
NATURAL ASSET BASE

NUMBER OF SPECIES

SHARE OF ENDANGERED SPECIES IN TOTAL

FOREST COVER

INDICATOR OF SURFACE WATERS AVAILABILITY PER CAPITA

TIMBER REMOVALS

WATER EXPLOITATION INDEX

WATER INTENSITY OF INDUSTRY

FARMLAND BIRD INDEX

WATER PRODUCTIVITY

SHARE OF EXTRACTION IN NATURAL GAS RESOURCES

FOREST GROWING STOCK

SHARE OF EXTRACTION IN HARD COAL RESOURCES

EXPLOITABLE UNDERGROUND WATER RESOURCES

PRIMARY ENERGY PRODUCTIVITY

SHARE OF ENDANGERED SPECIES IN TOTAL NUMBER OF SPECIES

ENVIRONMENTAL AND RESOURCE PRODUCTIVITY OF THE ECONOMY

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GROSS NITROGEN BALANCE

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PARTICIPANTS OF GREENEVO TECHNOLOGY ACCELERATOR

ORGANIC AGRICULTURAL AREA IN % OF TOTAL AGRICULTURAL AREA

BIAŁYSTOK 2017

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# PREFACE

We are pleased to present you with the second edition of the publication entitled *Green Economy Indicators in Poland 2017*, which is a result of a cooperation of the Statistical Office in Białystok with the Central Statistical Office.

Green economy, as the authors of this publication see it, is such economy that supports economic growth and development while simultaneously maintaining access to natural capital and ecosystem services, which, in turn, affect human well-being. This economy is inextricably connected with the concept of sustainable development through efficient achievement of its objectives.

Initiatives of building green economy that take into consideration needs connected with environment protection make it necessary to build statistical monitoring methods and assessing the level of greening the economy. Reliable, properly selected, and up-to-date data from this scope are an important element of both introducing environment protection policies, implementing economic instruments or activities stimulating ecological innovations and investments in green technology as well as monitoring efficiency of these activities. Such data should provide public and private sector entities with information that would support their decision-making process, and when presented in a wider context, may make it possible to follow changes in environment, economy, and society.

This publication on methodology of studying green economy makes use of Organisation for Economic Co-operation and Development suggestions as well as experiences of other countries, such as, among others, the Czech Republic, the Netherlands, Germany, Slovenia, Slovakia. Moreover, we present new measures, not used in other countries so far, which enable us to make a more comprehensive evaluation of greening the economy while taking into account conditions in Poland. It should be noted, however, that the set of indicators presented in this report is not exhaustive and will be assessed with new phenomena, instruments and changes in data availability.

The suggested set of indicators to monitor greening the economy includes, apart from public statistics information, data from various national and international authorities. Presenting *Green Economy Indicators in Poland 2017,* I would like to sincerely thank all institutions for the data and suggestions which have enriched the content of this publication.

D i r e c t o r
Statistical Office in Białystok
Ewa Kamińska-Gawryluk

Białystok, December 2017

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## SYMBOLS

| | | |
|---|---|---|
| Dot (.) | – | data not available or not reliable. |
| „Of which" | – | indicates that not all elements of the sum are given. |
| Comma (,) | – | used in figures represents the decimal point. |

## MAJOR ABBREVIATIONS

| | | |
|---|---|---|
| thous. | – | thousand |
| mln | – | million |
| bn | – | billion |
| zl | – | zloty |
| pcs | – | pieces |
| µg | – | microgram |
| kg | – | kilogram |
| t | – | tonne |
| ha | – | hectare |
| $m^3$ | – | cubic metre |
| $dam^3$ | – | cubic decametre |
| $hm^3$ | – | cubic hectometre |
| dB | – | decibel |
| kgoe | – | kilogram of oil equivalent |
| toe | – | tonne of oil equivalent |
| Mtoe | – | megatonne of oil equivalent |
| GJ | – | gigajoule |
| MWh | – | megawatt·hour |
| pp | – | percentage point |
| DMC | – | domestic material consumption |
| GDP | – | gross domestic product |

| | | |
|---|---|---|
| EEA | – | European Environment Agency |
| EUROSTAT | – | Statistical Office of the European Union |
| OECD | – | Organisation for Economic Co-operation and Development |
| EU | – | European Union |
| UNEP | – | United Nations Environment Programme |
| EMEP | – | European Monitoring and Evaluation Program |
| EU ETS | – | European Union Emissions Trading System |
| EMAS | – | Eco-Management and Audit Scheme |
| IPCC | – | Intergovernmental Panel on Climate Change |
| NFI | – | National Forest Inventory |
| PROW | – | Rural Development Programme |
| EPO | – | European Patent Office |
| IPC | – | International Patent Classification |

# INTRODUCTION – GREEN ECONOMY AND ITS ELEMENTS

Internationally and in literature, there are two terms related to green economy, namely *green growth* (OECD) and *green economy* (UNEP, EEA), which, in this publication, are considered as strongly interconnected but not equivalent in meaning. Green growth and green development lead to reaching the state of green economy, which is, alongside social development, one of the pillars of sustainable development.

UNEP defines green economy as such, which enhances human well-being, social equity and leads to a significant decrease in environmental degradation. Thus, green economy is low emission economy, making efficient use of resources and favouring social inclusion. Green economy supporters aim at moving these three: political actions, public and private investment towards clean technologies, expanding ecosystem services, natural asset base, and education. The increase in revenues and employment in green economy may be achieved through public and private investment which reduces pollutant emission and increases efficiency of energy and resource use, as well as prevents biodiversity loss and degradation of ecosystem services. Therefore green economy is considered an important tool for sustainable development (and not as the target itself) and green economy indicators are significant in public government decisive processes.

