recruitment was announced in 2016 for students at the Postgraduate School "Environmental Consultant", launched at the Institute of European Education.

University level institutions are conducting educational and popularization activities for the broader audience, organizing popular science sessions, open days and participating at the Science Festivals organized by the Copernicus Science Centre in Warsaw. The Copernicus Science Centre is a modern, widely open for public educational institution, which places great emphasis on scientific demonstrations to explain natural phenomena, including those related to global climate change and renewable energy sources. The Copernicus Science Centre together with the Polish Radio organizes popular scientific events called Scientific Picnics under the auspices of the Ministry of Science and Higher Education. Since 2014, the picnics are held at the National Stadium in Warsaw and are the largest open-air events in Europe, devoted to popularizing science. In 2012, the topic of the 16th Science Picnic was Energy, and the 21st Picnic 2017 – Earth and how we care about our planet. This provided opportunities for universities and Student Scientific Circles to present various scientific demonstration related to climate studies.

The Student Scientific Circles undertake many other interesting educational projects in the field of climate protection, what contributes to upgrading the environmental awareness of other students. The Student Science Circles from many universities from the whole country participated in

the exhibition "Sustainable Development at Universities" prepared by University Centre for Environmental Studies at the Warsaw University, and presented in the Gallery of the University of Warsaw in May 2016. This exhibition embraced various manifestations of the implementation of sustainable development solutions in educational programmes and the performance of the Polish university campuses in the fields of energy saving and renewable energy. In March 2017, this exhibition was presented during the Nationwide Scientific Conference "Theory and Praxis of Sustainable Development – 30 years after the Brundtland Report", organized by the Cardinal Stefan Wyszyński University in Warsaw.

9.3. General information on training

Apart from the formal education at all levels and the educational activities addressed to a wider public in order to shape environmentally friendly habits, the specialist vocational training courses are also necessary. There are diverse forms of upgrading courses, which raise the level of vocational knowledge with respect to all aspects related to environmental protection. Such training courses have been organized by companies, which intend to implement the environmental quality standards, e.g. ISO 14 001, and conduct trainings for all their staff. Training courses for entire sectors have also been organised, such as the one under the "Responsible Care Programme" in which several hundred companies from the chemical sector participated. Many training courses are addressing individual vocational groups, and they have been organised by different institutions, such as e.g. the EU Grundtvig programme providing trainings in the field of sustainable development (in particular, energy savings) for craftsmen.

Some academic centres and non-governmental organizations deliver training courses in the field of environmental impact assessments, for both the institutions which carry out the assessments and the recipients of these assessments. Training courses have also been carried out for the representatives of local authorities and self-governments, e.g. tranings on the practical provision of access to environmental information or trainings in the scope of air protection**.** A good example of training for the city council staff and urban green practicians was the 2014 training cycle on multi-faceted approaches to trees and greens in urban areas, in the context of mitigating the effects of climate change. These trainings were conducted in two rounds by the Institute of Spatial Management and Housing in Warsaw, within the framework of a large project "Ideal city – a sustainable city".

Training courses addressing farmers cover advice on examples of "good practices" which help to minimize the adverse impact of agriculture on the greenhouse gas emissions, and promote the use of renewable energy sources. Training for farmers have been routinely organized by the specialized Regional Advisory Centres for Agriculture. In the 2014–2020 Rural Development Programme, funds will be provided to support the training of consultants advising in the field of environmentally- and climate-friendly farming practices, and Advisory Centres may apply for a refund of 100% of the training costs.

There are also open training courses, such as a series of 74 trainings on the air quality awareness, organized by the Green Mazovia Association and financed by the NFOŚiGW, addressed to all inhabitants of the provinces: Dolnośląskie, Wielkopolskie, Lubuskie and Zachodniopomorskie. The Ministry of the Environment also implements a programme of apprenticeships for students and

graduates of the university level institutions in the Ministry and in the supervised by the Ministry sectoral institutes.

Of vital importance is the fact that the quality of formal education is subject to upgrade thanks to the 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). Such training courses are delivered by the National Teacher Training Centre (CODN) and Voivodeship Methodological Centres. Examples may include annual training for teachers of natural subjects organized by the Mazovian Self-government Teacher Training Center, which includes methods and the content of teaching about the causes and consequences of climate change.

Numerous training and teacher skills upgrading courses are also run by universities, including postgraduate studies for teachers of ecological education, conducted at the Cardinal Stefan Wyszyński University. In recent years, teacher training courses conducted by research institutes and international organizations are focused on explaining causes and effects of climate change. This applies not only to teachers of natural sciences, although most of trainings address teachers of these subjects. Good examples include trainings for teachers organized by the UNEP/GRID Environmental Information Centre, as part of the Climate Campaign Research Programme, as well as basic and tailor-made workshops under the specially targeted MASS programme, which was initiated in 2014. The purpose of these trainings is to disseminate knowledge on best practices in the scope of attractive and effective teaching methods of natural subjects, including climate science.

Similarly, the training for forest educators organized by the State Forests in 2015, covered the methodology and contents of education on sustainable development (with special emphasis on the role of forests in adapting to climate change).

With respect to education of teachers, many training programmes assume that they will have a cascade effect, that is, the trained persons will pass the knowledge gained to their peers in educational institutions. In 2016, the InE Foundation launched a project within the framework of the "Capacity Building in the Region" programme, consisting of three-day trainings in adaptation to climate change for the representatives of self-governments.

A high demand for professional development and acquisition of new qualifications may best be testified by the special website *www.szkolenia.com.pl*, which contains a comprehensive catalogue of training in various environmental areas as well as a long list of institutions and companies providing specialist trainings in this field. The analysis of the trainings conducted shows that some topics and professional groups, such as medical services or self-government institutions are represented relatively modestly in the scope of adaptation to the effects of climate change.

9.4. Education outside formal education institutions

Apart from the curriculum-based activities in the education system, different types of educational, promotional and information activities in the field of climate protection have also been offered by the State administration institutions, scientific centres and environmental non-governmental organisations. A large part of these activities is carried out by the Ministry of the Environment or under the patronage of the Minister, and is aimed at raising environmental awareness, as well as at the acquisition of knowledge and skills needed to improve the environment, to estimate ecological safety and to adopt the interdisciplinary principles of sustainable development

of the country. The challenge of tackling and adapting to the changing climate is one of the thematic areas within the above activity.

Seeing the need for a widespread ecological education, the Ministry of the Environment is committed to ensuring that the out-of-school environmental education addresses both the young generation and adults:

- taking into consideration issues close to specific spheres of human life (family, tourism, work, school, hobbies);
- focusing also on the development of specialist knowledge of particular occupational groups and local opinion leaders (in line with the concept of educational cascades).

According to these assumptions, the Ministry of the Environment has been carrying out the informational and educational activities in the form of press releases, radio broadcasts, using social media as well as in the form of educational packages - scenarios of classroom activities (also available on the website: teacher.mos.gov.pl), including also in the form of participation of the Ministry of the Environment in public events, during which educational actions are carried out from the described area.

An example of a large campaign that runs across Europe is the European Week of Sustainable Transport and European Car-free Day celebrated every year in September. The aim of this campaign is to raise awareness of the impact of transport on greenhouse gas emissions and to promote collective urban transport and bicycles as an alternative to individual car transport. In promoting environmentally friendly urban transport, it is also important to develop a bicycle rental system operating in many urban agglomerations and enjoying growing interest year by year.

Dissemination of knowledge about air pollution in Poland, its sources and effects, as well as showing how individual decisions can contribute to improving the situation are the most important objectives of the "*TworzyMY atmosferę*" (We create the atmosphere) campaign organized in 2015 by the Ministry of the Environment. The goal of the campaign was to convince the general public that even small changes in daily habits could significantly improve their quality of life. The idea was to make people aware that such demeanors as a decision on the purchase of coal of suitable parameters, ensuring optimum energy efficiency of a domestic boiler, using public transport or bicycle instead of a car - constitute activity that would not only reduce emissions, but also translate into significant savings in the home budget.

As part of this campaign, the radio, television and internet spots were broadcast. Activities in the social media and the blogosphere as well as on the campaign website (www.planetatmosfere.pl) were also undertaken. In addition, meetings were held, among others, in the form of family picnics. Information on the impact of air pollution on health, was provided by the Ministry of Health The campaign provided the platform for informing about the possibility of current monitoring of air condition owing to the portal prepared by the Chief Inspectorate for Environmental Protection: www.powietrze.gios.gov.pl and the mobile application. "Quality of air in Poland". The brochure on the campaign was prepared for children, also an on-line version.

One of the biggest national events promoting environmental protection is the celebration of the World Earth Day organized in Poland since 1996. The Ministry of the Environment has been supporting the idea for many years and participates in the celebration.

Each year the Earth Day is celebrated under a different flagship, which allows for educating the public in various areas of ecological education. The theme of the celebration of the Earth Day in 2016 was "Smoky Subject – Low Emission!". As part of this event, at the stand of the Ministry of the Environment, issues were presented concerning air protection, including pollution prevention and actions aimed at preserving the balance between greenhouse gas emissions and their sequestration by forests. To this event the honorary patronage was granted by the Minister of the Environment. In 2017, the Earth Day was devoted to "Biodiversity", which was further expanded by education to reduce CO_2 emissions. It is estimated that various forms of education within the framework of the Earth Day (among others competitions of knowledge and ideas for pro-ecological activities) embraced more than 100 thousand people, in the years 1996 - 2016.

Referring to the needs, identified by the Ministry of the Environment, for the lifelong education and the exchange of the newest knowledge in the field of environmental protection and sustainable development, and, in particular, as regards the development of the specialized competences of the groups most influential in shaping the environment, it should be emphasized that satisfying this demand is realized by the organization of specialist conferences, seminars, e-learning and postgraduate studies. Exhibitions, forums and meetings taking place at regional, national and international levels (e.g. International Trade Fair of Environmental Protection POL-ECO SYSTEM in Poznań) are complementary to the informational and educational activities. Some of these initiatives take place under the honorary patronage of the Minister of the Environment. It should also be stressed that the above acivities are qualified to receive financial support from the Environmental Protection and Water Management funds.

A strong educational base provides the network of Regional Centres of Ecological Education (RCEE) run by local self-governments or social organizations and centres operating in national parks and landscape parks. Information about the whole base of ecological education centres can be found on the NFOŚiGW website. These centres offer a variety of activities – regular classes, workshops for teachers, thematic competitions and campaigns. The programmes offered engage local communities and provide significant support for formal education. A good example of this support is the activity of the Regional Centre in Płock and the RCEE in Włocławek, which celebrated its 20th anniversary in 2017, and organized a great methodological conference for school teachers from the region.

Individual activities of various non-governmental organizations dealing with the dissemination of knowledge about the threats of climate change have been strengthened by cooperation within the voluntary association – the Climate Coalition. The coalition is an open agreement that has included a large group of more than 20 active ecological NGOs (including the Lower Silesian Eco-Development Foundation, Aeris Futuro Foundation, Energy Efficiency Foundation, Legnica Ecological Foundation, Green Action, Greenpeace, ARKA Ecological Foundation, Institute for Sustainable Development Foundation, Gaja Club, Nature Protection League, Polish Green Network, Polish Ecological Club (4 Districts), Social Ecological Institute, Ecological Association "Eco-Unia", WWF Poland Foundation, Green Mazovia, GAP Poland). The Coalition organizes workshops, conferences and thematic workshops related to climate change and conducts information campaigns through its website, where activities are presented of the Coalition members. The Climate Coalition participates in document consultation, such as e.g. the European Commission document on climate policy until 2030. In addition to the joint activities, each

organization has its own specificity expressed in the forms of education, promotion campaigns and respective activities.

Particularly active in the scope of climate protection, has been since 2012 the expert organization Institute for Sustainable Development Foundation (InE). InE is implementing a nationwide educational projects called "Climate and Agriculture" and "Climate for the Districts". A particularly valuable initiative to promote climate change issues in the media is the preparation of a "Small lexicon for journalists on renewable energy sources". Many other popularization and educational activities have been carried out within the framework of the project "Innovations for climate protection". In 2016, the leading InE campaign is "Adapt-City" to prepare a climate change adaptation strategy for a metropolitan city using a climate map and taking advantage of social participation. The project has been carried out jointly with the Capital City of Warsaw, the Union of Polish Metropolies and the Verband Region Stuttgart. Another project is "Ekolokator" – providing education for professional groups associated with the management of buildings.

The Mazovian Section of the Polish Ecological Club, in turn, has a special committee on climate and air protection, which, within the framework of the Climate Coalition, organizes, among others, a nationwide campaign "S.O.S. for Climate Change" and the "Stop Global Warming" project. The purpose of these projects is, among others, to facilitate the use of knowledge on climate protection and change in schools and other educational establishments.

The WWF Poland Foundation runs programmes aimed at reaching out to different audiences to provide guidance on how to save energy and reduce CO_2 emissions. The Earth Foundation directed to children the programme "Forest with a climate". Under this project, school children participated in forest planting. The Aeris Futuro Foundation also works on the "Time for Forest" project to compensate CO_2 emissions by planting trees in different regions of the country in cooperation with the State Forests. The project is part of an international campaign under the patronage of UNEP and the Polish Minister of the Environment. Likewise, the Gaja Club has bet on trees as a source of compensation for carbon dioxide emissions by running the Tree Day campaign on October 10 2017 joining people around the world. This is the programme whose strategic partner is the State Forests and the aim is to activate local communities, especially children and youth. Anyway, the theme of forest as an ally in the fight against global warming is an important motive of education in the classes offered by the State Forests within the framework of extensive education system conducted in its own centers of education and financed from its own resources. The role of the forest in reducing the negative effects of climate change is also popularized during the 15th of May celebrations of the Polish Forget-me-not Feast. Since 2013, the celebrations have been organized in the Andrzej Zalewski Forest Education Centre in Jedlnia. The Centre is named after the founder of the Forget-me-not Feast and popularizer of climate issues on radio weather forecasts in the Eko-radio. The State Forest Information Centre (CILP) also runs an impressive publishing business and exhibitions (e.g. an exhibition that was organized together with the University Centre for Environmental Studies and Sustainable Development at the University of Warsaw during COP 21 in Warsaw in 2015).

Among other events, during which the role and importance of forests in the context of climate protection have been strongly emphasized, it is worth to mention the promotional activities implemented by the State Forests, including: IV European Forest Week. Additionally, in the years 2010–2013, the State Forests units implemented two information campaigns, which were co-

financed by the European Union under the LIFE+ Financial Instrument and the National Fund for Environmental Protection and Water Management. The campaigns were dedicated to the forest fire prevention:

- Forest fire and nature – Raising the awareness of forest fire prevention among rural societies;
- Forest fire and nature II – The second stage of campaign informing the public about fire hazard in forests.

In addition, in 430 State Forests units across the whole country, activities have been conducted with the aim to indicate the role of forest in climate protection.

At the edge of school education programmes and those run by NGOs there is situated the Programme of Eco-initiation, initiated in Poland by the Foundation Global Action Plan (GAP) Poland. This programme consists in creating school teams with the participation of students, teachers and parents and organizing competitions to reduce energy waste and to apply the principles of eco-friendly lifestyle. The GAP Foundation adapts the ecological footprint calculator to the Polish conditions, and conducts trainings for school leaders of environmental campaigns.

Church organizations that specialize in environmental education, including ethical and religious themes, such as the Millennium Foundation for the gifted youth of the poor environments, and the Saint Francis of Assisi Ecological Organization (REFA), are particularly worthy of attention. The latter organization is particularly active in ecological projects devoted to shaping ecological ethics with the catchphrase "Make the Earth a loved one". From the proclamation of the papal encyclical Laudato Si' in 2015, REFA promotes its message, calling for the public involvement in climate protection activity, among others, by saving energy and promoting renewable energy sources.

Non-formal climate education and the promotion of individual actions to prevent climate change is dedicated not only to the young but also to the growing number of seniors in the Polish society. The Earth and People Foundation ran the "Green Knowledge on Sustainable Development" programme for students of the Third Age Universities (UTW) since 2012. With the lecture programme and a publication entitled "The future we want for our grandchildren" the issue of climate protection in the package for seniors was launched in 2012, and in 2016 the subsequent edition of the programme was implemented, together with the publication of a guide "About climate warming – unemotionally". This programme covers issues related to limiting the effects of global warming and adaptation to climate change and is intended for older people with the understanding that they can use it in practice and will share the knowledge with their grandchildren. Based on the prepared publications consisting of two guidebooks: "for grandparents" and "for grandchildren", a series of lectures and discussions were conducted in several dozen of the UTWs operating in Poland. The series was met with great interest and attendance. Numerous Third Age Universities affiliated to the UTW Federation, covering over 450 institutions throughout Poland, expressed their willingness to take advantage of the offer of Green Knowledge. Within these projects, seniors have established contacts with local schools and kindergartens and participated in various activities such as lectures, lessons and workshops.

In the years 2013–2017, the Bank for Environmental Protection Foundation was involved in two important projects on climate protection. The first project "Bet on the Sun" was aiming at the promotion of the use of RES micro-installations among the youth and adults. The aim of the second

project, "Green Bench", was to green the urban space. "Bet on the Sun" is a nationwide project of active education that broadens the public awareness and knowledge about Renewable Energy Sources, their impact on the environment and the economic and environmental advantages resulting from using RES, on the example of photovoltaic micro-installations. The main goal of the project was to initiate a public discussion on the use of RES in Poland and to carry out extensive educational and informational activities related to RES in secondary schools, post-secondary schools and in the local communities.

The lauching of the school project was preceded by a large media campaign using different methods to reach adults, ie: the nationwide press and regional, central and regional radio antennas, brochures, flyers, posters, as well as correspondence sent to municipalities, cooperatives and housing associations. Within the framework of the school project, competition teams composed of students were working under supervision of the tutor preparing energy audits for schools and for selected single-family houses as well as films promoting micro-installations of RES. Then the teams organized and coordinated the local information campaigns on RES in the community, in which their schools were located. The campaigns peaked at the conferences attended by parents of the students involved, self-government authorities and, above all, by experts in RES technology. The project third edition was terminated, and in September 2017, the fourth edition of the project was launched.