According to EEA, green economy is the one in which environment, economy and society policies together with innovation enable the society to efficiently use resources in production and consumption processes thus constituting a potential for enhancing well-being in a complete way, while maintaining the stability of natural systems. At the base of transformation to green economy lies the integration of economic and environmental policies to create new sources of economic development taking into account the need to avoid excessive pressure on natural capital. At the same time, such a transformation has a potential to foster social capital and fair burden-sharing in the policy preparation, equitable distribution of environment protection costs and access to environment benefits. Green economy may create new opportunities, especially in relation to new vacancies in different sectors of economy. It may also lead to transferring job places from activity based on non-renewable resources to the one based on renewable ones. By and large moving to green economy depends on the scope of investment (among others in green technology), making use of innovations (and ecological technologies in particular) as well as citizens' involvement.

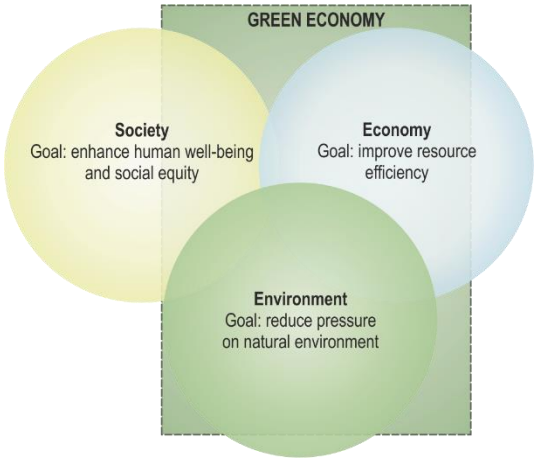
According to OECD, green growth is the undertaking of activities supporting economic growth and development, whilst ensuring constant availability of natural capital and ecosystem services. What is needed then is supporting green investments and innovations, which are the basis of constant economic growth and new economic opportunities. Green growth is such growth that takes into consideration resource and energy reduction as well as their efficient use

to tackle climate change and natural environment pollution. It is also such growth that takes place after the introducting new growth drivers through research and development of green technologies, that creates green jobs, and, as a result, leads to green economy ensuring balance between economy and environment.

Polish public statistics has tried to adjust the term of green economy to Polish circumstances on the basis of achievements of OECD and other environmental organisations, such as UNEP and EEA. The term **green economy** means such economy in which economic growth and development are encouraged and simultaneously access to natural capital and ecosystem services, which affect human well-being, is maintained. Green economy, inextricably linked to green growth, cannot replace sustainable development – it has a narrower scope. Green economy is connected with operational targets, which should lead to clearly specified activities within the fields of economy and environment protection to create such conditions that would foster innovations and investments. These latest, then, can lead to the creation of new sources of economic development while making efficient use of environment resources. That is why green economy makes it possible to reach the state of sustainable economy.

The survey on greening the economy concerns mainly the assessment of natural environment state and economy efficiency (figure 1). The social factor is, however, treated in a narrower sense – solely in this part that directly concerns either environment or economy. It is directly reflected in the proposed set of measurement indicators.

*Figure 1. Green economy elements*




Source: own elaboration on the basis of *Environmental Indicator Report 2012. Ecosystem Resilience and Resource Efficiency in a Green Economy in Europe,* EEA, 2012, page 20.

Economy and society functioning are based on environment, while economy development – on society. Therefore, to illustrate these issues better, it is advisable, at first, to present context indicators (which are shown in table 1), constituting the background and the source of basic information on the state of the country and providing **the socio-economic context**.

*Table 1. Indicators of socio-economic context*

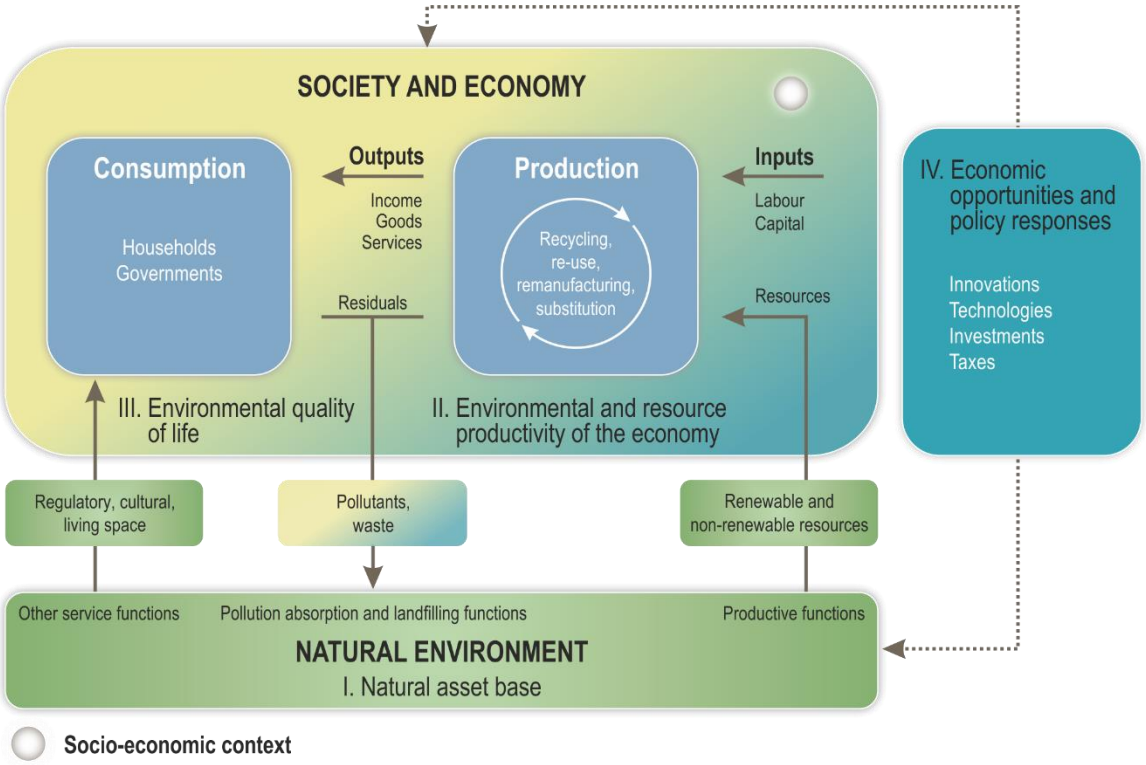
| Topic | Indicator group / name |
|---|---|
| **Socio-economic context** | |
| Population | Population density<br>Natural increase<br>Economic dependency ratio<br>Life expectancy |
| Labour market | Employed persons<br>Registered unemployment rate |
| Education | Early school leavers<br>Lifelong learning<br>Spendings on Human Resources (public expenditures on education) in relation to GDP |
| Living conditions of population | Total gross real disposable income of households sector<br>At-risk-of-poverty rate after social transfers |
| Information society | Households equipped with access to Internet<br>Enterprises equipped with access to Internet |
| Investments | Investment outlays |
| National accounts | Gross domestic product per capita<br>Gross value added |

Elements of green economy (environment, economy, and society) are interrelated and these relations have enabled Polish public statistics, just like OECD, to establish 4 areas to monitor green economy state in Poland, i.e.:

1) **natural asset base** – comprises indices describing the state of natural environment,
2) **environmental and resource productivity of the economy** – this group consists of indicators depicting relations between natural environment and economy,
3) **environmental quality of life** – presenting indices that are to monitor relations between natural environment and society,
4) **economic opportunities and policy responses** – comprising indicators that characterize instruments affecting economy and society, creating such desired trends in development that aim at greening the economy.

The scheme below presents relations between elements of green economy that have been identified and groups of indicators (fig. 2).

*Figure 2. Relations between green economy elements and indicator groups*




Source: own elaboration on the basis of *Towards Green Growth: Monitoring Progress: OECD Indicators*, OECD, 2011, page 12.

Natural environment performs three basic functions in green economy:

- productive (supplying) constituting a resource base of renewable resources (e.g. wood) and non-renewable ones (e.g. fossil fuels) for economy and society,
- pollution absorption and landfilling,
- other, which can be divided into services:
  - regulatory, including, i.a., climate regulation, amortization of extreme weather events, regulation of water cycles, erosion prevention, monitoring of soil fertility and nutrient cycles, pollination and biological control of growing crops, flood prevention activities,
  - cultural, which are not vital for life but improve its quality, i.e. bring non-material benefits, which people gain while coming into contact with ecosystems, e.g. aesthetic stimuli, possibilities of recreation and tourism, inspiration for culture, arts, and spiritual experiences,
  - living space for humans, fauna and flora; maintaining biodiversity.

Natural environment is a source of natural resources vital for economy and society, which can be described through a group of natural capital indicators. **Natural capital** comprising natural renewable and non-renewable resource stocks plays a fundamental role in green economy and pressure on making use of it is inevitable. Constant overexploitation of soil may lead to an irreversible loss and then may upset the natural capital balance. Green economy is to

provide economic growth with sufficient renewable and non-renewable resources and other ecosystem services, while minimising the negative effect on environment, caused by the acquisition, exploitation, and processing of natural capital. Therefore, it is important to monitor the state and the changes of different kinds of resources, i.a.: mineral, fauna, flora and freshwater one. A set of indices proposed to monitor natural capital is shown in table 2.

*Table 2. Indicators of natural asset base*

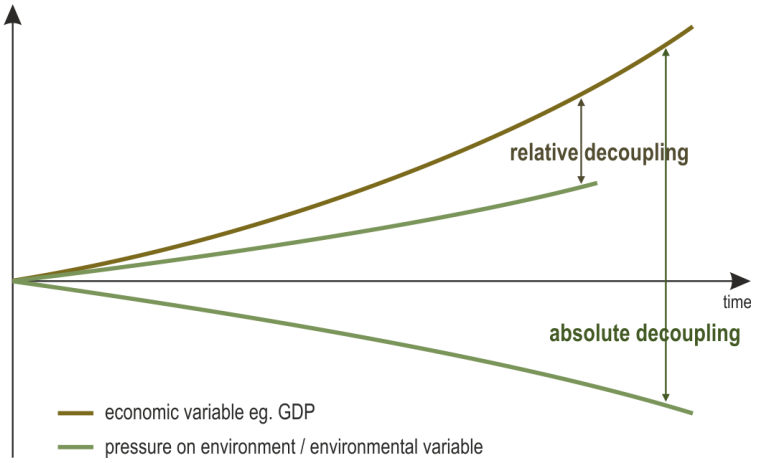
| Topic | Indicator group / name |
|---|---|
| **Natural asset base** | |
| Biodiversity and ecosystems | **Biodiversity**<br>1. Share of legally protected area in total country area<br>2. Farmland Bird Index<br>3. Forest Bird Index<br>4. Share of endangered species in total number of species<br>**Land use**<br>1. Agricultural land designated for non-agricultural purposes and forest land designated for non-forest purposes<br>2. Degree of reclamation and management of devastated and degraded land |
| Renewable stocks | **Forest resources**<br>1. Forest cover<br>2. Forest growing stock<br>3. Timber removals<br>4. Share of damaged forest stands area in total forest area<br>**Freshwater resources**<br>1. Indicator of surface waters availability per capita<br>2. Exploitable underground water resources<br>3. Water exploitation index |
| Non-renewable stocks | **Mineral resources**<br>1. Share of extraction in hard coal resources<br>2. Share of extraction in lignite resources<br>3. Share of extraction in natural gas resources |

The production section and its relations with natural environment are a starting point for setting up another group of green economy indicators. Exploitation of natural resources, making use of labour and capital take part in production processes to make goods and to provide services. The side effects are the residue of pollutants and waste and thus environment is used as a site of their absorption and landfilling.