"The Green Bench" is a nationwide, pro-social grant project addressed to residents of open settlements (managed by cooperatives and communities). The project was aiming at increasing the green space of highly urbanized areas and allowing for the conversion of neglected areas into green areas, or mini gardens with benches. This could allow for reviving the space around city blocks, and create space for rest and meetings. By engaging the residents, the Foundation wanted to show, how much can be done thanks to joint forces – only the will and the good idea will suffice. The registered neighbourhood teams could submit to the Foundation their designs for the development of a public square and receive grants of up to PLN 1,200 for purchasing seedlings, fertilizers, plants and park benches. The Foundation prepared a dedicated portal: www.zielonalaweczka.pl, which contained all relevant information useful for designing and setting up mini-gardens. The project partners included the Department of Landscape Architecture and Department of Landscape Art of University of Life Sciences in Warsaw (SGGW). Three editions of the project have been completed, with nearly 1,100 participants registered in the contest, gathered in more than 160 neighbouring teams. 65 grants were granted to neighbourhood initiatives, 180 publications appeared in the press, TV, radio and on the Internet.

Education for climate is not just about organizations with a clear ecological mission. For example, the PROMETHEUS Regional Development Foundation conducts the "Clean Air on the Vistula" project and proposes an interactive application - an educational game (it will be discussed in more detail in the section on the role of the Internet). Similarly, the Foundation for the Development of Polish Agriculture implements the "Together for Climate" competition, thus promoting local individual initiatives to adapt to climate change. Also an organization whose primary mission is not related to environmental protection, the Federation of Polish Food Banks (PFBŻ), devotes more and more attention to education for the protection of climate. Various forms of social communication and PFBŻ publications prove that the common phenomenon of food waste at every stage of life – from production to decay in landfills (where more than 9 million tonnes of

food is deposited every year) is not only unethical, but also results in unnecessary emissions of greenhouse gases. Thus, leaflets and gadgets (such as information on refrigerator magnets) produced by the Food Banks network show how to reduce food waste and prevent climate change.

It is impossible to list all educational initiatives carried out in the framework of non-formal education. Even a handful of selected examples demonstrate the high activity of social organizations and institutions, their potential and the diversity of forms of education. All these actions were part of the UN Decade of Education for Sustainable Development (DEZR) 2005–2014, one of which was the coordination of education in line with the recommendations of the United Nations Framework Convention on Climate Change. After the completion of the DEZR, its natural continuation is the UN Global Action Plan.

9.5. Participation in international activities

There is practically no large international programme dealing with broadly understood environmental protection and sustainable development, in which institutions or organizations from Poland are not involved more or less. The Polish schools are particularly active in international programmes. In this respect, an example can be the GLOBE Programme (Global Learning and Observations to Benefit the Environment), which has been present in the 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. The Programme, in which more than 20,000 schools from 110 countries participate, is coordinated in Poland by the Environmental Information Centre UNEP/GRID, operating at the National Foundation for Environmental Protection, and celebrated its 20th anniversary in Poland in 2017. An important part of the programme consists in systematic observations of the environment, including air pollutants and temperature measurements, which are subsequently forwarded and stored at the NASA database. As is indicated by the statistics, the largest number of data comes from observations made by the Polish schools. The GLOBE programme is part of the Student Climate Research Campaign (SCRC). This international education has been ongoing since 2011, and involves students from all over the world to gain knowledge on climate. The SCRC in Poland organized in Ruciane-Nida the three large Globe Game student seminars, in 2012, 2014 and in 2017, respectively. The theme of the GLOBE edition in 2017 was "Climate, Water and Forest", and the partner of the Polish edition was the US Embassy in Poland. The UNEP–GRID, as the UN agency in Poland, promotes educational materials (in co-operation with the Bank for Environmental Protection) as a translation of the UN's official guidebook "Abandon bad habits – be friendly to the climate".

Another important international program, in which Polish schools take part, is Baltic Sea Project (BSP) involving the UNESCO Schools Network. The Baltic Sea Project consists in an exchange of information and cooperation between schools, in the projects enabling students to become familiar with different elements of the environment and their protection, including air protection and energy saving. In 2016, Poland organized the International Research Camp in Międzyzdroje, which was attended by 45 students and 15 teachers, and the activities of Polish schools were presented at BSP conferences, inter alia in Tallinn in 2015.

Climatic education has also been conducted by various international organizations, scientific institutions and cultural representations in Poland. A good example of bilateral cooperation is the educational activity conducted under the auspices of embassies of European countries. Since 2013,

the Embassy of France in Poland has organized seminars to exchange good practice and concrete solutions between Polish and French local sel-governments under the ECO–MIASTO project. This topic is well illustrated by the seminar on energy efficiency in construction organized jointly by the Lodz University of Technology and the Embassy of France. The Ambassador of France participates in the local events, such as the Climate Picnic organized by the City of Warsaw. On the other hand, the British Embassy organized seminars devoted to intelligent and environmentally-friendly power production. Education for climate is also supported by the Embassy of the Federal Republic of Germany in Poland, which together with the Deutsche Bundesstiftung Umwelt (German Federal Environmental Foundation) have been organizing the "Journalists for Climate" competition every year since 2013.

A significant effect on the level of public awareness in the scope of climate have international meetings of signatories to the Framework Convention (UNFCC) called Climate Summits in Poland. This was visible on both occasions, when UN COP 14 "Climate Summit" was organized in Poznań in 2008, and the UN COP 19 Climate Summit was held in Warsaw on November 2013 at the National Stadium and in the premises of the University of Warsaw. Within the framework of COP 19 at the University of Warsaw, the programme was implemented by The Global Landscape Forum (GLF), which dealt with forestry issues. The GLF exhibition was accompanied by a photographic exhibition entitled "Forests around the city – an element of environmental stabilization and the place of education and recreation – beauty, climate and leisure" organized by the University Centre for Environmental Studies and Sustainable Development (UCBS) together with the State Forest Information Centre (CILP). The main message of the Exhibition, visited by hundreds of participants both from Poland and COP 19 delegates, was the presentation of the role of Polish forests and the actions of Polish foresters to mitigate climate change in the city. Other events (sessions, workshops, lectures) which were also held during COP 19 were dedicated to the development of climate education methods and conducted by international organizations such as the IUCN Commission on Education and Communication (CUC IUCN) and the World Environmental Education Congress (WEEC). In addition to the main sites of the COP 19, special sessions open to the public were held by the non-governmental organizations and the Warsaw authorities at the Climate Tent in Defilad Square. A large exhibition "Green Climate" devoted to climate protection activities and technologies for environmental protection organized by the Polish NGOs was presented at the Museum of Technology and Industry in the Palace of Culture and Science. All in all, during the COP 19 several educational events took place in Warsaw, being mostly open to the public.

Educational activities are also promoted by other international or national organizations, an example being a series of seminars, workshops and conferences organized, by the Heinrich Böll Foundation in cooperation with the Institute for Sustainable Development in order to raise public awareness of climate change issues.

A number of programmes run by the Environment Partnership Foundation have a similar goals. The Foundation is the continuation of the "Environmental Partnership for Central Europe" programme (implemented by the German Marshall Fund of the US in the 1990s in Poland and in other Central European countries), which supports sustainable development by building partnerships and disseminating patterns of environmentally friendly activities. In the field of climate protection, the Greenways program, which promotes environmentally friendly transport and planting of trees

along the ancient routes connecting Central Europe, is of particular importance. Similarly, the Clean Business programme contributes to the promotion of innovative environmental initiatives among small and medium-sized enterprises, including energy savings. The cooperation of the Environmental Partnership Foundation with the British environmental organization Groundworks plays a special role in creating "Pure Business". The Foundation also coordinates the previously discussed programme – awarding the Green Flag certificate to schools.

An example of the exchange of educational experiences under bilateral agreements is a scholarship programme for environmental graduates from Polish universities, offered by the German Foundation Deutsche Bundesstiftung Umwelt (DBU). Eligible candidates can further improve their qualifications in German institutions and businesses, gaining experience in various fields of environmental protection. In 2016, the jubilee 20th anniversary of the scholarship was launched. From the beginning, over 250 students from Poland participated in this scholarship programme.

Particularly active in the Polish-German educational bilateral cooperation is also organization of the Polish-German Youth Office (Deutsch-Polnisches Jugendwerk). Every three years this organization issues a competition for the German-Polish Youth Award.

International exchange of experiences in the field of education for climate is particularly evident in the case of the Regional Environmenal Center for Central and Eastern Europe (REC), owing to the close cooperation of the network of national offices in all the countries forming REC. The Polish Office of REC promotes a multimedia educational package for schools "Green Package" that addresses environmental sustainability issues and global issues such as climate change. In the years 2012–2014, REC implemented the subsequent comprehensive educational material – the "Blue Package" – also in the context of adaptation to global warming. The Polish Office of REC is participating in the Mobile 2020 programme, which seeks to increase the share of cycling transport via the introduction of bicycle-friendly urban solutions.

The Polish organizations participate as partners in a wide range of projects, with the aim of spreading knowledge about climate change and change in lifestyles. The projects are financed by the European funds such as Grundtvig, Socrates and the Lifelong Learning Programme. Similarly, an international participation is coordinated by WWF Poland in the form of the annual Earth Hour action, which involves simultaneously turning off all the lights in the world, as a sign of solidarity with climate action. The international co-operation of the Polish university level education institutions within the various academic networks, devoted to environmental protection, is well developed. Over a dozen Polish universities (including the Adam Mickiewicz University in Poznań, the Lodz University of Technology and the University of Łódż) are partners of the European Baltic University Programme (BUP), which celebrated its 20th anniversary in 2016. The University of Warsaw is the first Polish university to become a member of the Copernicus Aliance – European Network on Higher Education for Sustainable Development since 2015. The Polish specialists advise on the work of international organizations devoted to environmental education, including climate, as for example, the expert from the University of Warsaw, Dr. Anna Batorczak was elected to the International Advisory Committee of the World Environmental Education Congress, and Dr. Anna Kalinowska represents Europe in the Informal Advisory Committee on Communication, Education and Public Awareness (CEPA IAC) for the Convention on Biological Diversity.

The Ministry of National Education gives recommendations to project proposals developed by the Polish NGOs to be submited to the EU Development, Education and Awareness Raising

(DEAR) programme. The project proposals concern activities in the field of global education, education for sustainable development, etc. and are addressing students, teachers, educators, parents and other social groups.

The examples given above concerning international cooperation are just a selected part of the joint projects and the Poland' cooperation in the global climate action in recent years. However, even this brief review clearly illustrates the extent to which a wide range of opportunities for global knowledge and experience exchange have been used in education on climate change, prevention and adaptation.

9.6. Education and awareness raising in business sector

There is a very distinct tendency for the private sector and the different business institutions to become involved in activities contributing to awareness raising in their own enterprises, and to launching or sponsoring external actions to educate public in the field of climate. In doing this, they often emphasise their own achievements in the field of energy saving and reductions in pollutant emissions as an example of good practice. Enabling the public to acquire the knowledge and skills needed to improve the environment is valued by both public institutions and other private sector companies. This may be illustrated by the annual gala accompanying the International Trade Fair of Environmental Protection POL-ECO SYSTEM in Poznań, during which prizes were awarded to numerous laureates of industry competitions (including Product in Circulation, International Poznań Fair Golden Medal, Eco-responsible Business, Promotor of Clean Energy).

POL-ECO SYSTEM fair is also involved in an event promoting the environmental awareness of the business sector – ENVICON Environment – *International Environmental Protection Congress.* During the annual Congress there were several sessions covering the most important topics of environmental protection. This is well illustrated by the Envicon Congress in 2017 – "The wealth of ideas for the environment". This event was aiming at gaining new knowledge and exchange of experiences between entrepreneurs, local government and academics. The best solutions and investments in the field of climate protection developed by the business were presented in the form of a publication.

Educational and information aid for companies wishing to implement, among others, SDGs Goal 13 – Action to combat climate changes, is offered by the project "Sustainable Development in Practice" run by the corporate social responsibility (CSR) consulting company, which specializes in strategic advice in the area of corporate social responsibility and sustainable development. The project's partners are UN Global Compact Network Poland, BGŻ BNP Paribas bank, ORLEN oil cncern and Polpharma company. The purpose of the project is to encourage and support companies to translate the SDGs into business strategies and policies, showing how businesses can integrate into the Agenda 2030, and take advantage of the opportunities for development. Within the framework of the project there were conducted industry workshops, questionnaire survey among Polish managers and meetings of the Expert Council. In 2016, the "SDGs in Practice. A Business Guide" was published. In the field of climate protection, the guide promotes companies' efforts to reduce CO_2 emissions from their production and supply chain operations, and to increase investment in innovation.

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 climate. The results of the audit will influence the environmental awareness of its staff, what shall result in management changes to become a more environmentally friendly. 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 their example may influence the environmental awareness of other entrepreneurs and have a pronounced effect on the environment.

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. The corporate environmental volunteering plays a greater role in shaping environmental awareness, as the individual actions of environmental workers inspired by the Bank for Environmental Protection Foundation or the PKN ORLEN grants fund for Płock. This innovative activity, tailored to the needs of the Płock community, was launched in 2014 and involves working with children from dysfunctional families through a variety of actions including the sphere of environmental protection. A similar educational role for employees is played by the business endeavor to issue certificates of sustainable management of the Green Office, which is increasingly sought in Poland. As of 2012, the Environmental Partnership Foundation has been implementing the Green Card for retail outlets. This certificate was awarded, among others to Tchibo and IKEA stores.

These examples well illustrate the business engagement in climate protection and this becomes one of the most important elements of the CSR – Corporate Social Responsibility.

9.7. Role of media

The research conducted for many years has systematically shown that the vast majority of knowledge on the subject of environment Poles are drawn from the media. In addition, the role of the media as the main source of information grows with the passing of time since the completion of formal education. The role of the media is growing rapidly, and the TNS Polska study in 2014 indicates that the main source of information on the environment for 76% of Poles is television. The role of press was dramatically reduced (from 42% in 2013 to 19% in 2014), but the role of media using the Internet is constantly increasing, of which more than 30%, especially young users, are learning about environmental issues. By comparison, for example, 6% of respondents who declare that their primary source of knowledge is a school or college is as important as media coverage (according to Article 6 of the Framework Convention) in climate education. In recent years, the media involvement in education for the climate has intensified, but manifests itself in different ways in each of their categories. The most dedicated space is in the specialized press, i.e. about 90 titles, including branch journals, such as the *Problemy Ocen Środowiskowych*, *Gospodarka Wodna*, *Echa Leśne*, as well as addressed to environmental administrations, such as *Środowisko*, and to business, such as *Przegląd Komunalny* or *Biznes i Ekologia*. Readers interested in ecology are addressed by popular scientific journals, such *as Aura*, or NGOs periodicals, such as *Dzikie Życie* and *Biuletyn*

Polskiego Klubu Ekologicznego. These journals play an important role in the flow of information in the professional or hobby circles related to environmental protection, although in the light of media studies they can count on no more than 2% of readers of the press 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. Numerous publications in *Rzeczpospolita* present the directions of Polish activities devoted to the protection of climate, e.g. the state and advantages of energy from renewable sources. The large opinion-forming magazines also exert some influence on the level of public awareness, presenting he risks arising from global warming. Increasingly, issues related to the climate are tackled by the so-called coloured press, primarily intended for women, showing the relationship beween climate change and everyday lifestyles, and offering advice on environmentally friendly attitudes.

In reaching out to the inhabitants of smaller towns, a few hundred titles of local press plays a huge role, discussing regional issues, such as air pollution and practical advice on energy conservation and other pro-ecological consumer activities.

Undoubtedly, the international events play an important role in strengthening the public interest in the effects and causes of global warming. Among these are the Climate Summits, such as 14th Conference of the Parties to the UN Framework Convention on Climate Change (COP 14) in Poznań and the Climate Conference (COP 19) in Warsaw. The fact that these important international meetings were taking place in Poland has caused the frequency of information in the media to rise. Similarly, the Climate Conference in Paris in 2015, although it took place abroad, activated the national media due to the content of signed agreements. More than usual television debates were held, news articles and expert publications and debates were published in the press. It is hoped that the media will also be more acive during the next 24th Climate Conference (COP 24) to be held in Poland, in Katowice, in 2018.

Electronic media, radio and television, play an important role in keeping up to date with reports from places affected by climate change and to present live debates to professionals and politicians.

In addition to the media itself, many regular radio programmes (including the renewable energy cycle) and TV programmes have been financed by NFOŚiGW. However, Telewizja Polska S.A. declares that it treats the emission of ecological programmes as an integral part of fulfilling a public mission, it usually does not provide them with good airtime.

The journalists who specialise in environmental issues, including those specializing in energy policy and climate protection, are associated in the Club of Environmental Journalists EKOS affiliated to the Association of Polish Journalists. The Club organises training courses and study visits for them to gain more knowledge concerning climate change and to improve their journalism competences. From 2013 onward, the EKOS together with the Embassy of the Federal Republic of Germany in Poland and the Deutsche Bundesstiftung Umwelt (German Federal Environmental Foundation) organize a national competition "Journalists for the climate". The prize is to honor the

authors of journalistic works, who in the most interesting and reliable manner will present the problems, consequences and threats of the changing climate. According to the rules of the competition, awarded works should contribute to popularizing the idea of using renewable energy sources and ecological education of the society. In 2017, the fifth edition of the "Journalists for the Climate" competition takes place. Laureates of the current edition of the competition "Journalists for the Climate" are representatives of traditional media (press, radio, television) and electronic (internet).

When it comes to discussing the role of media, the quantitative effects of reaching the public awareness that a good media campaign organization can provide are also worth noting. For example, the campaign of the Bank for Environmental Protection Foundation, accompanying the project "Bet on the Sun", is aimed at promoting the use of micro-installations of RES for youth and adults. According to estimates by experts, 300 billboards used in the media campaign have reached over 9 million people, and 600 publications in the press, radio and TV, reached some 5 million people. The campaign was accompanied by the distribution of 5,500 copies of brochures on RES, 3 thousand posters, 10 thousand leaflets and 11 thousand letters on renewable energy sources sent to municipalities, cooperatives and housing associations.