Economy greening progress may be monitored by the relations of generated production to environment service exploitation and the observation of *decoupling* trends (fig. 3), i.e. the

tendencies of breaking the link between production and environmental services. The decoupling may be either relative or absolute. *Relative decoupling* occurs when the intensity of natural resources exploitation (pressure on environment) is growing, but this process is slower than the pace of the increase of the economy variable. The green economy objective is *absolute decoupling*, i.e. the state when economic output is on the increase and the environmental service use is either stable or in decline.

*Figure 3. Relative and absolute decoupling*




Source: *Environmental Indicator Report 2012. Ecosystem Resilience and Resource Efficiency in a Green Economy in Europe,* EEA, page 23.

The growth of environmental and resource productivity is a necessary condition to green the economy. The efficient use of natural resources and waste should lead to the reduction of a negative impact on environment. This efficiency is measured by indices belonging to the group of **environmental and resource productivity of the economy**, which are presented in table 3.

*Table 3. Indicators of environmental and resource productivity of the economy*

| Topic | Indicator group / name |
|---|---|
| **Environmental and resource productivity of the economy** | |
| Resources | **Water productivity**<br>1. Consumption of water for needs of the national economy and population per capita<br>2. Water productivity<br>3. Water intensity of industry<br>4. Water intensity of households<br>**Domestic material consumption**<br>1. Resource productivity (GDP/DMC)<br>2. Domestic material consumption per capita<br>**Waste management**<br>1. Share of waste recovered in waste generated<br>2. Share of waste disposed in waste generated<br>3. Municipal waste generated per capita<br>4. Municipal waste collected separately in relation to total waste<br>5. Recycling of packaging waste<br>**Nitrogen and phosphorus balances**<br>1. Gross nitrogen balance<br>2. Gross phosphorus balance |
| Energy | **Energy productivity**<br>1. Primary energy productivity<br>2. Final energy intensity of the economy<br>**Renewable energy**<br>1. Share of renewable energy in gross final energy consumption |
| Greenhouse gas | **Greenhouse gas emissions**<br>1. Greenhouse gas emissions<br>2. Greenhouse gas emissions by emission source<br>3. Greenhouse gas emissions in non-ETS sectors |

A further element that is observed to get an insight into green economy is **the environmental quality of life**, which is connected with regulatory, living space, and cultural services that environment provides for the people. This function also refers to the general condition of environment and is an example of the relations that exist between environment and society. The environmental quality is a key factor directly affecting general well-being of humans and other living creatures. The pollution level directly affects the quality of life of a society by the impact it has on its health. The environmental quality of life indicators refer to the human exposure to various pollutants and to health conditions resulting from them as well as to access of population to basic services that protect the environment. These objective measurement indices are

complemented with the subjective ones that determine people's feeling about the quality of environment they inhabit. The suggested array of indicators of the population's environmental quality of life is compiled in table 4.

*Table 4. Indicators of environmental quality of life*

| Topic | Indicator group / name |
|---|---|
| **Environmental quality of life** | |
| State of environment and human health | **Gaseous air pollutants**<br>1. Average number of days with exceeded value of 120 µg/m$^3$ by 8-hour ozone concentration<br>2. Urban population exposure to air pollution by ozone (SOMO35)<br>3. Premature deaths attributable to ozone exposure<br>**Particulate air pollutants**<br>1. Emissions of $PM_{10}$ i $PM_{2,5}$ per capita<br>2. Urban population exposure to air pollution by $PM_{10}$<br>3. Urban population exposure to air pollution by $PM_{2,5}$<br>4. Premature deaths attributable to $PM_{2,5}$ exposure<br>**Noise**<br>1. Percentage of plants exceeding industrial noise limits<br>2. Percentage of population exposed to road traffic noise in agglomerations over 100 thous. inhabitants<br>3. Percentage of households exposed to excessive noise |
| Environmental services | **Access to drinking water**<br>1. Percentage of population using water supply network<br>2. Percentage of population supplied with water meeting requirements<br>**Municipal sewage treatment**<br>1. Percentage of population using sewage network<br>2. Wastewater treatment facilities per 1000 population not using sewage network<br>**Green areas**<br>1. Green areas in cities per capita<br>2. Green areas in cities in % of total area of cities |

Transition from a traditional economy to a green one demands from government and self-government sectors many various instruments within different **economic policies**. There are diverse tools within public government reach that force entities to certain actions that entail greening of economy, i.a. legal regulations, taxes or subsidies. They can support actions to increase efficiency (e.g. the use of environment elements) and to provide stimuli for the development of eco-friendly production and consumption patterns. Monitoring of such tools and actions as well as their results should become a focal point of the decision makers. Simultaneously, these

instruments create new economic opportunities that lead to the development of certain kinds of activities generating job places and stimulating economic growth. Activities within various policies that aim at promoting green economy should both be based on a deep insight into factors affecting green growth and properly reflect relations between green economy components. To make it possible, decision taking representatives of different public authorities must have access to information on the results of implemented actions. A set of indicators of economic opportunities and policy responses is presented in table 5.