9.8. Use of 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. By leveraging the power of the Internet, knowledge is not limited to specific groups of professionals, but may reach everyone interested in environmental protection. However, on the Internet, sometimes at seemingly very professionally run portals, there are a number of myths and fakes that have nothing to do with scientific knowledge, reliable information, statements and theories.

According to a TNS study conducted by the Ministry of the Environment in 2014, the Internet was the main source of information on the environment for over 30% of Poles compared to 27% in 2012. This was particularly true for younger age groups. In line with this growing tendency to reach the Internet for information, many state and scientific institutions carry out their own websites and portals devoted to climate issues. The Ministry of the Environment runs an information portal www.ekoportal.gov.pl, which includes information on the current climate policy and climate change issues. In parallel, the Department of Environmental Education of the Ministry of the Environment maintains an educational website aimed at interesting children, providing in a fun way the age-appropriate information on the environment and promoting positive behavior. The Klimada portal is a special place at the website of the Ministry of the Environment.

The websites of research institutes, such as: IOŚ–PIB, IMGW–PIB, IGPiM as well as the Ministry of Energy and the Ministry of Science and Higher Education are also available as sources of available information and data.

Apart from the more frequent coverage of climate problems on the websites devoted to broadly understood environmental education, which have been in operation for a long time now, recently many new specialist portals were also launched. An example 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 addresses 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, many space dedicated to climate is devoted at the websites by the large NGOs, such as WWF and Nasza Ziemia (Our Earth). The Climate Coalition is also running its website: www.koalicjaklimatyczna.org.

In 2008, a climatic portal was launched and has been professionally run by the Institute for Sustainable Development www.chronmyklimat.pl, the portal constitutes a complementary whole with a cyclical issue of the electronic edition of *Biuletyn Klimatyczny*.

The Abrys company specializes in business support, offering a range of specialized portals targeted at professionals in a variety of areas with climate protection and appropriate education. This portal dedicated to the energy industry: www.cleanenergy.com, to the management staff of various specialist municipal companies: www.ecomanager and teachers: www.zielonalekcja.pl

The website www.naukaoklimacie.pl was created in order to render available the current knowledge about climate and allowed the scientific path, reliable facts to overthrow the myths and half-truths about global warming. The portal is supported by the University of Warsaw Foundation, which is a good brand of its scientific reliability.

Internet education often includes interactive applications. One such example is the quiz-type "Clean Air – Are You Ecological" educational game, prepared by the Rural Development Foundation. It is a game of making choices where positive choices are rewarded. During the game one can determine his/her ecological footprint and ways to reduce it.

The Internet also enables communication between participants in a variety of designer programmes and environmental actions organized by international institutions such as the GRID/UNEP Environmental Information Centre in the GLOBE programme or businesses such as the Bank for Environmental Protection Foundation in its school competition programmes. Online education programmes are also run by non-governmental organizations, such as the Internet courses on sustainable development offered by the Sendzimir Foundation. The Internet is also a way to establish a university co-operation network in the field of sustainable development, as in the case of UNEP's Global Universities Partnership for Education (GUPES).

It is not possible to list all uses of the Internet for the dissemination of knowledge about the climate. It is also impossible to list even the most important websites, as there are more and more specialized portals devoted to particular issues from a wide range of issues related to the protection and adaptation to climate change. Unfortunately, there are also unprofessional or misleading websites. That is why, it is so important to prepare young people throughout the educational system for the development of critical thinking in the assessment of the sources of information from the Internet, and create a list of recommended addresses with proven scientific reliability.

9.9. Education financing

The implementation of all the programmes and forms of education needs large financial support. 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) and the Voivodeship Funds (WFOŚiGW) are the largest sponsors of environmental education. In successive years, since

they were founded, the level of financial resources allocated for education has systematically grown, reaching about PLN 50 million annually in 2010, and remaining at roughly the same level over the subsequent years. The grants are given for diverse educational projects: training courses, films, radio broadcasts, campaigns, competitions etc. There is also a very important programme to support NGOs, thus enhancing the potential for civil activities. Similar financial support for projects with a local range is granted by 16 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 2013–2016 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 tries to encourage the beneficiaries to affect the directions of the education financing policy, convening since 2012, the periodical discussion meetings called Environment – Education – Eco-innovation.

A certain part of the resources used to start up the 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 the resources of the Global Environment Facility (UNDP-GEF). In particular, despite the closedown of the GEF activity in 2008, the effects of the GEF small grants, 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. educational 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 Operational 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. A recent example of this programme is the project of the Maria Grzegorzewska Pedagogical University and the GAP Polska Foundation on the development of early school education in the field of natural sciences. In the area of formal education, opportunities are offered to participate in European-funded education programmes, such as Minerva and Grundtvig. Educational projects are also financed by the Visegrad Fund, such as training for local self-governments run by the Institute for Sustainable Development Foundation or the development of

lesson scenarios concerning sustainable development, prepared under an international project by the University Center for Environmental Research at the University of Warsaw.

Moreover, many educational projects in the field of climate protection find sponsors in the embassies of different countries and in the Polish and foreign foundations, 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 and funds small grants awarded through the competition for educational projects in schools. Funding from the Civic Initiatives Fund and the European Agricultural Fund for Rural Development can be obtained through the competition for climate-related education projects, but intended for specific social groups. Many forms of educational activities are financed from the resources of universities, as exemplified by open lectures on "Sustainable development in theory and practice", conducted at the University of Warsaw.

Various educational and promotional activities are financed within the framework of the realization of the objectives of Corporate Social Responsibility from the company's own resources.

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. Among them are the Provincial (Voivodeship) Fund for Environmental Protection and Water Management in Warsaw and the local self-government authorities. A few examples of such multi-sponsorship funding are projects for Third Age Universities. This extraordinary programme of intergenerational education is financed from a number of sources, such as: the Civic Initiatives Fund, NFOŚiGW and the EEA Financial Mechanism.

Unfortunately, this does not mean that they fully meet the needs of education and that it is easy to obtain the money.

9.10. Public awareness of global climate change

Environmental awareness is defined as a set of information and beliefs about the environment and the perception of the relationship between the state and nature of the environment and the conditions and quality of human life, and as a translation of the above into the human own attitudes and behaviors. The effectiveness of all educational activities presented and the results of social communication on climate change can only be assessed on the basis of their impact on the ecological awareness of the society.

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 the commission by the Ministry of the Environment, systematic surveys on the environmental awareness and behaviour of Poland's population have been carried out by TNS Poland, as an element of a long-term research programme (the so-called tracking surveys). Such studies, repeated in 2012, 2013 and in 2014, showed that the knowledge of the concept of "climate change" is widespread among the Poles – about 80% of respondents declare that they know and understand this concept, and that percentage is systematically increasing, so that in 2014 that was claimed by 86% of Poles. In the area of environmental threats, however, climate issues are only the fifth issue (after waste, air and water pollution and natural disasters), although most Poles consider them an important problem.

When a question is asked about the important problems, which Poland has to solve, only 7% of the respondents mention environmental protection, indicating that the environmental issues are absent from the list of most urgent difficulties. Only 20% of respondents declares that climate changes constitute the most important environmental threat. However, characteristically, this is declared by 31% of twenty year olds respondents. At the same time, according to a report by Flash Eurobarometer 416 *Attitudes of Europeans towards the environment*, research conducted in 2014 commissioned by the European Commission shows that a Pole care less about energy saving than an average European. Poles' awareness of energy saving is lower than average for Europe. Energy saving declares on average 52% of EU residents, while only 38% of Poles. Also in terms of environmentally friendly transport, the average willingness of choice for 28 EU countries is 39% of respondents' declarations, and only 23% among Poles confirm this choice. Poles are also least aware of the condition of the air – 31% think so, while on average in Europe it is 27%.

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, apart from 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.

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 largest cities.

Although in specific age and professional groups, the results corroborate the increase in awareness about climate issues, in practice this is not so well translated to every day life styles as is seen from the report published in 2015, which summarizes the results of the individual studies. The report prepared by TNS Polska, commissioned by the Ministry of the Environment, is based on an analysis of 83 publications, including 59 reports and 12 messages on awareness, attitudes and ecological behavior of Poles conducted in 2009–2015. The results of such a comprehensive analysis indicate that the problem of climate change is not widely known to the respondent, although information on this subject is needed. The analysis of all the awareness surveys conducted in Poland shows that respondents have information gaps identified in these studies, in areas such as knowledge on renewable energy sources, climate change issues and knowledge on energy saving. There are also reservations about the methodology and methodology of some studies, as well as the noticeable deficiencies in the public opinion survey on some thematic areas.

The results of the social awareness research show that education is more effective in the sphere of interest and knowledge of climate change, but there is still much to be desired in educating

the use of this information in everyday practice. Broadening of theoretical knowledge is relatively slower in changing consumer behavior and lifestyles, although this process speeds up the perception of the economic situation that drives savings.

In conclusion it is worth noting that in the reported period both formal education programmes (despite frequent changes to the curriculum) and non-formal education devotes much attention to climate protection. However, the educational offer and the way to promote climate-friendly behaviors in non-formal activities are richer and more diversified than in formal education, and addressed to many social and professional groups. It is important to note the growing interest in climate in the business environments.

In the vast majority of educational programmes and information campaigns, the focus is on actions to reduce CO_2 emissions (both through the production of energy-saving habits and the promotion of renewable energy sources). Adequate adaptations to climate change are rarely included in education. It is therefore important to treat education as a priority topic in both climate protection and adaptation methods, especially in urban areas, and to broaden the range of social groups and to address their specificities during training.

ABBREVIATIONS

AAU	Assignment Amount Unit
AGH	University of Technology and Science
ARiMR	The Agency for Restructuring and Modernisation of Agriculture
BR2	Second Biennal Report
BULiGL	Office for Forest Planning and Management
CALM	Circumpolar Active Layer Monitoring
CDI	Climatic Drought Index
CDM	Clean Development Mechanism
CODN	National In-Service Teacher Training Centre
COP	Conference of Parties UNFCCC
CTF	Common tabular format
DSRK	Long-Term National Development Strategy
EEA	European Environment Agency
EFRROW	European Agricultural Fund for Rural Development
EMEP	European Monitoring and Evaluation Programme
Eq	Equivalent
EU ETS	EU Emissions Trading Scheme
GAP	Global Action Plan
GEF	Global Environment Facility
GIS	National Green Investment Scheme
GreenEvo	Green Technology Accelerator Project
GUS	Central Statistical Office
HELCOM	Helsinki Commission (Baltic Marine Environment Protection Commission)
IBL	Forest Research Institute
IFJ PAN	Institute of Nuclear Physics Polish Academy of Sciences
ICM UW	Interdisciplinary Centre for Mathematical and Computational Modelling of the University of Warsaw
IG PAN	Institute of Geophysics Polish Academy of Sciences
IM	Maritime Institute
IMGW-PIB	Institute of Meteorology and Water Management – National Research Institute
IO PAN	Institute of Oceanology Polish Academy of Sciences
IOŚ–PIB	Institute of Environmental Protection – National Research Institute
IPCC	Intergovernmental Panel on Climate Change
ITP	Institute Of Technology And Life Sciences in Falenty
ITS	Motor Transport Institute
JI	Joint Implementation
IUNG PIB	Institute of Soil Science and Plant Cultivation – State Research Institute

KOBiZE	National Centre for Emissions Management – Institute of Environmental Protection – National Research Institute
KPGO	National Waste Management Plan
KPN	Kampinos National Park
KPRU	National Allowance Allocation Plan
KPZK 2030	National Spatial Development Concept 2030
KPZL	National Programme for the Augmentation of the Forest Cover
LULUCF	Land use, land-use change and forestry
MWC	Urban heat island
MIR-PIB	National Marine Fisheries Research Institute
MŚ	Ministry of the Environment
NFOŚiGW	National Fund for Environmental Protection and Water Management
NILU	Norwegian Institute for Air Research in Oslo
NIR	National inventory report
OZE	Renewable Energy Sources
PAN	Polish Academy of Sciences
PIG-PIB	National Geological Institute – National Research Institute
PLP	National forestry policy
POE	Non-governmental ecological organisations
PSHM	State Hydrological and Meteorological Service
PzK	Kyoto Protocol
RES	Renewable Energy Sources
SGGW	Warsaw University of Life Sciences
SRK 2020	Medium-Term National Development Strategy 2020
SOR	Strategy for Responsible Development until 2020 (with prospects until 2030)
SRT	Transport Development Strategy 2020
UP	Poznań University of Life Sciences
UG	University of Gdańsk
UMK	Nicolaus Copernicus University in Toruń
UMCS	Maria Curie-Skłodowska University
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UŚ	University of Silesia
UW	University of Warsaw
UWr	University of Wrocław
WMO	World Meteorological Organization

ANNEX 1. THE THIRD BIENNIAL REPORT FOR THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

In order to avoid duplication of information in the 7th national communication and the 3rd biennial report, below is the location in the 7th national communication of the descriptive information required in biennial reports in accordance with Annex I to Dec. 2/CP.17.

Information required in biennial reports	Chapter of the government report
Information on greenhouse gases	3
Reduction target	4.1
Progress in achieving the reduction target:	
Mitigation actions and their effects	4.6
Market mechanisms (including emission and absorption units from the LULUCF sector)	4.9
Projections	5
Providing financial, technological and capacity-building assistance to developing countries:	
Financial aid	7.2
Technology transfer	7.2
Capacity building	9.5

Table 1. Emission trends

Table 1 – Summary Table

Source: Submission 2018 v1, POLAND

	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Emission changes in the last year of reporting in relation to the base year (%)
	kt of CO_2 equivalent																											%
CO_2 emissions without net CO_2 from LULUCF	470 886.43	376 039.78	373 379.31	363 720.14	364 128.74	359 612.30	361 305.16	375 306.19	366 571.50	337 342.94	327 653.71	317 098.60	313 546.99	305 731.84	318 416.96	322 540.32	321 670.63	334 625.08	334 367.83	327 450.53	314 146.67	332 132.43	331 703.81	324 225.51	319 921.73	307 601.95	310 638.59	-34.03
CO_2 emissions with net CO_2 from LULUCF	453 865.18	350 082.31	355 155.04	367 565.97	361 674.83	355 728.68	346 298.38	341 718.38	332 955.46	297 143.34	280 751.08	285 220.31	290 956.07	273 599.28	282 970.33	275 712.79	275 525.14	293 989.64	299 067.88	293 009.73	281 590.63	300 746.11	293 121.48	285 772.55	278 690.55	274 312.69	280 665.84	-38.16
CH_4 emissions without CH_4 from LULUCF	70 015.17	64 386.78	59 710.04	57 942.76	56 533.16	55 585.64	54 179.39	53 498.76	53 359.57	51 606.13	50 687.16	49 387.68	51 209.95	49 601.07	49 935.26	49 537.66	49 992.78	50 192.29	49 543.83	49 303.35	48 156.79	48 178.30	47 085.31	46 796.31	47 067.85	46 594.56	47 176.03	-32.62
CH_4 emissions with CH_4 from LULUCF	70 059.30	64 430.84	59 755.03	57 987.27	56 575.37	55 626.58	54 225.29	53 535.15	53 397.50	51 640.46	50 724.26	49 420.23	51 242.53	49 635.78	49 972.17	49 571.92	50 026.26	50 231.36	49 573.53	49 337.99	48 186.63	48 209.94	47 116.39	46 828.08	47 104.83	46 629.82	47 210.15	-32.61
N_2O emissions without N_2O from LULUCF	29 322.01	27 312.65	22 842.50	21 285.45	22 210.73	22 143.19	23 121.04	23 247.81	23 151.41	22 895.52	22 174.03	22 533.39	22 690.55	21 581.12	21 795.56	22 299.95	22 476.06	22 974.44	23 746.84	23 179.29	20 025.09	19 707.86	20 039.26	20 116.82	20 202.33	19 790.29	18 989.19	-35.24
N_2O emissions with N_2O from LULUCF	29 492.30	27 495.61	23 047.68	21 545.27	22 797.25	22 458.10	23 468.69	23 584.50	23 485.77	23 259.85	22 547.34	22 916.01	23 104.16	21 992.06	22 220.36	22 743.52	22 927.11	23 442.99	24 270.34	23 720.85	20 603.28	20 338.17	20 684.94	20 834.75	20 945.77	20 875.54	20,082.82	-31.90
HFCs	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	134.69	335.49	481.02	569.32	780.47	1 378.08	1 937.55	2 524.04	3 104.97	3 760.17	4 588.89	5 269.92	5 885.98	6 222.43	6 181.23	6 902.13	7 536.17	7 875.88	8 278.26	8 915.81	8 948.85	100.00
PFCs	147.26	141.87	141.31	134.63	144.86	152.78	171.97	161.07	173.36	174.86	168.71	176.68	197.34	207.33	201.08	205.07	187.41	193.58	184.63	163.12	17.97	17.lip	16.22	15.41	14.64	13.90	13.21	-91.03
Unspecified mix of HFCs and PFCs	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
SF_6	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	13.27	29.12	23.80	22.91	23.94	23.50	23.07	22.86	23.29	20.72	22.36	26.80	33.20	31.16	32.87	37.60	35.37	39.02	41.92	47.54	52.79	77.03	100.00
NF_3	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
Total (without LULUCF)	570 370.88	467 881.09	456 073.16	443 082.97	443 017.48	437 507.17	438 941.37	452 573.12	443 759.77	412 612.70	401 487.58	390 597.49	389 605.24	379 668.68	393 474.53	398 365.54	398 942.56	413 288.50	413 760.27	406 351.60	388 565.35	406 973.16	406 419.78	399 071.85	395 532.34	382 969.30	385 842.89	-32.35
Total (with LULUCF)	553 564.04	442 150.63	438 099.06	447 233.14	441 192.30	433 979.40	424 328.15	419 358.40	410 516.02	372 811.76	354 995.37	359 134.37	367 460.52	347 981.78	358 489.62	352 015.83	353 281.62	373 160.69	379 013.52	372 486.99	356 617.34	376 248.79	368 514.22	361 368.59	355 081.59	350 800.55	356 997.90	-35.51
Total (without LULUCF, with indirect)	NA	NA	NA	NA	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
Total (with LULUCF, with indirect)	NA	NA	NA	NA	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
1. Energy	474 968.03	382 000.95	380 031.93	371 208.50	373 045.81	366 398.98	366 667.32	381 856.41	371 602.25	342 236.89	333 704.00	321 025.82	322 051.76	314 470.19	325 914.67	329 567.15	330 166.84	341 729.69	339 003.08	333 240.37	322 148.82	339 152.32	335 838.27	329 881.06	326 101.74	312 409.80	316 109.87	-33.45
2. Industrial processes and product use	31 198.21	22 693.33	20 092.42	19 695.46	19 309.78	21 255.05	22 691.59	22 040.45	22 956.50	21 380.10	20 583.30	23 802.06	22 474.12	20 800.61	23 681.51	25 475.29	25 450.80	27 800.65	30 372.76	28 959.10	22 872.65	24 897.11	27 768.20	26 747.38	26 502.93	28 121.59	28 525.12	-8.57
3. Agriculture	47 835.68	47 155.60	40 119.67	36 523.26	35 210.83	34 783.91	34 732.58	34 006.84	34 591.23	34 335.88	32 596.07	31 005.77	30 614.99	29 929.56	29 364.19	29 354.21	29 511.99	30 221.10	30 854.09	30 928.18	30 232.31	29 717.72	30 088.15	29 956.20	30 497.88	30 472.43	29 649.89	-38.02
4. Land use, land-use change and forestry	-16 806.83	-25 730.45	-17 974.09	4 150.16	-1 825.18	-3 527.77	-14 613.22	-33 214.72	-33 243.75	-39 800.94	-46 492.21	-31 463.13	-22 144.72	-31 686.90	-34 984.91	-46 349.71	-45 660.94	-40 127.81	-34 746.75	-33 864.61	-31 948.01	-30 724.36	-37 905.56	-37 703.26	-40 450.75	-32 168.74	-28 844.99	71.63
5. Waste	16 368.96	16 031.20	15 829.14	15 655.75	15 451.05	15 069.23	14 849.87	14 669.41	14 609.80	14 659.83	14 604.20	14 763.84	14 464.37	14 468.31	14 514.16	13 968.89	13 812.94	13 537.07	13 530.34	13 223.95	13 311.57	13 206.01	12 725.16	12 487.21	12 429.78	11 965.48	11 558.01	-29.39
6. Other	NO	NO	NO	NO	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)	553 564.04	442 150.63	438 099.06	447 233.14	441 192.30	433 979.40	424 328.15	419 358.40	410 516.02	372 811.76	354 995.37	359 134.37	367 460.52	347 981.78	358 489.62	352 015.83	353 281.62	373 160.69	379 013.52	372 486.99	356 617.34	376 248.79	368 514.22	361 368.59	355 081.59	350 800.55	356 997.90	-35.51