*Table 5. Indicators of economic opportunities and policy responses*

| Topic | Indicator group / name |
|---|---|
| **Economic opportunities and policy responses** | |
| Agriculture | **Organic farms**<br>1. Organic agricultural area in % of total agricultural area<br>2. Payments for organic farming in % of total payments for agriculture under agri-environmental programme |
| Environmental protection | **Outlays on environmental protection**<br>1. Outlays on fixed assets for environmental protection in relation to GDP<br>2. Share of outlays on fixed assets for environmental protection in investment outlays of national economy<br>3. Household expenditures on environmental protection per capita |
| Taxes | **Environmental taxes**<br>1. Share of environmental tax revenues in GDP<br>2. Share of environmental tax revenues in total revenues from taxes and social contributions |

*Table 5. Indicators of economic opportunities and policy responses (cont.)*

| Topic | Indicator group / name |
|---|---|
| **Economic opportunities and policy responses** | |
| Technology and innovation | **Research and development (R&D) activity**<br>1. Research and development (R&D) intensity<br>2. Research and development (R&D) expenditure per capita<br>3. Outlays on fixed assets for environmental protection in research and development activity in % of total outlays on fixed assets for environmental protection<br>**Inventions and patents**<br>1. Patent applications in environment-related technologies in % of total patent applications filed in the European Patent Office<br>2. Patents in environment-related technologies granted in % of total patents granted by the European Patent Office<br>3. Patent applications in environmental technologies in % of total patent applications filed in the Patent Office of the Republic of Poland<br>4. Patents in environmental technologies granted in % of total patents granted by the Patent Office of the Republic of Poland<br>**Eco-innovation**<br>1. Eco-innovation index<br>**Green technology**<br>1. Participants of GreenEvo Technology Accelerator |
| Management | **Eco-Management and Audit Scheme (EMAS)**<br>1. Organisations with Eco-Management and Audit Scheme (EMAS) registration<br>2. Sites of organisations with Eco-Management and Audit Scheme (EMAS) registration |
| Public procurement | **Green public procurement**<br>1. Green public procurement in % of total public procurement |

The given set of indicators to monitor green economy does not illustrate the analysed subject to the full and will be further assessed due to, among others, new data sources including the ones coming from public statistics surveys and introducing new instruments that are to stimulate economy greening process.


# SOCIO-ECONOMIC CONTEXT

# SOCIO-ECONOMIC CONTEXT

Poland in numbers:

| SPECIFICATION | 2000 | 2005 | 2010 | 2014 | 2015 |
|---|---|---|---|---|---|
| Population (as of 31 XII) in mln | 38,3 | 38,2 | 38,5 | 38,5 | 38,4 |
| urban areas | 23,7 | 23,4 | 23,4 | 23,2 | 23,2 |
| rural areas | 14,6 | 14,7 | 15,1 | 15,3 | 15,3 |
| Population per 1 km$^2$ of total area (as of 31 XII) | 122 | 122 | 123 | 123 | 123 |
| Natural increase in thous. | 10,3 | –3,9 | 34,8 | –1,3 | –25,6 |
| Population of age in % of total population: | | | | | |
| pre-working age | 24,4 | 20,6 | 18,8 | 18,0 | 18,0 |
| working age | 60,8 | 64,0 | 64,4 | 63,0 | 62,4 |
| post-working age | 14,8 | 15,4 | 16,8 | 19,0 | 19,6 |
| Economic liability rate (non-working age population per 100 persons of working age) | 64 | 56 | 55 | 59 | 60 |
| Life expectancy | 73,7 | 75,0 | 76,2 | 77,6 | 77,5 |
| males | 69,7 | 70,8 | 72,1 | 73,8 | 73,6 |
| females | 78,0 | 79,4 | 80,6 | 81,6 | 81,6 |
| Employed persons[a] in thous. | 15488,8 | 12890,7 | 14106,9 | 14563,4 | 14829,8 |
| of which in % of total in section: | | | | | |
| agriculture, forestry and fishing | . | 16,6 | 16,8 | 16,4 | 16,1 |
| industry | . | 22,2 | 20,6 | 20,3 | 20,3 |
| of which in division water supply; sewerage, waste management and remediation activities | . | 0,9 | 1,0 | 1,0 | 1,0 |
| transportation and storage | . | 4,9 | 5,0 | 5,1 | 5,2 |
| Registered unemployment rate (as of 31 XII) in % | 15,1 | 17,6 | 12,4 | 11,5 | 9,7 |
| Early school leavers[bc] in % | . | 5,3 | 5,4 | 5,4 | 5,3 |
| Lifelong learning[bd] in % | . | 4,9 | 5,2 | 4,0 | 3,5 |
| Spendings on Human Resources (public expenditures on education) in relation to GDP (Gross Domestic Product) | 4,74 | 5,08 | 4,66 | 4,43 | 4,44 |
| Total gross real disposable income of households sector (2000=100) | 100,0 | 104,7 | 129,3 | 136,9 | 141,3 |

*a* Including employed persons in budgetary entities conducting activity within the scope of national defence and public safety. *b* On the basis of the Labour Force Survey (LFS); the LFS results were generalized on the basis of the balance of population compiled: in 2005 using the results of the Population and Housing Census 2002, and since 2010 on the basis of Population and Housing Census 2011. *c* Percentage of the population aged 18–24 having completed at most lower secondary education, who do not continue education and do not attend vocational trainings to the total population of the same age group. *d* Percentage of the population aged 25–64 continuing education or attending vocational trainings to the total population of the same age group.

Poland in numbers (cont.):

| SPECIFICATION | 2000 | 2005 | 2010 | 2014 | 2015 |
|---|---|---|---|---|---|
| At-risk-of-poverty rate after social transfers in % | . | 20,5 | 17,6 | 17,0 | 17,6 |
| Households[e] in % of total households equipped with: | | | | | |
| access to Internet | . | 30,4 | 63,4 | 74,8 | 75,8 |
| broadband Internet | . | 15,6 | 56,8 | 71,1 | 71,0 |
| Enterprises[f] in % of total enterprises equipped with: | | | | | |
| access to Internet | . | 86,1 | 95,8 | 93,1 | 92,7 |
| broadband Internet | . | 42,3 | 69,0 | 90,4 | 91,9 |
| Investment outlays (current prices) in mln zl | 133160 | 131055 | 217287 | 250776 | 271839 |
| in % of total of: | | | | | |
| public sector | 34,8 | 34,9 | 43,5 | 37,4 | 37,3 |
| private sector | 65,2 | 65,1 | 56,5 | 62,6 | 62,7 |
| Gross domestic product (current prices) per capita in zl | 19527 | 25955 | 37524 | 44686 | 46790 |
| Gross value added (current prices) in mln zl | 662871 | 870349 | 1271475 | 1524940 | 1596295 |
| of which in % of total in section: | | | | | |
| agriculture, forestry and fishing | 3,5 | 3,3 | 2,9 | 2,9 | 2,5 |
| industry | 24,3 | 25,2 | 24,7 | 25,4 | 26,1 |
| of which in division water supply; sewerage, waste management and remediation activities | 1,1 | 1,1 | 1,2 | 1,3 | 1,3 |
| transportation and storage | 5,2 | 5,6 | 5,3 | 6,2 | 6,4 |

*e* Data concern households with at least one person aged 16–74 having the Internet access at home. *f* Data concern economic entities employing more than 9 persons.

The state of environment in Poland is a resultant of many factors, including social and economic ones. Thus, progress in greening the economy should be made with regard to socio-economic conditions of a country.

Poland is 6th country in Europe in terms of area, which is 312 679 km$^2$. Land use structure is dominated by agricultural land (59,8% of total area).

As of 31st December 2015, population equalled 38,4 million, of which the majority lived in urban areas (60,3% of total population). It means that 123 persons lived in 1 km$^2$.

In 2015, natural increase was negative and amounted to minus 25613 persons. Life expectancy in Poland is gradually elongating and in the analysed year equalled 77,5 years, and it was longer for females (81,6 years) than for males (73,6 years).

Taking into consideration the division by economic groups of age, it can be noticed that in 2015 in relation to 2000, the share of persons at pre-working age was reduced (by 6,4 pp), while the percentage of post-working age population and working age one increased (by 4,8 pp and 1,6 pp respectively). It is reflected in the economic liability rate, which in 2015 was 60 persons at non-working age per 100 persons at working age.

In 2015 in Poland there were employed 14,8 million persons, the most of which were in the industry sector (20,3% of total employed). Unemployment rate has been the lowest since 2000 (except for 2008) and equalled 9,7%.

In 2015, according to the LFS, 5,3% of young people at the age of 18–24 in total population in the same age group did not continue their education, while the number of adults at the

age of 25–64, who received education and training in the total population at the same age group was 3,5%. Public expenditure on education amounted to 4,4% GDP and was by 0,3 pp lower than in 2000.

In 2015 in comparison to 2000, gross real disposable income of household sector increased by 41,3%, however, at-risk-of-poverty rate after social transfers in relation to 2005 was gradually lowered and in 2015 reached 17,6%.

In 2015, 75,8% of households and 92,7% of enterprises had access to Internet. Investment outlays in national economy, which in the analysed year in current prices amounted to 271,8 billion zl more than doubled in comparison to 2000. It was incurred mainly by private sector (62,7% of total investment outlays).

Gross domestic product (in current prices) illustrating the final result of the activity of all entities of the national economy per capita increased from 19527 zl in 2000 to 46790 zl in 2015. Gross value added, in other words, value of goods produced by market and non-market national entities decreased by intermediate consumption connected with their production, in 2015 equalled 1596,3 billion zl. The section that dominated the share in gross value added, amounting to 26,1%, was industry.