Table 1 – CO_2

Source: Submission 2018 v1, POLAND

	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Emission changes in the last year of reporting in relation to the base year (%)
	kt																											%
1. Energy	441 908.41	354 264.09	354 556.83	345 555.51	346 796.89	340 426.88	340 895.26	355 816.52	345 921.31	318 155.71	309 762.34	297 437.53	295 808.71	289 538.18	300 484.50	303 751.60	303 913.91	315 531.20	313 589.10	307 634.87	297 511.83	314 263.19	311 496.81	305 415.99	301 365.87	287 948.22	290 841.09	-34.19
A. Fuel combustion (sectoral approach)	438 753.54	351 661.99	352 815.02	343 742.52	345 185.25	339 938.75	339 446.41	354 586.28	343 551.69	317 243.18	307 780.75	294 701.85	293 736.78	287 276.52	297 727.23	301 730.68	301 208.53	312 477.91	310 755.32	305 216.20	295 592.59	312 010.45	308 630.06	302 041.43	297 701.13	284 631.74	287 305.83	-34.52
1. Energy industries	256 963.48	235 095.08	228 816.70	219 603.78	206 759.94	205 915.34	190 561.55	197 141.58	191 457.06	184 170.78	178 750.48	176 303.92	177 914.75	171 702.44	180 070.21	178 772.18	177 392.29	182 590.45	179 248.49	173 512.14	166 016.71	172 325.82	173 748.85	168 613.38	169 173.97	159 841.27	162 689.57	-36.69
2. Manufacturing industries and construction	55 067.83	42 851.63	39 701.30	36 830.35	47 758.59	48 867.55	63 327.03	67 742.80	63 982.37	53 797.01	45 844.54	45 973.76	40 685.64	38 398.95	37 548.32	38 249.43	33 936.71	33 779.94	36 014.74	31 867.00	27 966.10	29 555.26	30 544.74	29 321.29	29 158.41	29 310.02	27 827.37	-49.47
3. Transport	23 597.10	19 986.35	20 991.91	21 337.26	20 805.92	21 814.04	22 535.63	25 519.46	26 982.25	28 420.76	30 924.19	27 223.46	27 040.38	26 122.53	28 538.05	32 306.17	34 718.34	38 454.47	42 475.70	44 387.85	45 061.80	47 491.50	48 080.08	46 236.82	43 502.25	43 814.89	46 033.81	95.08
4. Other sectors	103 125.14	53 728.94	63 305.10	65 971.12	69 860.80	63 341.82	63 022.20	64 182.44	61 130.01	50 854.63	52 261.53	45 200.70	48 096.02	51 052.60	51 570.66	52 402.90	55 161.19	57 653.05	53 016.39	55 449.20	56 547.98	62 637.88	56 256.40	57 869.94	55 866.50	51 665.56	50 755.08	-50.78
5. Other	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, IE	NO, IE	NO, IE	NO, IE	NO, IE	0.00
B. Fugitive emissions from fuels	3 154.87	2 602.10	1 741.81	1 812.99	1 611.64	488.12	1 448.85	1 230.25	2 369.62	912.52	1 981.59	2 735.68	2 071.92	2 261.65	2 757.27	2 020.92	2 705.38	3 053.29	2 833.78	2 418.68	1 919.24	2 252.73	2 866.75	3 374.56	3 664.74	3 316.48	3 535.26	12.06
1. Solid fuels	3 115.68	2 561.07	1 703.34	1 777.09	1 573.63	449.89	1 407.11	1 186.50	2 325.97	868.40	1 938.61	2 689.41	2 023.66	2 214.55	2 705.12	1 965.80	1 566.41	1 852.02	1 819.50	1 269.08	770.49	1 201.76	1 253.87	1 640.37	1 899.61	1 705.16	1 678.68	-46.12
2. Oil and natural gas and other emissions from energy production	39.19	41.02	38.47	35.90	38.01	38.23	41.75	43.75	43.65	44.13	42.98	46.27	48.26	47.11	52.14	55.12	1 138.97	1 201.27	1 014.29	1 149.60	1 148.74	1 050.97	1 612.88	1 734.19	1 765.13	1 611.31	1 856.58	4 637.24
C. CO2 transport and storage	NO	NO	NO	NO	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
2. Industrial processes	26 061.44	18 832.26	16 630.58	16 292.05	15 466.43	17 397.39	18 282.14	17 444.88	18 429.47	17 029.34	16 088.85	17 967.55	15 960.12	14 393.36	16 045.27	17 074.06	16 042.68	17 703.06	19 499.12	18 492.53	15 403.98	16 643.73	18 966.19	17 504.24	17 116.82	18 216.18	18 539.33	-28.86
A. Mineral industry	11 605.22	8 855.06	8 243.94	8 442.72	8 098.37	9 627.69	9 738.57	9 314.28	10 007.60	9 565.33	9 333.31	9 444.97	8 108.66	7 831.59	7 938.73	8 669.89	8 355.79	9 533.40	10 803.74	10 380.14	9 100.28	9 849.54	11 390.63	10 020.06	9 416.49	10 100.81	10 088.56	-13.07
B. Chemical industry	5 757.60	3 801.80	3 703.66	3 405.57	3 467.63	3 810.92	4 314.89	4 317.25	4 475.26	4 139.45	3 588.78	4 410.83	4 243.91	3 438.07	4 636.04	4 788.59	4 886.78	5 210.77	5 245.70	5 051.93	4 124.55	4 335.42	4 658.57	4 694.36	4 757.16	4 840.00	5 141.13	-10.71
C. Metal industry	7 729.51	5 766.77	4 297.06	4 038.20	3 461.49	3 522.64	3 716.05	3 314.46	3 454.69	2 775.81	2 627.89	3 489.08	2 974.89	2 513.12	2 879.85	3 017.26	2 216.99	2 329.48	2 813.72	2 366.63	1 527.58	1 784.33	2 228.17	2 126.53	2 263.68	2 581.62	2 592.10	-66.46
D. Non-energy products from fuels and solvent use	969.11	408.63	385.92	405.56	438.93	436.15	512.63	498.89	491.92	548.75	538.87	622.67	632.66	610.58	590.65	598.32	583.11	629.42	635.96	693.83	651.57	674.45	688.82	663.28	679.48	693.75	717.54	-25.96
E. Electronic industry																												
F. Product uses as ODS substitutes																												
G. Other product manufacture and use	NA	NA	NA	NA	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
H. Other	NO	NO	NO	NO	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. Agriculture	2 468.52	2 593.38	1 878.28	1 574.45	1 570.32	1 491.89	1 827.75	1 740.46	1 916.85	1 834.01	1 533.03	1 428.88	1 431.39	1 366.03	1 314.53	1 339.49	1 291.94	970.48	810.83	853.13	776.13	790.01	799.30	761.15	868.21	901.78	770.57	-68.78
A. Enteric fermentation																												
B. Manure management																												
C. Rice cultivation																												
D. Agricultural soils																												
E. Prescribed burning of savannas																												
F. Field burning of agricultural residues																												
G. Liming	1 950.86	2 099.38	1 593.28	1 334.43	1 305.48	1 197.97	1 503.59	1 410.09	1 571.75	1 488.52	1 198.79	1 095.03	1 084.35	1 031.79	991.92	992.45	944.90	584.28	401.36	410.31	351.38	391.55	376.22	336.67	419.89	467.55	373.84	-80.84
H. Urea application	517.66	494.00	285.00	240.02	264.84	293.92	324.16	330.37	345.10	345.49	334.25	333.86	347.04	334.25	322.61	347.04	347.04	386.21	409.47	442.82	424.75	398.46	423.08	424.48	448.32	434.23	396.73	-23.36
I. Other carbon-containing fertilizers	NO	NO	NO	NO	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
J. Other	NO	NO	NO	NO	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
4. Land Use, Land-Use Change and Forestry	-17 021.25	-25 957.47	-18 224.27	3 845.84	-2 453.91	-3 883.62	-15 006.78	-33 587.81	-33 616.04	-40 199.60	-46 902.62	-31 878.29	-22 590.92	-32 132.55	-35 446.63	-46 827.53	-46 145.49	-40 635.44	-35 299.95	-34 440.81	-32 556.04	-31 386.32	-38 582.33	-38 452.97	-41 231.17	-33 289.26	-29 972.75	76.09
A. Forest land	-21 594.63	-34 088.43	-26 347.86	-4 621.13	-11 687.10	-10 926.16	-21 971.89	-40 072.68	-39 453.85	-44 741.63	-52 207.63	-36 868.64	-28 562.72	-37 601.67	-39 625.41	-50 220.18	-49 904.41	-43 384.80	-36 515.70	-36 727.11	-34 830.71	-33 436.20	-40 147.50	-39 938.68	-42 020.73	-34 716.96	-30 622.92	41.81
B. Cropland	859.94	1 026.11	506.42	510.43	515.33	518.13	523.62	528.58	523.31	520.99	522.32	536.91	527.57	523.59	503.19	501.23	591.13	579.44	556.88	813.84	567.09	508.97	464.33	449.03	450.53	429.06	362.12	-57.89
C. Grassland	672.94	713.10	757.95	711.96	668.76	673.72	798.76	703.39	651.28	179.36	347.05	263.67	250.76	9.83	-304.26	-179.64	-204.66	-225.25	-312.01	-335.91	-312.58	-384.49	-413.03	-430.43	-425.90	-367.20	-544.66	-180.94
D. Wetlands	4 509.75	4 508.77	4 512.19	4 504.82	4 506.50	4 499.78	4 510.69	4 508.67	4 497.53	4 501.84	4 524.58	4 526.20	4 506.17	4 528.34	4 580.95	4 537.66	4 522.87	4 516.76	4 534.90	4 524.79	4 519.08	4 531.12	4 519.80	4 515.10	4 519.65	4 511.77	4 526.55	0.37
E. Settlements	462.83	377.03	449.21	457.36	1 351.75	594.29	615.33	515.71	522.51	641.66	687.06	675.65	683.55	649.27	629.52	706.07	761.77	877.93	1 002.55	941.62	1 106.75	1 197.99	1 155.14	1 325.02	1 301.52	2 378.47	1 646.71	255.79
F. Other land	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, NA	NO, NA	NO, NA	NA,NO	NO, NA	0.00
G. Harvested wood products	-1 932.09	1 505.95	1 897.83	2 282.41	2 190.85	756.63	516.72	228.52	-356.82	-1 301.83	-776.00	-1 012.08	3.74	-241.90	-1 230.62	-2 172.69	-1 912.18	-2 999.51	-4 566.58	-3 658.03	-3 605.67	-3 803.71	-4 161.07	-4 373.00	-5 056.25	-5 524.40	-5 340.55	176.41
H. Other	NA	NA	NA	NA	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. Waste	448.05	350.06	313.63	298.12	295.11	296.13	300.02	304.33	303.86	323.88	269.48	264.63	346.77	434.27	572.66	375.17	422.11	420.33	468.79	470.00	454.73	435.50	441.50	544.14	570.83	535.77	487.60	8.83
A. Solid waste disposal	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, NA	NO, NA	NO, NA	NA,NO	NA,NO	0.00
B. Biological treatment of solid waste																												
C. Incineration and open burning of waste	448.05	350.06	313.63	298.12	295.11	296.13	300.02	304.33	303.86	323.88	269.48	264.63	346.77	434.27	572.66	375.17	422.11	420.33	468.79	470.00	454.73	435.50	441.50	544.14	570.83	535.77	487.60	8.83
D. Waste water treatment and discharge																												
E. Other	NO	NO	NO	NO	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
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	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
International bunkers	2 758.50	1 876.91	1 132.24	1 454.27	1 118.65	1 125.10	1 201.44	1 412.74	1 470.44	1 649.62	1 888.02	1 678.55	1 587.76	1 602.94	1 710.21	1 596.14	1 912.01	2 131.89	2 038.86	2 388.94	2 159.64	2 121.65	1 937.35	1 965.18	1 952.62	2 159.11	2 459.23	-10.85
Aviation	1 007.58	620.72	640.92	695.78	692.89	701.55	756.41	889.21	796.83	811.26	724.65	770.84	759.29	744.86	805.49	791.05	886.93	1 192.81	1 248.33	1 511.81	1 366.07	1 431.37	1 394.21	1 505.72	1 507.52	1 692.42	1 874.01	85.99
Navigation	1 750.92	1 256.20	491.32	758.49	425.76	423.54	445.03	523.53	673.62	838.36	1 163.37	907.71	828.47	858.08	904.72	805.09	1 025.07	939.09	790.53	877.13	793.57	690.28	543.14	459.46	445.10	466.68	585.22	-66.58
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	NA	NA	NA	NA	0.00
CO_2 emissions from biomass	6 869.31	6 813.47	5 770.98	6 394.32	17 805.11	17 261.14	17 602.21	17 320.56	17 300.09	17 381.11	16 666.03	16 888.14	18 046.22	18 371.76	18 549.12	19 192.10	19 804.99	20 685.53	21 040.37	23 784.71	26 449.74	30 353.35	32 940.10	35 680.13	34 828.76	34 397.02	34 767.31	406.13
CO_2 captured	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, IE	NO, IE	NO, IE	NO, IE	NO, IE	0.00
Long-term storage of C in waste disposal sites	16 591.02	18 242.65	19 005.72	19 730.14	20 439.77	21 132.70	21 837.80	22 581.89	23 353.69	24 155.43	24 991.24	25 749.33	26 422.15	27 071.78	27 680.80	28 281.74	28 830.94	29 400.08	29 963.68	30 485.44	30 970.90	31 452.30	31 901.00	32 361.44	32 760.56	33 127.24	33 449.02	101.61
Indirect N_2O																												
Indirect CO_2	NA	NA	NA	NA	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
Total CO_2 emission excluding LULUCF	470 886.43	376 039.78	373 379.31	363 720.14	364 128.74	359 612.30	361 305.16	375 306.19	366 571.50	337 342.94	327 653.71	317 098.60	313 546.99	305 731.84	318 416.96	322 540.32	321 670.63	334 625.08	334 367.83	327 450.53	314 146.67	332 132.43	331 703.81	324 225.51	319 921.73	307 601.95	310 638.59	-34.03
Total CO_2 emission including LULUCF	453 865.18	350 082.31	355 155.04	367 565.97	361 674.83	355 728.68	346 298.38	341 718.38	332 955.46	297 143.34	280 751.08	285 220.31	290 956.07	273 599.28	282 970.33	275 712.79	275 525.14	293 989.64	299 067.88	293 009.73	281 590.63	300 746.11	293 121.48	285 772.55	278 690.55	274 312.69	280 665.84	-38.16

Table 1 – CH_4

Source: Submission 2018 v1, POLAND

	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Emission changes in the last year of reporting in relation to the base year (%)
	kt																											%
1. Energy	1 219.20	1 021.15	931.60	937.66	953.42	939.04	929.24	934.19	917.14	861.15	855.84	841.94	950.55	899.79	917.36	930.71	946.01	950.54	920.94	928.76	891.09	896.69	873.99	879.46	892.51	884.99	916.95	-24.79
A. Fuel combustion (sectoral approach)	221.89	127.08	155.54	160.39	211.96	181.22	180.34	186.34	167.45	142.24	143.11	117.77	125.87	129.66	128.14	132.77	140.67	154.69	143.69	150.75	153.73	172.17	158.46	163.43	159.34	147.07	144.20	-35.01
1. Energy industries	3.61	3.29	3.19	3.15	2.87	2.89	2.30	2.38	2.32	2.16	2.10	2.09	2.16	2.11	2.20	2.28	2.51	2.66	2.77	3.09	3.52	3.92	4.31	5.05	4.49	4.66	4.70	30.21
2. Manufacturing industries and construction	4.04	4.14	3.95	3.70	4.74	4.89	6.58	6.93	6.42	5.08	4.40	4.41	3.95	3.79	3.68	3.73	3.37	3.48	3.61	3.46	3.22	3.52	3.81	3.77	4.09	4.26	4.27	5.70
3. Transport	7.54	7.20	7.97	8.19	19.54	8.39	8.33	8.62	8.87	8.66	8.88	8.09	6.81	6.19	6.08	6.28	6.47	6.70	6.73	6.50	6.28	5.72	5.38	5.05	4.65	4.34	4.26	-43.44
4. Other sectors	206.70	112.45	140.43	145.35	184.80	165.06	163.12	168.41	149.84	126.34	127.72	103.18	112.96	117.58	116.19	120.49	128.32	141.85	130.59	137.70	140.70	159.01	144.95	149.56	146.11	133.81	130.96	-36.64
5. Other	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, IE	NO, IE	NO, IE	NO, IE	NO, IE	0.00
B. Fugitive emissions from fuels	997.31	894.07	776.06	777.27	741.47	757.82	748.90	747.85	749.69	718.91	712.73	724.17	824.68	770.12	789.21	797.94	805.34	795.85	777.25	778.01	737.37	724.52	715.53	716.03	733.17	737.92	772.75	-22.52
1. Solid fuels	951.03	853.19	735.19	735.61	693.11	706.69	693.82	690.44	693.19	659.19	649.21	648.05	740.64	688.52	706.70	705.16	712.92	707.86	692.86	692.23	656.65	639.75	632.97	630.67	633.93	640.55	675.85	-28.94
2. Oil and natural gas and other emissions from energy production	46.28	40.88	40.87	41.66	48.36	51.13	55.08	57.41	56.50	59.71	63.52	76.12	84.03	81.60	82.51	92.78	92.41	87.99	84.39	85.79	80.72	84.77	82.57	85.36	99.24	97.38	96.90	109.40
C. CO2 transport and storage																												
2. Industrial processes	2.81	2.51	1.93	1.86	1.78	1.73	1.99	2.05	2.16	2.01	1.81	2.09	1.91	2.14	2.09	2.23	1.89	2.80	2.92	2.58	2.41	2.50	2.75	2.41	2.55	2.52	2.62	-6.64
A. Mineral industry																												
B. Chemical industry	1.74	1.60	1.27	1.22	1.20	1.06	1.31	1.39	1.45	1.46	1.29	1.46	1.35	1.56	1.46	1.54	1.39	2.30	2.37	2.08	2.10	2.03	2.22	1.86	1.99	1.94	2.02	16.47
C. Metal industry	1.07	0.91	0.66	0.64	0.58	0.67	0.68	0.65	0.71	0.56	0.52	0.62	0.56	0.57	0.63	0.68	0.50	0.50	0.55	0.50	0.32	0.46	0.53	0.55	0.55	0.58	0.60	-44.16
D. Non-energy products from fuels and solvent use	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
E. Electronic industry																												
F. Product uses as ODS substitutes																												
G. Other product manufacture and use	NA	NA	NA	NA	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
H. Other	NO	NO	NO	NO	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. Agriculture	972.35	953.91	864.06	793.70	729.39	720.30	683.16	658.50	671.85	658.07	626.91	582.10	562.22	551.72	551.57	535.74	547.48	560.84	586.92	561.85	551.15	550.70	548.60	547.28	549.71	555.42	562.50	-42.15
A. Enteric fermentation	878.10	862.16	771.85	705.56	650.75	641.19	604.95	586.46	598.74	583.45	553.11	512.92	493.60	477.62	476.61	462.75	471.12	482.39	488.27	487.81	479.96	479.57	480.34	482.93	486.03	490.25	496.78	-43.43
B. Manure management	93.44	90.95	91.43	87.46	77.82	78.44	77.42	71.27	72.37	73.79	73.05	68.48	67.80	73.34	74.24	72.10	75.59	77.71	77.92	73.13	70.21	70.27	67.42	63.47	62.71	64.12	64.77	-30.68
C. Rice cultivation	NO	NO	NO	NO	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
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	NA	NA	NA	NA	0.00
E. Prescribed burning of savannas	NO	NO	NO	NO	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
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	0.88	0.97	1.06	0.95	17.06
G. Liming																												
H. Urea application																												
I. Other carbon-containing fertilizers																												
J. Other	NA	NA	NA	NA	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
4. Land Use, Land-Use Change and Forestry	1.77	1.76	1.80	1.78	1.69	1.64	1.84	1.46	1.52	1.37	1.48	1.30	1.30	1.39	1.48	1.37	1.34	1.56	1.19	1.39	1.19	1.27	1.24	1.27	1.48	1.41	1.36	-22.68
A. Forest land	1.35	1.35	1.39	1.37	1.27	1.22	1.24	1.25	1.23	1.23	1.19	1.19	1.18	1.18	1.16	1.17	1.15	1.15	1.13	1.14	1.15	1.21	1.19	1.21	1.39	1.29	1.27	-5.72
B. Cropland	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	NA, NO	NA, NO	NA, NO	NO, NA	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	0.07	0.09	0.12	0.09	-78.05
D. Wetlands	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, NA	NO, NA	NO, NA	NA, NO	NO, NA	0.00
E. Settlements	NO	NO	NO	NO	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
F. Other land	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, NA	NO, NA	NO, NA	NO, NA	NO, NA	0.00
G. Harvested wood products																												
H. Other	NA	NA	NA	NA	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. Waste	606.25	597.90	590.81	584.49	576.74	562.35	552.78	545.21	543.23	543.02	542.93	549.38	533.71	530.40	526.39	512.82	504.33	493.51	490.97	478.94	481.61	477.25	458.07	442.70	437.95	420.85	404.97	-33.20
A. Solid waste disposal	440.49	446.58	445.06	444.18	439.92	437.14	433.96	434.28	437.49	443.03	448.83	449.75	449.99	445.96	441.43	437.15	433.57	427.39	425.64	419.88	417.62	408.83	397.41	390.48	385.59	376.54	364.47	-17.26
B. Biological treatment of solid waste	0.13	0.20	0.24	0.30	0.37	0.46	0.80	0.87	0.88	1.22	1.29	1.29	1.58	1.19	0.98	1.57	2.15	1.91	2.01	1.95	2.73	3.13	1.94	4.26	5.49	5.17	7.34	5 635.38
C. Incineration and open burning of waste	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	NO, NA	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	100.00
D. Waste water treatment and discharge	165.63	151.12	145.50	140.02	136.46	124.75	118.03	110.06	104.86	98.77	92.81	98.35	82.14	83.25	83.99	74.10	68.82	64.20	63.33	57.11	61.26	65.29	58.71	47.97	46.87	39.14	33.16	-79.98
E. Other	NO	NO	NO	NO	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
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	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 with CH_4 from LULUCF	2 802.37	2 577.23	2 390.20	2 319.49	2 263.01	2 225.06	2 169.01	2 141.41	2 135.90	2 065.62	2 028.97	1 976.81	2 049.70	1 985.43	1 998.89	1 982.88	2 001.05	2 009.25	1 982.94	1 973.52	1 927.47	1 928.40	1 884.66	1 873.12	1 884.19	1 865.19	1 888.41	-32.61
Memo items:																												
International bunkers	0.17	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	0.05	0.05	0.06	0.07	-60.03
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	0.01	0.01	0.01	0.01	85.99
Navigation	0.16	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	0.04	0.04	0.04	0.05	-66.36
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	NA	NA	NA	NA	0.00
CO_2 emissions from biomass																												
CO_2 captured																												
Long-term storage of C in waste disposal sites																												
Indirect N_2O																												
Indirect CO_2																												

Table 1 - N_2O

Source: Submission 2018 v1, POLAND

	Base year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Emission changes in the last year of reporting in relation to the base year (%)
	kt																											%
1. Energy	8.66	7.41	7.33	7.42	8.10	8.38	8.53	9.01	9.24	8.57	8.54	8.52	8.32	8.18	8.38	8.55	8.73	8.17	8.02	8.01	7.92	8.29	8.36	8.32	8.13	7.84	7.87	-9.09
A. Fuel combustion (sectoral approach)	8.66	7.41	7.33	7.42	8.10	8.38	8.53	9.01	9.24	8.56	8.54	8.52	8.32	8.18	8.38	8.55	8.73	8.17	8.02	8.01	7.92	8.29	8.36	8.32	8.13	7.84	7.87	-9.11
1. Energy industries	3.71	3.43	3.39	3.26	3.06	3.02	2.78	2.88	2.80	2.69	2.61	2.55	2.58	2.48	2.60	2.58	2.61	2.69	2.66	2.60	2.58	2.68	2.74	2.75	2.70	2.58	2.60	-30.08
2. Manufacturing industries and construction	0.59	0.60	0.57	0.54	0.69	0.71	0.96	1.02	0.94	0.75	0.65	0.65	0.58	0.55	0.53	0.54	0.48	0.50	0.52	0.49	0.45	0.50	0.54	0.53	0.57	0.59	0.60	1.07
3. Transport	1.35	1.11	1.04	1.00	0.85	1.11	1.15	1.21	1.27	1.32	1.42	1.28	1.26	1.21	1.28	1.40	1.51	1.57	1.68	1.71	1.72	1.81	1.83	1.75	1.64	1.62	1.67	23.30
4. Other sectors	3.00	2.27	2.33	2.62	3.49	3.53	3.63	3.89	4.22	3.80	3.86	4.04	3.90	3.93	3.96	4.03	4.13	3.42	3.16	3.20	3.17	3.31	3.26	3.29	3.22	3.05	3.01	0.23
5. Other	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, IE	NO, IE	NO, IE	NO, IE	NO, IE	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	0.00	0.00	0.00	0.00	121.86
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	NA	NA	NA	NA	0.00
2. Oil and natural gas and other emissions from energy production	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	0.00	0.00	0.00	0.00	121.86
C. CO2 transport and storage																												
2. Industrial processes	16.51	12.27	10.98	10.81	12.26	12.24	13.50	13.50	12.74	11.85	11.67	14.11	14.46	12.08	14.29	14.62	15.29	15.20	15.77	13.37	3.93	4.15	3.83	4.19	3.30	2.89	2.96	-82.09
A. Mineral industry																												
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	3.71	3.39	3.75	2.86	2.44	2.51	-84.39
C. Metal industry	NA	NA	NA	NA	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. Non-energy products from fuels and solvent use	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
E. Electronic industry																												
F. Product uses as ODS substitutes																												
G. Other product manufacture and use	0.40	0.40	0.41	0.41	0.41	0.41	0.41	0.42	0.42	0.42	0.42	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.44	0.44	0.44	0.44	0.44	0.44	0.44	10.70
H. Other	NO	NO	NO	NO	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. Agriculture	70.67	69.51	55.84	50.69	51.70	51.29	53.11	53.03	53.28	53.86	51.65	50.42	50.77	49.57	47.85	49.06	48.77	51.11	53.26	53.79	52.61	50.87	52.26	52.06	53.31	52.63	49.72	-29.64
A. Enteric fermentation																												
B. Manure management	10.50	10.39	10.10	9.67	8.81	8.84	8.72	8.34	8.47	8.55	8.30	7.77	7.78	7.77	7.58	7.18	7.37	7.76	7.77	7.44	7.12	7.24	7.15	6.86	6.76	6.91	7.01	-33.27
C. Rice cultivation																												
D. Agricultural soils	60.13	59.09	45.71	40.99	42.85	42.42	44.35	44.66	44.78	45.27	43.31	42.61	42.95	41.77	40.24	41.85	41.37	43.32	45.46	46.31	45.45	43.60	45.08	45.16	46.52	45.69	42.68	-29.02
E. Prescribed burning of savannas	NO	NO	NO	NO	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
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	0.04	0.04	0.04	0.04	-2.33
G. Liming																												
H. Urea application																												
I. Other carbon-containing fertilizers																												
J. Other	NA	NA	NA	NA	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
4. Land Use, Land-Use Change and Forestry	0.57	0.61	0.69	0.87	1.97	1.06	1.17	1.13	1.12	1.22	1.25	1.28	1.39	1.38	1.43	1.49	1.51	1.57	1.76	1.82	1.94	2.12	2.17	2.41	2.49	3.64	3.67	542.22
A. Forest land	0.03	0.04	0.02	0.17	0.03	0.04	0.03	0.07	0.04	0.04	0.04	0.04	0.02	0.05	0.11	0.06	0.05	0.03	0.05	0.03	0.03	0.03	0.02	0.04	0.01	0.02	0.02	-35.60
B. Cropland	NA, NO	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	0.00	0.00	0.00	100.00
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	0.00	0.00	0.00	0.00	-78.05
D. Wetlands	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, NA	NO, NA	NO, NA	NA, NO	NO, NA	0.00
E. Settlements	0.53	0.57	0.66	0.70	1.93	1.01	1.13	1.06	1.08	1.17	1.21	1.24	1.37	1.33	1.31	1.43	1.46	1.54	1.71	1.79	1.91	2.09	2.14	2.37	2.48	3.62	3.65	583.13
F. Other land	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, NA	NO, NA	NO, NA	NO, NA	NO, NA	0.00
G. Harvested wood products																												
H. Other	NA	NA	NA	NA	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. Waste	2.57	2.46	2.50	2.50	2.47	2.40	2.45	2.47	2.43	2.55	2.56	2.57	2.60	2.60	2.62	2.59	2.63	2.61	2.64	2.62	2.74	2.82	2.79	2.94	3.05	3.05	3.17	23.72
A. Solid waste disposal																												
B. Biological treatment of solid waste	0.01	0.01	0.01	0.02	0.02	0.03	0.05	0.05	0.05	0.07	0.08	0.08	0.09	0.07	0.06	0.09	0.13	0.11	0.12	0.12	0.16	0.19	0.12	0.26	0.33	0.31	0.44	5 635.38
C. Incineration and open burning of waste	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.06	0.05	0.05	0.07	0.06	0.08	0.06	0.06	0.07	0.06	0.07	0.08	0.09	0.11	0.13	0.17	0.19	0.18	465.92
D. Waste water treatment and discharge	2.53	2.43	2.46	2.46	2.43	2.35	2.38	2.39	2.36	2.42	2.43	2.44	2.44	2.47	2.48	2.44	2.43	2.43	2.46	2.43	2.50	2.54	2.57	2.55	2.55	2.55	2.55	0.99
E. Other	NO	NO	NO	NO	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
6. Other (as specified in the summary table in CRF)	NO	NO	NO	NO	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 direct N2O emissions with N2O from LULUCF	98.97	92.27	77.34	72.30	76.50	75.36	78.75	79.14	78.81	78.05	75.66	76.90	77.53	73.80	74.56	76.32	76.94	78.67	81.44	79.60	69.14	68.25	69.41	69.92	70.29	70.05	67.39	-31.90
Memo items:																												
Aviation	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	85.99
Navigation	0.05	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	0.01	0.01	0.01	0.02	-66.36
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	NA	NA	NA	NA	0.00
CO2 emissions from biomass																												
CO2 captured																												
Long-term storage of C in waste disposal sites																												
Indirect N2O	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indirect CO2 (3)																												

Table 1 – HFC, PFC, SF_6, NF_3

Source: Submission 2018 v1, POLAND																												
	Base year (kt)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Emission changes in the last year of reporting in relation to the base year (%)
	kt																											%
Emissions of HFCs and PFCs - (kt CO2 equivalent)	147.26	141.87	141.31	134.63	144.86	152.78	306.66	496.57	654.38	744.18	949.18	1 554.76	2 134.89	2 731.37	3 306.04	3 965.25	4 776.29	5 463.50	6 070.61	6 385.55	6 199.19	6 919.20	7 552.38	7 891.29	8 292.90	8 929.71	8 962.06	5 985.97
Emissions of HFCs - (kt CO2 equivalent)	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	134.69	335.49	481.02	569.32	780.47	1 378.08	1 937.55	2 524.04	3 104.97	3 760.17	4 588.89	5 269.92	5 885.98	6 222.43	6 181.23	6 902.13	7 536.17	7 875.88	8 278.26	8 915.81	8 948.85	100.00
HFC-23	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-32	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.02	0.02	0.04	0.05	0.08	0.10	0.11	0.16	0.21	0.23	0.25	0.28	0.30	0.31	0.32	0.29	100.00
HFC-41	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	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-43-10mee	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-125	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.03	0.05	0.05	0.06	0.07	0.11	0.15	0.19	0.25	0.30	0.36	0.39	0.49	0.49	0.53	0.59	0.65	0.69	0.72	0.78	0.77	100.00
HFC-134	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-134a	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.02	0.11	0.19	0.22	0.28	0.41	0.60	0.75	0.81	1.02	1.33	1.55	1.49	1.49	1.15	1.21	1.29	1.35	1.39	1.46	1.42	100.00
HFC-143	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-143a	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.01	0.01	0.02	0.08	0.12	0.17	0.23	0.26	0.30	0.36	0.43	0.49	0.55	0.63	0.69	0.72	0.76	0.83	0.87	100.00
HFC-152	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-152a	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	0.01	0.00	0.00	0.03	0.03	0.20	0.42	0.48	0.49	0.41	0.47	0.26	100.00
HFC-161	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-227ea	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	100.00
HFC-236cb	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-236ea	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-236fa	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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
HFC-245ca	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-245fa	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-365mfc	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	0.00	0.00	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00
Unspecified mix of HFC (kt CO_2 eq.)	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
CF_4	0.01779956	0.017148302	0.017080789	0.016273244	0.017509366	0.018466857	0.020786544	0.019367652	0.01999802	0.02020466	0.0190133	0.01952096	0.0203658	0.0219324	0.02135052	0.02198126	0.01998609	0.02086525	0.01991037	0.01743029	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	
C_2F_6	0.00128844	0.001241298	0.001236411	0.001177956	0.001267434	0.001336743	0.001504656	0.001401948	0.00144758	0.00146254	0.0013763	0.00141305	0.0014742	0.0015876	0.00154548	0.00159114	0.00144671	0.00151035	0.00144123	0.00126171	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	
C_3F_8	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	NA, NO	NA, NO	NA, NO	NA, NO	0
C_4F_{10}	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.0000952	0.00089337	0.00086938	0.00128828	0.00171346	0.00325677	0.00292112	0.00275882	0.00262088	0.00248984	0.00236534	0.00224708	0.00213472	0.00202799	0.00192659	0.00183026	0.00173875	0.00165181	0.00156922	0.00149076	100.00
c-C_4F_8	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	NA, NO	NA, NO	NA, NO	NA, NO	0
C_5F_{12}	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	NA, NO	NA, NO	NA, NO	NA, NO	0
C_6F_{14}	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	NA, NO	NA, NO	NA, NO	NA, NO	0
C10F18	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	NA, NO	NA, NO	NA, NO	NA, NO	0
c-C3F6	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	NA, NO	NA, NO	NA, NO	NA, NO	0
Unspecified mix of PFCs (kt CO_2 eq.)	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	NA, NO	NA, NO	NA, NO	NA, NO	0
Unspecified mix of HFC and PFC (kt CO_2 eq.)	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00
SF_6	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	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	100.00
NF_3	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	NA, NO	NA, NO	NA, NO	NA, NO	0.00