# NATURAL ASSET BASE

## 2.1. BIODIVERSITY

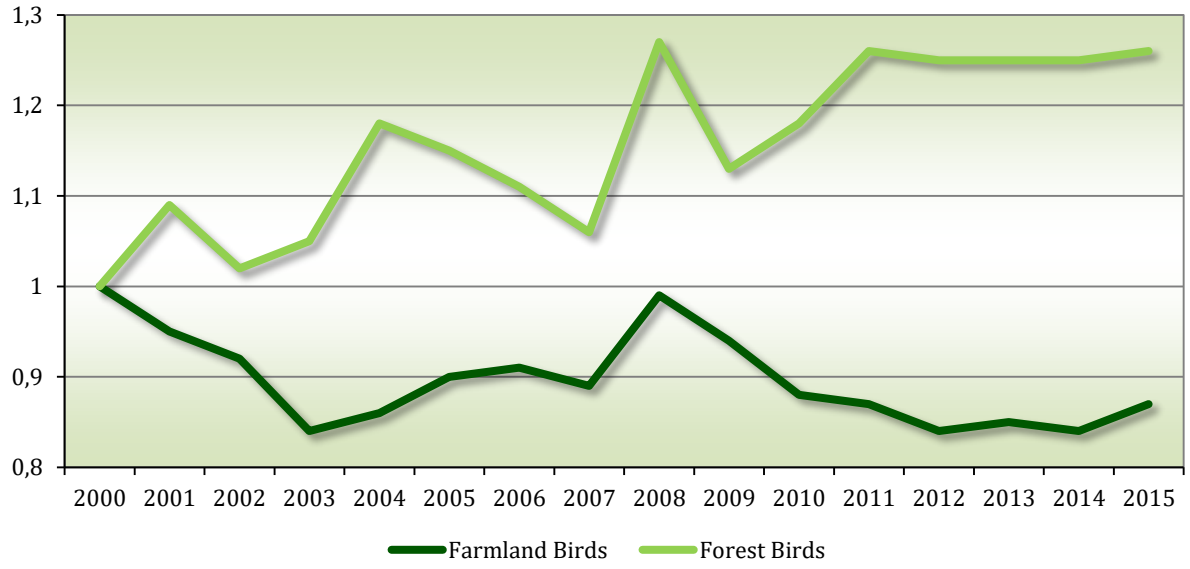
***Biodiversity*** *means diversity of all living organisms inhabiting the Earth in terrestrial, marine and freshwater ecosystems as well as ecological complexes, of which they are a part. It concerns diversity within a scope of species (genetic diversity), among different species as well as diversity of ecosystems.*

Biodiversity plays a vital role in many fields of human interest. Maintaining ecological value is a key factor in ecological and economic terms, on both national and international levels. Loss of ecosystem biodiversity is a threat to proper functioning of our planet, and then, in turn, to economy and population.

Establishing areas of special nature value under legal protection is a form of ecosystem protection against uncontrolled human pressure on environment. In 2015, these areas comprised 10176,0 thous. ha in Poland, i.e. 32,5% of the total area of the country. In comparison to 2000, the percentage remained the same. There were 2647 $m^2$ of areas under legal protection per capita. The biggest share in their structure had protected landscape areas (69,7%) and landscape parks (25,6%).

Natural environment condition of ecosystems relating to agricultural and forest land may be evaluated on the basis of aggregated Farmland Bird Index (FBI) and Forest Bird Index. Changes in the bird population on a regional or national level are important factors revealing information concerning either the improvement, homeostasis or the deterioration of environment quality. Index value for the year 2000 was 1 (100%).

***Graph 1. Farmland Bird Index and Forest Bird Index***




*Source:* data of the Chief Inspectorate of Environmental Protection obtained under the State Environmental Monitoring.

In the years 2000–2003, there was almost a 15% decrease in number of 22 species of farmland birds (graph 1). In the following years, except for 2007, their number increased and in 2008, reached the reference level from the year 2000. Since 2009, the index was 12–16% lower than in the base year, which means that in these years the number constituted between 84% to 88% of the figure from 2000.

Changes in the number of 34 common species of forest birds indicate the reverse tendency, their populations are in good condition and their number is increasing in general.

Within the years 2012–2014 this index was by 25% higher than in the reference year and its highest value (26%) was noted in 2011 and 2015.

Many species of animals and plants are endangered due to natural reasons or human activity. So as to keep record of the number of these species, Red Data Book of Plants and Red Data Book of Animals were created. According to OECD data, among all species existing in Poland, endangered animals covered , among others, 488 vascular plant species (16% of total vascular plants), 1159 animal species, including 1080 invertebrates (3% of total invertebrates) and 79 vertebrate species: 13 mammal species (12% of total mammals), 34 bird species (8% of total birds), 3 reptile species (27% of total reptiles) as well as 29 fish species (21% of total fish).

## 2.2. LAND USE

***Land use*** *means the land classified into the following categories: agricultural land, forest, wooded and bushy land, land under waters, built-up and urban area, ecological area, waste-land and various areas.*

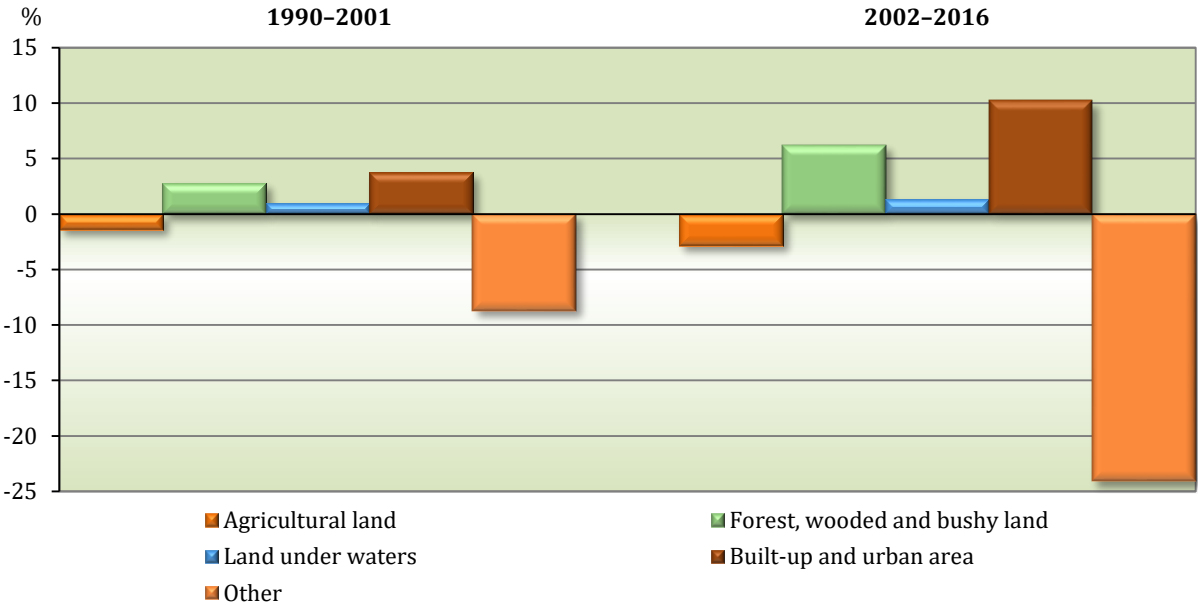
Land, apart from air and water, is a basic element of environment and natural resources. It plays an important role for society, providing it with room for settlement, with raw materials necessary for food production, with biomass as well as helping to conserve biodiversity and ecosystem productivity. The land use, then, affects soil coverage and its quality in terms of carbon storage, its richness in nutrients as well as greenhouse gas emission. It has an impact on water and air quality, the level of erosion risk, moreover, it plays an important role in flood protection.