Table 2. Description of quantified economy-wide emission reduction target[a]

Emission reduction target: base year and target			
Base year/base period			1990
Emission reduction target (% of base year/base period)			20%
Emission reduction target (% of year 1990)[b]			
Period for reaching target			BY-2020
Gases and sectors covered. GWP values			
Gases covered	Included?	Base year	GWP[c] Reference source
CO_2	Yes	1990	AR4
CH_4	Yes	1990	AR4
N_2O	Yes	1990	AR4
HFCs	Yes	1990	AR4
PFCs	Yes	1990	AR4
SF_6	Yes	1990	AR4
NF_3	No		AR4
Other gases[d]			
Sectors covered[e]			Included?
Energy			Yes
Transport[f]			Yes
Industrial processes[g]			Yes
Agriculture			Yes
LULUCF			No
Waste			Yes
Other sectors[h]			
Aviation in the scope of EU ETS	Regulation (EU) No 421/2014 of the European Parliament and of the Council of 16 April 2014		
Role of LULUCF sector			
LULUCF in the base year level and target			excluded
Contribution of LULUCF is calculated using:			
Market mechanisms			
Possible scale of contributions of market-based mechanisms under the Convention (estimated kt CO2 eq)			
CERs units			NA
ERUs units			NA
AAUs units[i]			NA
Carry-over units[j]			NA
Other mechanism units under the Convention[k]			
Possible scale of contributions of other market-based mechanisms (estimated kt CO2 eq)			
Any other information			
Any other information:[l]			

Table 2 gives 1990 as the base year for Poland, which results from the commitment to reduce greenhouse gas emissions by the EU adopted in 2010 under the UNFCCC. If the reduction target is accounted for under the Doha Amendment to the Kyoto Protocol, the base year for Poland includes the emissions of CO_2, CH_4 and N_2O in 1988 and fluorinated gases in 1995 (see Chapter 4.1 of the report).

[a] The reporting by developed countries of the information specified in the common formatting tables does not prejudge the position of other countries regarding the treatment of entities coming from market mechanisms under the convention or other market mechanisms used to achieve the reduction target

[b] Optional

[c] Please provide references for GWP: Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) or the Fourth Assessment Report of the IPCC.

[d] Name the other gases

[e] You can choose more than one option. If the parties use other sectors than presented, please attach information on the relationship between the sectors used and those defined by the IPCC

[f] Transport is reported as part of the energy sector

[g] The industrial processes sector covers emissions from industrial processes and the use of solvents and other products

[h] Name the other sectors

[i] AAUs issued or obtained by the Party

[j] Units transferred from the first to the second commitment period in accordance with Decisions 13/CMP.1 and 1/CMP.8.

[k] As indicated in paragraph 5 (e) of the guidelines contained in Annex I to Decision 2/CP.17.

[l] Here you can enter information about the national legal status of the target or the allocated number of emission units defining the target. Some of this information should be included in the descriptive part of the biennial report.

Table 3. Progress in achieving the reduction target: information on activities leading to the reduction of greenhouse gas emissions

No	Activity	Inclusion in the scenario "with activities" (yes/no)	Sector covered by the activity	Greenhouse gas	Target/Activity	Type of instrument	Implementation status (W – implemented; P – planned)	Description	Year of implementation	Implementing institution	Quantitative assessment of the impact on emission reduction [kt CO_2 eq./year] in 2020
1	Implementation of the Greenhouse Gas Emission Trading Scheme (EU ETS)	Yes	Cross-cutting	CO_2, N_2O, PFCs	Reducing emissions in the EU by 21% compared to 2005	Legal	W	Reducing emissions in a cost-effective and economically efficient way	2005	Minister responsible for the environment	20344
2	Effort Sharing Decision (ESD)	Yes	Cross-cutting	CO_2, N_2O, CH_4, HFC, PFC, SF_6	Not exceeding the limit of specific emissions in the sectors of the "non-EU ETS" (transport – except for international aviation and shipping, agriculture, construction and the municipal and household sector)	Legal	W	Reduction of emissions in sectors not covered by the EU ETS	2013	Minister responsible for the environment	12111
3	National Green Investment Scheme (GIS)		Cross-cutting	CO_2	Creation and strengthening of the pro-ecological effect resulting from disposal of assigned emission units(Assigned Amount Units – AAU)	Financial	W	Implementation of projects related to avoiding or reducing greenhouse gases emissions	2009	Minister responsible for the environment, NFOŚiGW	1734.7
4	Enhancing the use of renewable energy sources, including biofuels	Yes	Production and use of energy	CO_2	15% share of RES in gross final energy and 10% share of renewable energy in transport in 2020.	legal, organizational	W	A system of support mechanisms to increase energy from renewable sources	2010	Minister responsible for energy	35 396 avoided CO_2 emission
5	Nuclear Power Programme for Poland	Yes	Production and use of energy	CO_2	Change in the structure of electricity generation, i.e. gradual limitation of use sources with high CO_2 emissions which are replaced by zero-emission and low-emission sources	legal, organizational, financial	W	Construction of two nuclear power plants with combined total capacity of 6,000 MW	2014	Minister responsible for energy	-
6	National Energy Efficiency Action Plan for Poland 2014	Yes	Production and use of energy	CO_2	Limiting the final energy consumption by 8.27 Mtoe in 2020 thanks to improved energy efficiency	legal, organizational, financial, educational	W, P	Energy saving among end users obtained as a result of many already implemented and planned activities.	2012	Minister responsible for economy, Minister responsible for infrastructure and development, Minister responsible for environment, NFOŚiGW, BGK, EBRD, Centre for EU Transport Projects (CUPT)	16026 avoided CO_2 emission

7	Clean Transport Package		Production and use of energy	CO_2	Development of electromobility, development of alternative fuels infrastructure	legal, finacial, organizational	P	A support system for producers and consumers of vehicles powered by alternative fuels	2017	Minister responsible for energy, Minister responsible for economy	
8	Support for the use of methane from hard coal mines to produce electricity and heat	Yes	Production and use of energy	CH_4	Increased utilization of methane from mine coal seams	legal, financial, research	W	Industrial use of methane from demethanization of coal mines	2007	Minister responsible for economy	405
9	Reduction of methane emissions from fuel production and distribution		Production and use of energy	CH_4	Savings in liquid fuels trading (mean 0.37%)	legal	W	Introduction of hermetic sealing systems at gas stations	2005	Minister responsible for economy	
10	The use of fluorinated greenhouse gases		Industrial processes	HFC, PFC, SF_6	Emission limitations in the refrigeration, air conditioning, fire protection and power engineering sectors	legal	W	Introduction of a mechanism to control gas consumption	2015	Minister responsible for environment	
11	Package for road transport		Transport	CO_2	Decrease of GHG emission growth rate from road transport	legal, financial, technical, educational	W, P	The package of instruments and activities includes modernization and construction of road infrastructure smoothing road traffic, improvement of energy efficiency and road vehicle emissions, promotion of public transport, optimal traffic management, shaping environmentally aware driver behavior, dissemination of the use of alternative fuels and supporting the development of non-motorized transport	2011	Minister responsible for transport, Minister responsible for environment, Minister responsible for regional development, Minister responsible for economy, National Road Safety Council, NFOŚiGW	
12	Package for rail transport		Transport	CO_2	Reduction of GHG emissions through the use of higher fuel-emission efficiency of rail transport, in particular railway transport, to carry out transport operations	legal, financial, technical, educational	W, P	Improvement of the competitiveness of this form of transport is meant for moving part of the carriages from road and air transport to rail transport. The package of instruments and activities includes: modernization of railway infrastructure and rolling stock for passenger and freight transport, strengthening of inter-branch integration, promotion of public rail transport and modernization of traffic management systems as well as the use of research support.	2007/ 2008	Minister responsible for transport, Minister responsible for regional development	
13	Package for domestic air transport		Transport	CO_2	Reducing the growth rate of greenhouse gases emissions from domestic air transport	legal, technical	W, P	The package of instruments and activities includes improvement of operational efficiency, certificates for aircraft and optimization of flights	2007	Minister responsible for transport	
14	Package for international air		Transport	CO_2, N_2O	Reducing the growth rate of greenhouse gases emissions from international air transport	legal, financial,	W, P	The package of instruments and activities includes improvement of	2007	Minister responsible for transport, Minister	1357

	transport				.	technical		operational efficiency, certificates for aircrafts, optimization of flights performed, modernization of the fleet, including this part of air transport to the EU ETS		responsible for environment – KOBiZE	
15	Package for inland waterway transport		Transport	CO_2	Reduction of GHG emissions through the use of higher fuel-emission efficiency carriages in inland waterway transport	legal, financial, technical	W, P	The improvement of competitiveness of this mode of transport is to transfer part of the carriages from road and air transport to inland waterway transport. The package of instruments and activities includes the modernization of waterways and the inland navigation fleet as well as the requirements for pollutant emissions.	2011	Minister resposible for inland navigation/water management	12
16	Package for maritime shipping		Transport	CO_2	The aim of the activities is to reduce GHG emissions through the use of higher fuel-emission efficiency shimpent in maritime transport	legal, financial, technical	W, P	The improvement of competitiveness of this mode of transport is to transfer part of the carriages from road and air transport to maritime transport. The package of instruments and activities includes fuel requirements, a project energy efficiency indicator, the development and modernization of harbour infrastructure, including intermodal infrastructure, and the improvement of harbour access from land and sea	2009	Minister responsible for maritime economy	
17	Urban-Building Code		Construction and housing	CO_2	Introduction of spatial management principles conducive to counteracting the effects of climate change and adaptation to the effects of these changes	legal, organizational	P	The framework for territorial self-government units for conducting a spatial policy favoring reduction of greenhouse gases emissions and adaptation to the effects of climate change	2018	Minister responsible for construction engineering	–
18	Rationalization of the use of fertilizers, including nitrogen fertilizers	Yes	Agriculture	N_2O	Optimization of fertilization and limitation of negative effects on the environment	legal, organizational	W	A system of activities supporting the effective use of fertilizers	2007	Minister responsible for agriculture	NA
19	Afforestation of agricultural land and afforestation of non-agricultural land	No	Agriculture	CO_2	Increased CO_2 sequestration in forest areas	legal, organizational, financial	W	Afforestation of agricultural land and of non-agricultural land under the Rural Development Programme (PROW)	2007	Agency for Restructuring and Modernisation of Agriculture (ARiMR), farmers	1435.79
20	Restoring the forest production potential destroyed by disasters and implementing preventive measures	No	Agriculture	CO_2	Increasing CO_2 sequestration in forest areas	financial	W	Renewal and maintenance of forest stands damaged by disasters and prevention of disasters	2007	ARiMR, farmers	–
21	Sustainable management of agricultural land	No	Agriculture	CO_2	Increasing the efficiency of fertilizers used and limiting the mineralization of organic matter in the soil	legal, organizational, financial,	W	Observance of good agricultural culture practices in order to inhibit the mineralization of organic soils	2005	research institutes, farmers, advisors, agricultural	

						Research, educational				machinery industry	
22	Support for adaptation and reduction measures in agricultural holdings		Agriculture	CO_2	Harmonizing the conditions of agricultural production with the requirements of environmental protection	financial	W	Supporting investments contributing to the reduction of greenhouse gases emissions	2007	ARiMR, farmers	
23	Improvement of monogastric livestock systems, reduction of methane emissions from livestock manure	Yes	Agriculture	CH_4, N_2O	Changes in animal nutrition and waste management	Research	W	Research and implementation works regarding the development of new technological systems of buildings and new methods of maintaining livestock	1999	research institutes, farmers	
24	Elimination of gaseous pollutants emitted from livestock buildings		Agriculture	CH_4, N_2O	Eliminating emissions from livestock buildings	Research	W	Research and implementation works on conversion into energy of methane and nitrous oxide contained in ventilated air from livestock rooms	1999	research institutes, manufacturing companies	
25	National waste management plan 2022		Waste	CH_4, CO_2	Achieving 50% recycling levels and preparing for the re-use of paper, metals, plastics and glass by 2020	legal, organizational	W	An action system for waste management aimed at increasing the level of waste recycling, reducing the amount of biodegradable waste deposited in landfills and increasing energy production as a result of thermal waste treatment processes	2016	Minister responsible for environment	[1)]emission “avoided” 4345
26	Counteracting changes in land use	No	Forestry	CO_2	Increasing CO_2 sequestration	legal	W	Maintenance of existing forest areas	1991	State Forests National Forest Holding	NA
27	Rationalization of forest management, incentives and measures to support afforestation and protection of ecological stability of forests	Yes	Forestry	CO_2	Increasing CO_2 sequestration	legal	W	Afforestation of non-forest areas, reforestation, increase of stocks on the trunk and harvesting of wood, which can not exceed 50–60% of annual growth	1991	State Forests National Forest Holding	NA

Table 4. Report on progress in achieving the reduction target

Unit	Unit	Base year/period	2010	2011	2012	2013	2014	2015	Comments
Total emission (excluding LULUCF sector)	kt CO_2 eq.	570 370.88	406 973.16	406 419.78	399 071.85	395 532.34	382 969.30	385 842.89	
LULUCF sector share	kt CO_2 eq.	NA	NA	NA	NA	NA	NA	NA	Not included: LULUCF balance data not reported because this sector has not been included in the reduction target of the convention
Market mechanisms in the frame of the convention	number of units	NA	NA	NA	NA	NA	NA	NA	Not included: units from mechanisms have been not taken into account in the settlement of the I period of the Kyoto Protocol
Other market mechanisms	number of units	NA	NA	NA	NA	NA	NA	NA	Not included: lack of other market mechanisms

Table 4(a) I. Progress in achieving the reduction target - further information on mitigation relevant to the LULUCF sector

	Unit	Net emissions/removals balance	Base year/period value	Contribution from LULUCF for the reported year	Cumulative contribution from LULUCF	Accounting approach
2015						
Total LULUCF	kt CO_2 eq.					
A. Forest land	kt CO_2 eq.					
1. Forest land remaining forest land	kt CO_2 eq.					
2. Land converted to forest land	kt CO_2 eq.					
3. Other	kt CO_2 eq.					
B. Cropland	kt CO_2 eq.					
1. Cropland remaining cropland	kt CO_2 eq.					
2. Land converted to cropland	kt CO_2 eq.					
3. Other	kt CO_2 eq.					
C. Grassland	kt CO_2 eq.					
1. Grassland remaining grassland	kt CO_2 eq.					
2. Land converted to grassland	kt CO_2 eq.					
3. Other	kt CO_2 eq.					
D. Wetlands	kt CO_2 eq.					
1. Wetlands remaining wetlands	kt CO_2 eq.					
2. Land converted to wetlands	kt CO_2 eq.					
3. Other	kt CO_2 eq.					
E. Settlements	kt CO_2 eq.					
1. Settlements remaining settlements	kt CO_2 eq.					
2. Land converted to settlements	kt CO_2 eq.					
3. Other	kt CO_2 eq.					
F. Other land	kt CO_2 eq.					
1. Other land remaining other land	kt CO_2 eq.					
2. Land converted to other land	kt CO_2 eq.					
3. Other	kt CO_2 eq.					
G. Other	kt CO_2 eq.					
Harvested wood products	kt CO_2 eq.					

2016						
Total LULUCF	kt CO_2 eq.					
A. Forest land	kt CO_2 eq.					
1. Forest land remaining forest land	kt CO_2 eq.					
2. Land converted to forest land	kt CO_2 eq.					
3. Other	kt CO_2 eq.					
B. Cropland	kt CO_2 eq.					
1. Cropland remaining cropland	kt CO_2 eq.					
2. Land converted to cropland	kt CO_2 eq.					
3. Other	kt CO_2 eq.					
C. Grassland	kt CO_2 eq.					
1. Grassland remaining grassland	kt CO_2 eq.					
2. Land converted to grassland	kt CO_2 eq.					
3. Other	kt CO_2 eq.					
D. Wetlands	kt CO_2 eq.					
1. Wetlands remaining wetlands	kt CO_2 eq.					
2. Land converted to wetlands	kt CO_2 eq.					
3. Other	kt CO_2 eq.					
E. Settlements	kt CO_2 eq.					
1. Settlements remaining settlements	kt CO_2 eq.					
2. Land converted to settlements	kt CO_2 eq.					
3. Other	kt CO_2 eq.					
F. Other land	kt CO_2 eq.					
1. Other land remaining other land	kt CO_2 eq.					
2. Land converted to other land	kt CO_2 eq.					
3. Other	kt CO_2 eq.					
G. Other	kt CO_2 eq.					
Harvested wood products	kt CO_2 eq.					

LULUCF balance data for 2015 and 2016 are not reported because this sector has not been included in the reduction target of the convention.

Table 4 (a) II. Progress in achieving the reduction target – further information on mitigation relevant to the counting of emissions and removals under articles 3.3. and 3.4 of the Kyoto Protocol

Submission 2018 v1, POLAND												
Greenhouse gases emissions and removals – activities under articles 3.3. and 3.4 of the Kyoto Protocol	**Base year**	**Net emissions/removals**									**Accounting parameters**	**Accouting quantity**
		2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**Total**		
	(kt CO_2 equivalet)											
A. Art. 3.3												
A.1. Afforestation/Reforestation		-2 844.38	-2 818.22	-2 851.87						-8 514.46		-8 514.46
Excluded emissions from natural disturbances		NA	NA	NA						NA		NA
Excluded subsequent removals from land subject to natural disturbances		NA	NA	NA						NA		NA
A.2. Deforestation		203.67	316.94	301.57						822.18		822.18
B. Art. 3.4												
B.1. Forest management										-117 549.87		-36 150.87
Net emissions/removalse		-45 448.98	-38 107.10	-33 993.79						-117 549.87		
Excluded emissions from natural disturbances(5)		NA	NA	NA						NA		NA
Excluded subsequent removals from land subject to natural disturbances(6)		NA	NA	NA						NA		NA
Any debits from newly established forest (CEF-ne)(7),(8)												
Forest management reference level (FMRL)											-27 133.00	
Technical corrections for FMRL											NA	
Forest management cap											20 300.70	-20 300.70
B.2. Cropland management (if selected)	NA	NA	NA	NA						NA		NA
B.3. Grassland management (if selected)	NA	NA	NA	NA						NA		NA
B.4. Revegetation (if selected)	NA	NA	NA	NA						NA		NA
B.5. Wetland drainage and rewetting (if selected)	NA	NA	NA	NA						NA		NA

Table 5. Summary of key variables and assumptions used in the emission projections analysis

Key underlying assumpions		Historical							Projected				
	Unit	1990	1995	2000	2005	2010	2011	2015	2020	2025	2030	2035	2040
Population	thousands								38 138	37 741	37 185	36 477	35 668
Primary energy consumption	Mtoe								103.3	103.3	102.5	99.5	97.3
Gross electicity production	TWh								177.9	187.5	206.8	221.4	229.7
GDP growth rate	%								4.0		2.9		2.5
Cattle population	thousands								5 910	5 868	5 800	5 655	5 600
Nitrogen fertilisers use	kt								1 175	1 250	1 300	1 300	1 300
Municipal solid waste generation	kt								11 330	11 797	12 280	12 280	12 280
Clinker cement production	kt								13 000	14 000	15 000	15 600	16 500
Lime production	kt								1 580	1 522	1 466	1 466	1 466
Ammonia production	kt								2 944	3 036	3 022	3 022	3 022
Nitric acid production	kt								2 579	3 196	3 177	3 177	3 177
Iron ore sinter production	kt								9 604	9 604	9 604	9 604	9 604
Pig iron production	kt								5 786	6 494	6 494	6 494	6 494

Table 6 (a). Information on updated greenhouse gases emission projections

									GHG emission projections - scenarios				
		GHG emissions and removals							With measures				
GHG emissions projections	**Unit**	**Base year**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Sector													
Energy	kt CO_2 eq.	450 778.96	361 503.91	343 579.94	293 219.56	294 837.49	290 979.56	269 471.88	262 018.41	247 513.44	228 114.48	194 709.32	195 095.06
Transport	kt CO_2 eq.	24 189.07	20 497.04	23 087.38	27 806.26	35 329.35	48 172.76	46 637.99	53 842.65	57 006.06	56 792.16	55 173.38	55 173.38
Industry/industrial processes	kt CO_2 eq.	31 198.21	22 693.33	22 691.59	23 802.06	25 450.80	24 897.11	28 525.12	29 180.59	30 880.64	31 903.33	32 572.93	33 360.15
Agriculture	kt CO_2 eq.	47 835.68	47 155.60	34 732.58	31 005.77	29 511.99	29 717.72	29 649.89	31 029.39	32 027.68	32 320.47	32 140.06	32 158.36
Forestry/LULUCF	kt CO_2 eq.	-16 806.83	-25 730.45	-14 613.22	-31 463.13	-45 660.94	-30 724.36	-28 844.99	-21 820.22	-18 446.49	-13 796.38	-11 804.84	-9 500.20
Waste/waste management	kt CO_2 eq.	16 368.96	16 031.20	14 849.87	14 763.84	13 812.94	13 206.01	11 558.01	11 922.22	11 945.93	11 802.59	11 688.53	11 606.97
Other sectors													
Gas													
CO_2 emissions including net CO_2 from LULUCF	kt CO_2 eq.	453 865.18	350 082.31	346 298.38	285 220.31	275 525.14	300 746.11	280 665.84	291 732.13	285 517.76	271 877.46	239 473.91	242 783.55
CO_2 emissions excluding net CO_2 from LULUCF	kt CO_2 eq.	470 886.43	376 039.78	361 305.16	317 098.60	321 670.63	332 132.43	310 638.59	314 091.83	304 566.17	286 338.15	252 005.49	253 072.98
CH_4 emissions including CH_4 from LULUCF	kt CO_2 eq.	70 059.30	64 430.84	54 225.29	49 420.23	50 026.26	48 209.94	47 210.15	45 469.36	45 422.73	44 681.57	44 350.03	44 258.39
CH_4 emissions excluding CH_4 from LULUCF	kt CO_2 eq.	70 015.17	64 386.78	54 179.39	49 387.68	49 992.78	48 178.30	47 176.03	45 427.52	45 381.54	44 641.04	44 310.15	44 219.10
N_2O emissions including N_2O from LULUCF	kt CO_2 eq.	29 492.30	27 495.61	23 468.69	22 916.01	22 927.11	20 338.17	20 082.82	20 817.52	21 360.26	21 552.57	21 285.71	21 178.40
N_2O emissions excluding N_2O from LULUCF	kt CO_2 eq.	29 322.01	27 312.65	23 121.04	22 533.39	22 476.06	19 707.86	18 989.19	20 319.87	20 799.54	20 928.79	20 598.86	20 428.46
HFCs	kt CO_2 eq.	0.00	0.00	134.69	1 378.08	4 588.89	6 902.13	8 948.85	8 095.06	8 565.51	8 962.32	9 305.46	9 607.75
PFCs	kt CO_2 eq.	147.26	141.87	171.97	176.68	187.41	17.07	13.21	11.53	10.74	10.10	9.55	9.08
SF_6	kt CO_2 eq.	0.00	0.00	29.12	23.07	26.80	35.37	77.03	47.44	50.25	52.63	54.71	56.55
NF_3	kt CO_2 eq.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other gases													
Total emission including LULUCF	kt CO_2 eq.	553 564.04	442 150.63	424 328.15	359 134.37	353 281.62	376 248.79	356 997.90	366 173.04	360 927.26	347 136.65	314 479.37	317 893.70
Total emission excluding LULUCF	kt CO_2 eq.	570 370.88	467 881.09	438 941.37	390 597.49	398 942.56	406 973.16	385 842.89	387 993.26	379 373.75	360 933.03	326 284.21	327 393.91

Table 7. Provision of public bilateral and multilateral financial support in 2015

Allocation channels	EUR					PLN				
	Core/general	Climate-specific				Core/general	Climate-specific			
		Mitigation	Adaptation	Cross-cutting	Other		Mitigation	Adaptation	Cross-cutting	Other
Total contributions through multilateral channels	20 224 145.20			3 024 426.00		84 615 800.91				
Multilateral climate change fund										
Other multilateral climate change funds	20 224 145.20					84 615 800.91				
Specialized United Nations bodies				3 024 426.00					12 653 895.95	
Total contributions through bilateral. regional and other channels		968 700.68	1 481 091.71	199 713.30			4 052 946.76	6 196 739.62	835 580.47	
Total		**5 673 931.69**					23 739 162.79			

Note: exchange rates 1 USD = 3.7701 PLN; 1 USD = 0.9011 EUR

Table 7. Provision of public bilateral and multilateral financial support in 2016

Allocation channels	EUR					PLN				
	Core/general	Climate-specific				Core/general	Climate-specific			
		Mitigation	Adaptation	Cross-cutting	Other		Mitigation	Adaptation	Cross-cutting	Other
Total contributions through multilateral channels				3 258 944.43					14 217 145.08	
Multilateral climate change fund										
Other multilateral climate change funds										
Multilateral financial institutions. including regional development banks	26 741 933.14					116 661 683.32				
Specialized United Nations bodies				3 258 944.43					14 217 145.08	
Total contributions through bilateral. regional and other channels		1 036 340.67	1 041 418.78	42 310.50	0.00		4 521 036.16	4 543 189.41	184 579.56	0.00
Total		**5 379 014.38**					**23 465 950.21**			

Note: exchange rates 1 USD = 3.9431PLN; 1 USD = 0.9039EUR

Table 7(a). Provision of public financial support: contribution through multilateral channels in 2015

Donor	Total				Status	Funding source	Finanacial instrument	Type of support	Sector
	Core/general		Climate-specific						
	EUR	PLN	EUR	PLN	Disbursed, 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
Total contribution through mulitlateral channels									
1. Global Environment Facility									
2. Least Developed Countries Fund									
3. Special Climate Change Fund									
4. Adaptation Fund									
5. Green Climate Fund									
6. UNFCCC Trust Fund for Supplementary Activities									
7. Other multilateral climate change funds									
Subotal									
Multilateral financial institutions. including regional development banks									
1. World Bank									
IDA	3 291 897.23	13 772 968.80			disbursed	ODA	grant	cross-cutting	cross-cutting
IBRD	23 690 595.81	103 350 224.22			disbursed	ODA	grant	cross-cutting	cross-cutting
2. International Finance Corporation									
3. African Development Bank									

Donor	Total				Status	Funding source	Finanacial instrument	Type of support	Sector
	Core/general		Climate-specific						
	EUR	PLN	EUR	PLN	Disbursed, 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
4. European Bank for Reconstruction and Development									
5. Inter-American Development Bank									
Other	32 558.12	142 034.80			disbursed	ODA	grant	cross-cutting	cross-cutting
Subtotal	**26 741 933.14**	**116 661 683.32**							
Specialized United Nations bodies									
United Nations Development Programme (UNDP)									
United Nations Environment Programme (UNEP)			203 824.14	889 182.80	disbursed	ODA	grant	cross-cutting	cross-cutting
UNFCCC			158 440.70	691 197.55	disbursed	ODA	grant	cross-cutting	cross-cutting
Kyoto Protocol			85 385.63	372 494.82	disbursed	ODA	grant	cross-cutting	cross-cutting
UNCCD			71 428.22	311 605.60	disbursed	ODA	grant	cross-cutting	cross-cutting
Other									
IAEA – TCF			648 040.00	2 827 074.50	disbursed	ODA	grant	cross-cutting	cross-cutting
WMO			668 802.76	2 917 652.03	disbursed	ODA	grant	cross-cutting	cross-cutting
EPPO			72 682.38	317 076.88	disbursed	ODA	grant	cross-cutting	agriculture

Donor	Total				Status	Funding source	Finanacial instrument	Type of support	Sector
	Core/general		Climate-specific						
	EUR	PLN	EUR	PLN	Disbursed, 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 Fund for the Implementation of the Montreal Protocol			1 300 747.05	5 674 509.00	disbursed	ODA	grant	cross-cutting	cross-cutting
CITES			49 183.40	214 562.60	disbursed	ODA	grant	cross-cutting	cross-cutting
IUNC			410.15	1 789.30	disbursed	ODA	grant	cross-cutting	cross-cutting
Subtotal			**3 258 944.43**	**14 217 145.08**					
Total	**26 741 933.14**	**116 661 683.32**	**3 258 944.43**	**14 217 145.08**					

Note: exchange rates 1 USD = 3.7701 PLN; 1 USD = 0.9011 EUR

Table 7(a). Provision of public financial support: contribution through multilateral channels in 2016

Donor	Total				Status	Funding source	Finanacial instrument	Type of support	Sector
	Core/general		Climate-specific						
	EUR	PLN	EUR	PLN	Disbursed Committed Pledged	ODA OOF Other	Grant Concessional loan Non-concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Core/general
Total contribution through mulitlateral channels									
1. Global Environment Facility									
2. Least Developed Countries Fund									
3. Special Climate Change Fund									
4. Adaptation Fund									
5. Green Climate Fund									
6. UNFCCC Trust Fund for Supplementary Activities									
7. Other multilateral climate change funds									
Subotal									
Multilateral financial institutions. including regional development banks									
1. World Bank									
IDA	3 018 779.21	13 169 424.30			disbursed	ODA	grant	cross-cutting	cross-cutting
IBRD	23 690 595.81	103 350 224.22			disbursed	ODA	grant	cross-cutting	cross-cutting
2. International Finance Corporation									
3. African Development Bank									
4. European Bank for Reconstruction and Development									
5. Inter-American Development Bank									

Donor	Total				Status	Funding source	Finanacial instrument	Type of support	Sector
	Core/general		Climate-specific						
	EUR	PLN	EUR	PLN	Disbursed Committed Pledged	ODA OOF Other	Grant Concessional loan Non-concessional loan Equity Other	Mitigation Adaptation Cross-cutting Other	Core/general
Other (Council of Europe Development Bank)	32 558.12	142 034.80			disbursed	ODA	grant	cross-cutting	cross-cutting
Subtotal	**26 741 933.14**	**116 661 683.32**							
Specialized United Nations bodies									
United Nations Development Programme (UNDP)									
United Nations Environment Programme (UNEP)			203 824.14	889 182.80	disbursed	ODA	grant	cross-cutting	cross-cutting
UNFCCC			158 440.70	691 197.55	disbursed	ODA	grant	cross-cutting	cross-cutting
Kyoto Protocol			85 385.63	372 494.82	disbursed	ODA	grant	cross-cutting	cross-cutting
UNCCD			71 428.22	311 605.60	disbursed	ODA	grant	cross-cutting	cross-cutting
Other									
IAEA – TCF			648 040.00	2 827 074.50	disbursed	ODA	grant	cross-cutting	cross-cutting
WMO			668 802.76	2 917 652.03	disbursed	ODA	grant	cross-cutting	cross-cutting
EPPO			72 682.38	317 076.88	disbursed	ODA	grant	cross-cutting	agriculture
Multilateral Fund for the Implementation of the Montreal Protocol			1 300 747.05	5 674 509.00	disbursed	ODA	grant	cross-cutting	cross-cutting
CITES			49 183.40	214 562.60	disbursed	ODA	grant	cross-cutting	cross-cutting
IUNC			410.15	1 789.30	disbursed	ODA	grant	cross-cutting	cross-cutting
Subotal			**3 258 944.43**	**14 217 145.08**					
Total	**26 741 933.14**	**116 661 683.32**	**3 258 944.43**	**14 217 145.08**					

Note: exchange rates 1 USD = 3.9431 PLN; 1 USD = 0.9039 EUR

Table 7 (b). Provision of public financial support: contribution through bilateral, regional and other channels in 2015 (including capacity building)

Recipient country/ region/project/ programme	Total amount		Status	Source	Financial instrument	Obszar wsparcia	Sector	Additional information
	Climate-specific		Disbursed, committed, pledged	ODA/OOF/Other	Grant/Concessional loan/Non-concessional loan/other	Mitigation/ Adaptation/Cross-cutting/Other		
	EUR	PLN						
Georgia/Kachetia	134 266.12	561 756.00	disbursed	ODA	grant	adaptation	Flood prevention/ control	Polish Center for International Aid / Study of hydraulic modelling against floods- 1st stage – preparation to implementation of EU directive No 2007/60EC
Georgia/Kachetia	121 360.93	507 762.00	disbursed	ODA	grant	adaptation	Flood prevention/ control	Polish Center for International Aid/ Anti-flood early warning and prevention systems in Georgia: special focus on Kabali and Duruji rivers
Georgia/Tbilisi	45 430.34	190 076.00	disbursed	ODA	grant	adaptation	Advanced technical and managerial training	The Main School of Fire Service/ Development of specialized rescue skills
Ukraine	56 018.31	234 375.00	disbursed	ODA	grant	mitigation	Waste management /disposal	Foundation – Agency of Regional Development/Biogas production in water treatment plant – supporting the Lviv City programme
Ukraine / Tlumach, Ivano-Frankivsk	46 265.21	193 569.00	disbursed	ODA	grant	mitigation	Energy policy and administrative management	Associatio for innovation and technology transfer "Horizons" / Implementation of solutions using renewable energy sources and improvement of energy efficiency in the Tlumach Rajon
Ukraine / Khmielnik	38 358.23	160 487.00	disbursed	ODA	grant	adaptation	Water sector policy and administrative management	Municipality of Busko-Zdrój / The support for Chmielnik Municipality in Vinnytsia Oblast, Ukraine in its efforts to improve water resource and waste management based on EU ecological standards

Ukraine / Lviv, Tarnopol, Ivano-Frankivsk, Odessa	24 353.59	101 893.00	disbursed	ODA	grant	adaptation	Energy education/training	Marshal Office of the Podkarpackie Voivodeship / Renewable energy sources as opportunities for improving energy efficiency in Ukrainian oblasts.
Ukraine	57 571.88	240 875.00	disbursed	ODA	grant	mitigation	Energy policy and administrative management	Institute of Power Engineering / Reinforcing the capacity of public administration and local government of Ukraine in implementing solutions to improve energy efficiency and promote renewable energy in heating sector
Ukraine / Lviv Region	46 549.39	194 758.00	disbursed	ODA	grant	cross-cutting	Environmental education/ training	The Main School of Fire Service / SAFE WATER– improvement of local admninistration and rescue services activities during water emergencies response in Lviv region
Moldova	184 856.23	773 420.00	disbursed	ODA	grant	mitigation	Energy generation, renewable sources – multiple technologies	The "East" Foundation / Alternative energy sources in rural development of Moldova
Moldova / Drochia, Orhei, Causeni	108 009.51	451 901.00	disbursed	ODA	grant	mitigation	Energy generation, renewable sources – multiple technologies	Pomorski Agricultural Advisory Centre in Gdansk Department in Stare Pole / Technical and technological innovations in farms using renewable energy sources in Moldova
Kyrgyzstan	191 448.65	801 002.00	disbursed	ODA	grant	adaptation	Basic drinking water supply	East European Democratic Centre / Improving access to safe drinking water by supporting local water committees in rural areas of the Fergana Valley in Kyrgyzstan and Tajikistan.
Tajikistan	33 784.99	141 353.00	disbursed	ODA	grant	adaptation	Basic drinking water supply	East European Democratic Centre / Improving access to safe drinking water by supporting local water committees in rural areas of the Fergana Valley in Kyrgyzstan and Tajikistan.
Tajikistan / Bartang Shokhara Valley	47 801.09	199 995.00	disbursed	ODA	grant	adaptation	Basic drinking water supply	Democratic Society East / Water as a Source of Change – follow up. Support of the Village Infrastructure in Mountainnous Badakhshan
Kenya / Machakos, Kiambu, Muranga	102 052.15	426 976.00	disbursed	ODA	grant	adaptation	Disaster prevention and preparedness	Polish Center for International Aid / Training and equipment provision for Fire Brigades in Kenya and Ethiopia

Ethiopia / Hawassa, Bahir Dar	80 183.80	335 481.00	disbursed	ODA	grant	adaptation	Disaster prevention and preparedness	Polish Center for International Aid / Training and equipment provision for Fire Brigades in Kenya and Ethiopia
Uganda / Nakasongola	109 380.24	457 636.00	disbursed	ODA	grant	adaptation	Basic drinking water supply	Innovaid Foundation / Increasing the access to safe drinking water for the population of Nakasongola district in Central Uganda through the modernization of India Mark II
Ethiopia / regions: Guji, Oromia, Arsi Negele, Borena, Bishangari	233 442.72	976 701.00	disbursed	ODA	grant	mitigation	Education facilities and training	Polish Center for International Aid / Support for education in southern Ethiopia by providing solar lights and library books for the primary schools
Tanzania / Dar es Salaam	100 186.91	419 172.00	disbursed	ODA	grant	cross-cutting	Education facilities and training	Salesian Missionary Voluntary Service - Youth For The World / Knowledge for development. Creating conducive learning environment for secondary school students from Dar es Salaam in Tanzania
Tanzania / Arusha (Kisimiri Chini, Longido, Mlangarini)	61 067.66	255 501.00	disbursed	ODA	grant	mitigation	Education facilities and training	Foundation Article 25 / "Sun at work" - Solar Fund for Tanzanian Secondary Schools
Kenya / Bungoma	142 573.20	596 512.00	disbursed	ODA	grant	adaptation	Basic drinking water supply and basic sanitation	Partners Poland Foundation / WASH - improving sanitary safety and health of children attending public primary schools in the rural areas of Bungoma County in Kenya
Ukraine / Zamlynie	14 664.00	61 352.71	disbursed	ODA	grant	mitigation	Education facilities and training	Embassy of the Republic of Poland in Kiev / Promoting modern heating solutions - new boiler house for the Integration Centre in Zamlynnya
Ukraine / Ivano-Frankivsk	19 439.00	81 330.83	disbursed	ODA	grant	mitigation	Education facilities and training	Embassy of the Republic of Poland in Kiev / Environmentally friendly and energy - saving heating systems in educational institutions in Ukraine
Ukraine / Truskavets	26 176.00	109 517.77	disbursed	ODA	grant	mitigation	Housing policy and administrative management	Embassy of the Republic of Poland in Kiev / Implementation of innovative methods of exploitation of communal property in Truskavets - reconstruction of the electrical grids
Ukraine / Kharkiv	29 415.00	123 069.42	disbursed	ODA	grant	cross-cutting	Environmental policy and administrative management	Embassy of the Republic of Poland in Kiev / Efficient energy management - first step to Green University

Ukraine / Kyiv, Lviv, Ivano-Frankivsk	27 807.00	116 341.71	disbursed	ODA	grant	redukcja emisji	Energy policy and administrative management	Embassy of the Republic of Poland in Kiev / Energy efficiency in buildings - regulations, financing, technologies
Ukraine / Kamyanka Buzska, Lviv Region	23 562.00	98 581.05	disbursed	ODA	grant	cross-cutting	Water sector policy and administrative management	Embassy of the Republic of Poland in Kiev / Wastewater treatment facilities project in the city Kamyanka Buzka
Georgia / Tbilisi	29 688.00	124 211.62	disbursed	ODA	grant	adaptation	Flood prevention/ control	Embassy of the Republic of Poland in Tbilisi / Enhancement of the capacity of National Environmental Agency in monitoring and forecasting flood hazards in Tbilisi region
Moldova / Rascov, Kamenka	5 000.00	20 919.50	disbursed	ODA	grant	adaptation	Basic drinking water supply	Embassy of the Republic of Poland in Chisinau / Renovation works of the ecologic well in Rascov
Moldova	30 000.00	125 517.00	disbursed	ODA	grant	mitigation	Energy education/training	Embassy of the Republic of Poland in Chisinau / Raising ecological awarness among Moldovan citizens - Eco-campaign on water and energy saving
Moldova / Cimislia	85 100.00	356 049.89	disbursed	ODA	grant	adaptation	Basic drinking water supply	Embassy of the Republic of Poland in Chisinau / Construction of water supply network Leova-Filipeni-Romanovca - II phaze of the project
Kygyzstan / Kara-Dikan	13 299.00	55 641.69	disbursed	ODA	grant	adaptation	Basic drinking water supply	Embassy of the Republic of Poland in Astana / Improvement of living conditions in Kara-Diykan village
Ethiopia / Oromo Region, West Arsi Zone, Arsi Negele District, Dawe i Tufa Kebele	16 435.11	68 762.86	disbursed	ODA	grant	adaptation	Forestry development	Embassy of the Republic of Poland in Addis Ababa / Protection of the Kimpee forest through support for the local community
Kenya / Embu	14 482.00	60 591.24	disbursed	ODA	grant	mitigation	Forestry development	Embassy of the Republic of Poland in Nairobi / Preventing deforestration in Embu region by providing local communities with energy saving cook-stoves and conducting tree planting activities
Lao People's Democratic Republic / Vilabouli / Savannakhet Provience	24 469.29	102 377.06	disbursed	ODA	grant	adaptation	Basic drinking water supply and basic sanitation	Embassy of the Republic of Poland in Bangkok / Improvement of access to clean drinking water and sanitation at schools and medical centres in Vilabouli district in Savannakhet Provience in Laos

Myanmar	95 604.58	400 000.00	disbursed	ODA	grant	adaptation	Reconstruction relief and rehabilitation	International Federation of Red Cross and Red Crescent Societies / Voluntary payment to Disaster Relief Emergency Fund for Myanmar
Moldova	23 901.14	100 000.00	disbursed	ODA	grant	mitigation	Solar energy	United Nations Industrial Development Organisation / Payment for the technical assistance programme in the field of solar energy UNIDO for Moldova
Moldova	35 851.72	150 000.00	disbursed	ODA	grant	adaptation	Plant and post-harvest protection and pest control	NATO/PfP - OSCE/ENVSEC Trust Fund / Project for the destruction of peticides and dangerous chemicals in Moldova
Ukraine	18 367.55	76 848.00	disbursed	ODA	grant	adaptation	Water sector policy and administrative management	Gdańsk Water Foundation / The development of Polish-Ukrainian cooperation in the field of knowledge transfer in the economy of water and wastewater management
Armenia	86 283.13	361 000.00	disbursed	ODA	grant	adaptation	Disaster prevention and preparedness	Ministry of the Interior and Administration /The National Headquarters of the State Fire Service / Capacity building for search and rescue groups pf Armenia
Moldova	40 000.00	167 356	disbursed	ODA	grant	mitigation	Solar energy	Payment to UNIDO (voluntary contribution) / Technical assistance at the production of solar energy systems
Developing countries, undefined	25 000.00	104 598	disbursed	ODA	grant	mitigation	Energy policy and administrative management	Payment to UNIDO (voluntary contribution)
Total contribution through bilateral channels	**2 649 505.69**	**11 085 266.84**						

Note: exchange rates 1 USD = 3.7701 PLN; 1 USD = 0.9011 EUR

Table 7 (b). Provision of public financial support: contribution through bilateral, regional and other channels in 2016 (including capacity building)

Recipient country/ region/project/ programme	Total anount		Status	Source	Financial instrument	Obszar wsparcia	Sector	Additional information
	Climate change-specific		Disbursed, committed, pledged	ODA/OOF/ Other	Grant/ Concessional loan/Non-concessional loan/other	Mitigation/ Adaptation/Cross-cutting/Other		
	EUR	PLN						
Belarus / Minsk Region	143 885.62	627 701.00	disbursed	ODA	grant	adaptation	Environmental education / training	The "East" Foundation / Eco-innovations in the development of small enterprises in rural regions of Belarus
Ethiopia / Amhara, Southern Nations, Nationalities and Peoples' Region	157 152.62	685 578.31	disbursed	ODA	grant	adaptation	Disaster prevention and preparedness	Polish Center for International Aid / Provision of training and equipment for rescue services in Ethiopia
Ethiopia / Oromo, Southern Nations, Nationalities, and Peoples' Region	274 252.58	1 196 426.86	disbursed	ODA	grant	mitigation	Education facilities and training	Polish Center for International Aid / Educational support in Southern Ethiopia through providing a solar lighting systems
Ethiopia / Oromo, Lume Woreda and Modjo Regions	25 174.38	109 823.22	disbursed	ODA	grant	mitigation	Solar energy	Embassy of the Republic of Poland in Addis Ababa / Support to the clinic in Modjo through providing a medical equipment and solar energy system
Ethiopia / Oromo, Bora Woreda, and Alemtena Regions	22 299.12	97 279.90	disbursed	ODA	grant	mitigation	Solar energy	Embassy of the Republic of Poland in Addis Ababa / Support to the primary school in Alemtena - instalation of photo-voltaic cells
Georgia / Kachetia	165 683.61	722 794.74	disbursed	ODA	grant	adaptation	Flood prevention/ control	Polish Center for International Aid / Hydraulic modelling study against floods / support to the competence and readiness of Georgian institutions
Georgia / Tbilisi	61 326.45	267 536.65	disbursed	ODA	grant	adaptation	Disaster prevention and preparedness	The Main School of Fire Service / Development of specialized rescue in underground infrastructure in Georgia
Indonesia / Adonara, Flores, East Nusa Tenggara	14 992.75	65 405.87	disbursed	ODA	grant	mitigation	Energy conservation and demand-side	Embassy of the Republic of Poland in Jakarta / Development of a village agricultural depot and training for

							efficiency	farmers in the area of energy efficieny technologies in food processing
Iraq	18 041.10	78 704.28	disbursed	ODA	grant	adaptation	Basic drinking water supply	CA Irbil / Water well project for Yazidis on Sinjar Mountain
Kenya / Murang'a, Kiambu, Machakos	70 604.80	308 013.44	disbursed	ODA	grant	adaptation	Disaster prevention and preparedness	Polish Center for International Aid / Provision of training and equipment for rescue services in Kenya
Kenya / Embu	18 946.90	82 655.85	disbursed	ODA	grant	cross-cutting	Forestry development	Embassy of the Republic of Poland in Nairobi / Mount Kenya forest restoration
Moldova / Cimislia Region	23 363.60	101 923.71	disbursed	ODA	grant	cross-cutting	Waste management/disposal	Embassy of the Republic of Poland in Chisinau / Construction of municipal landfill for 11 willages in raion Cimislia
Moldova	50 429.80	220 000.00	disbursed	ODA	grant	mitigation	Environmental policy and administrative management	NATO/PfP - OSCE/ENVSEC Trust Fund / Project for the destruction of peticides and dangerous chemicals in Moldova
Moldova	69 647.95	303 839.18	disbursed	ODA	grant	mitigation	Solar energy	Payment to UNIDO (voluntary contribution) / Promotion of the renewable energy generation in Moldova
Myanmar / Yangon	69 122.68	301 547.69	disbursed	ODA	grant	mitigation	Food security programmes	Foundation "Cultures of the World" / Farm school infrastructure development and better access for youth to quality education about sustainable agriculture in Myanmar
Nigeria / Bekwarra, Abuochiche (LGA), Cross River	28 266.17	123 311.17	disbursed	ODA	grant	adaptation	Water supply and sanitation	Embassy of the Republic of Poland in Abuja / Safe water and improved sanitation and hygiene
Tanzania / Moshi Rural, Rombo	134 396.67	586 305.49	disbursed	ODA	grant	mitigation	Biofuel-fired power plants	Poland - East Africa Economic Foundation / Biomass briquettes as a practical way to reduce deforestation of the Mt. Kilimanjaro Forest
Tanzania / Mvumi, Dodoma	150 311.16	655 732.45	disbursed	ODA	grant	mitigation	Solar energy	Young Businessman Club Poland / Delivery of photo-voltaic cells to St. Johns University and Mvumi Hospital
Tanzania	11 665.08	50 888.92	disbursed	ODA	grant	mitigation	Solar energy	Foundation "Science for Development" / The implementation of new technologies of milk processing - delivery of solar system

Ukraine	92 156.77	402 033.90	disbursed	ODA	grant	mitigation	Energy generation, renewable sources – multiple technologies	Managerial Initiatives Foundation / Ukrainian renewable energy clusters
Ukraine / Ivano-Frankivsk	44 899.22	195 872.85	disbursed	ODA	grant	adaptation	Disaster prevention and preparedness	Marshal Office of the Podkarpackie Voivodeship / The increase of competencies and operational potential of emergency services in Ivano - Frankivsk Oblast
Ukraine / Lviv Region	70 709.57	308 470.48	disbursed	ODA	grant	mitigation	Energy generation, non-renewable sources - unspecified	Central Mining Institute / Implementation of innovative technologies in Lviv region using local energy resources
Ukraine / Ternopil, Zaporizhia and Zhytomir	26 815.00	116 980.44	disbursed	ODA	grant	mitigation	Energy conservation and demand-side efficiency	Embassy of the Republic of Poland in Kiev / Energy efficiency in residential buildings - regulation, financing, technology
Ukraine	43 355.98	189 140.47	disbursed	ODA	grant	adaptation	Disaster prevention and preparedness	Ministry of the Interior and Administration / The National Headquarters of the State Fire Service/ The enhancement of the effectiveness of the Ukraine search and rescue team by improving the competence of management
Ukraine / Ivano-Frankivsk District, Cherson District	36 333.24	158 503.78	disbursed	ODA	grant	adaptation	Disaster prevention and preparedness	Ministry of the Interior and Administration/The National Headquarters of the State Fire Service / The enhancement of the effectiveness of the Ukrainian emergency services responding to emergency situations
West Bank and Gaza Strip	271 869.96	1 186 032.72	disbursed	ODA	grant	adaptation	Food security programmes	Polish Center for International Aid / Adopting green hydroponic production to increase food security
Developing countries, undefined	24 367.17	106 301.76	disbursed	ODA	grant	mitigation	Energy policy and administrative management	Payment to UNIDO (voluntary contribution)/ Contribution to the Vienna Energy Forum
Total contribution through bilateral channels	**2 120 069.94**	**9 248 805.13**						

Note: exchage rates 1 USD = 3.9431 PLN; 1 USD = 0.9039 EUR

Table 8. Provision of technology development and transfer support 2015–2016

Technology	County	Area	Sector	Source of the funding for technology transfer	Activities undertaken by private/public sector	Status	Additional information
Bioreaktor	Chile	mitigation	water management, waste management	public	private and public	implemented	A hydrophobic bioreactor with biopreparation
EKOPAL	Kazahhstan, Ukraine (2x)	mitigation	renewable energy sources	public	private and public	implemented	Biomass boilers
IZODOM	Nigeria, Morocco, Republic of South Africa, Bosnia and Herzegowina, Costa Rica	mitigation	energetic efficiency	public	private and public	implemented	IZODOM
Biomasser®	Ukraine, Senegal	mitigation	renewable energy sources	public	private and public	implemented	Biomasser® - briquetting technology - environmentally friendly fuels

Table 9. Provision of capacity building

Programme/project	Country	Area	Additional information
Development of adaptation plans for climate change in cities over 100,000 residents	Poland	Adaptation	The main objective of the project is to assess the sensitivity and vulnerability to climate change of each of the 44 partner cities and to plan adaptation activities that meet the identified threats. The objectives of the project include: – Determining the vulnerability of major cities to climate change – Planning of adaptation activities at the local level – Raising awareness of the need to adapt to climate change at the local level Urban adaptation plans will be dynamic and open, so it will be easy to update or change certain assumptions.
Handbook of adaptation for cities: guidelines for preparing the Urban Plan of Adaptation to climate change	Poland	Adaptation	The document contains guidelines developed in the Ministry of the Environment, in which the methodology and a checklist for the process of developing a plan for adaptation to climate change at the local level are presented. Guidelines can be used by local governments to coordinate the development process of adaptation to climate change.
Guide to investments preparation taking into account climate change, their mitigation and adaptation to these changes and resistance to natural disasters	Poland	Adaptation	The guide presents a set of guidelines and sets out rules to help investors, including those benefiting from EU funds in the financial perspective 2014–2020, in the preparation of investments (projects) and / or in the preparation of an application for EU funds in the areas of adaptation and mitigation of climate change as well as resilience to natural disasters. The aim of the Guide is to define guidelines and methodology of calculations taking into account climatic issues in the process of investment preparation (projects and projects), including, in particular, projects co-financed from EU funds under the 2014–2020 financial perspective.