According to a geodesic inventory, in 2016 agricultural land comprised 59,6%, forest, wooded and bushy land – 31,1%, and built-up and urban areas – 5,4% out of the total area of the country, equalling 31268,0 thous. ha.

Changes in land use reflect human influence on biodiversity and ecosystem state. As built-up and urban areas are incerasing, there is a loss of natural functions of soil, fertile agricultural land and semi-natural land. Moreover, new built-up land on areas outside already existing residential areas lead to traffic increase and land fragmentation.

New land register from 2001 has introduced changes concerning land classification, which makes it impossible to compare data referring to years 1990–2001 and 2002–2016. As a result of it, this analysis contains two periods to present data concerning land use. In both these periods (1990–2001 and 2002–2016) built-up and urban areas are larger by 3,7% and 10,2% respectively, as well as forest, wooded and bushy land by 2,8% and 6,2%, to the detriment of other area and agricultural land (graph 2).

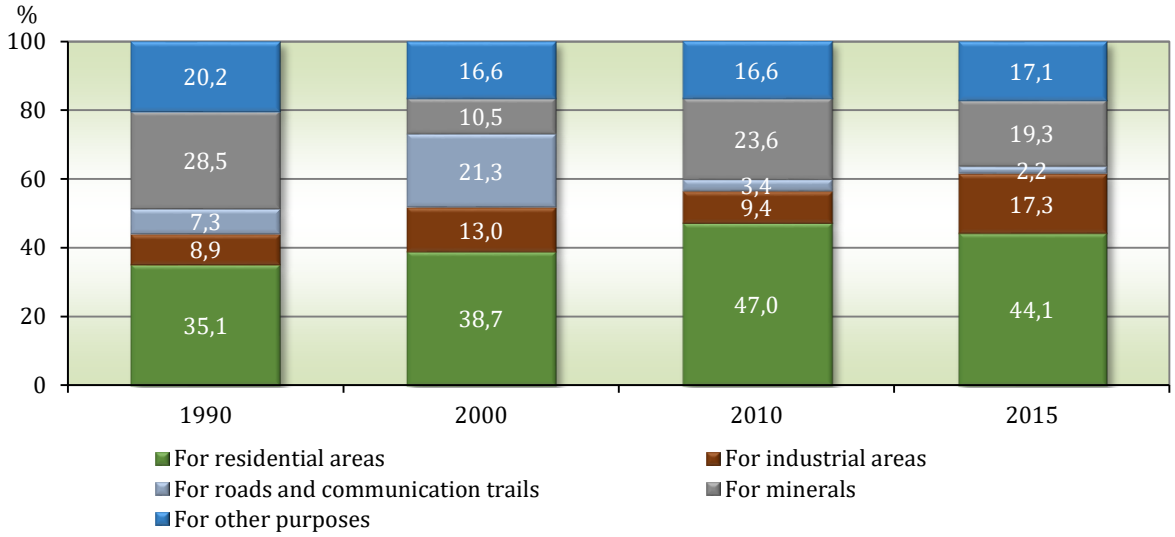
***Graph 2. Land use changes***




*Source:* data of the Head Office of Geodesy and Cartography.

In 2015, 3,9 thous. ha of agricultural and forest land were designated for non-agricultural and non-forest purposes, which means a 30,8% increase in relation to the previous year. The highest proportion of excluded land was designated for residential areas – 44,1%, followed by minerals – 19,3%, industrial areas – 17,3% and roads and communication trails – 2,2% (graph 3).

***Graph 3. Structure of agricultural land designated for non-agricultural purposes and forest land designated for non-forest purposes[a]***




*a* Excluding agricultural land designed for afforestation.

*Source:* data of the Ministry of Agriculture and Rural Development as regards agricultural land designated in accordance with the legal regulations on the protection of agricultural and forest land, data on designation of forest land – of the Ministry of Environment.

Land which lost its utility value due to human activity or other factors or which utility value was diminished due to the deterioration of natural conditions may be reclaimed and developed. Land reclamation means creation or restoration of the utility or the natural value for degraded or devastated land through proper formation of the landscape, enhancements of physical and chemical properties, regulation of water conditions, and restoration of soil, reinforcement of scarps and reconstruction or construction of indispensable routes. Reclaimed land is subject to development i.e. agricultural, forest or other type of utilization. In 2015, devastated and degraded land comprised in total 63,4 thous. ha, of which reclaimed land was solely 1,8 thous. ha, and then land for agricultural purposes was 1,3 thous. ha. Land development comprised 0,9 thous. ha, of which the majority was also designated for agricultural purposes – 0,6 thous. ha. Until now the degree of reclamation and development of devastated and degraded land has been low for many years. In 2015, it accounted for 2,9% and 1,3% of total devastated and degraded land respectively.

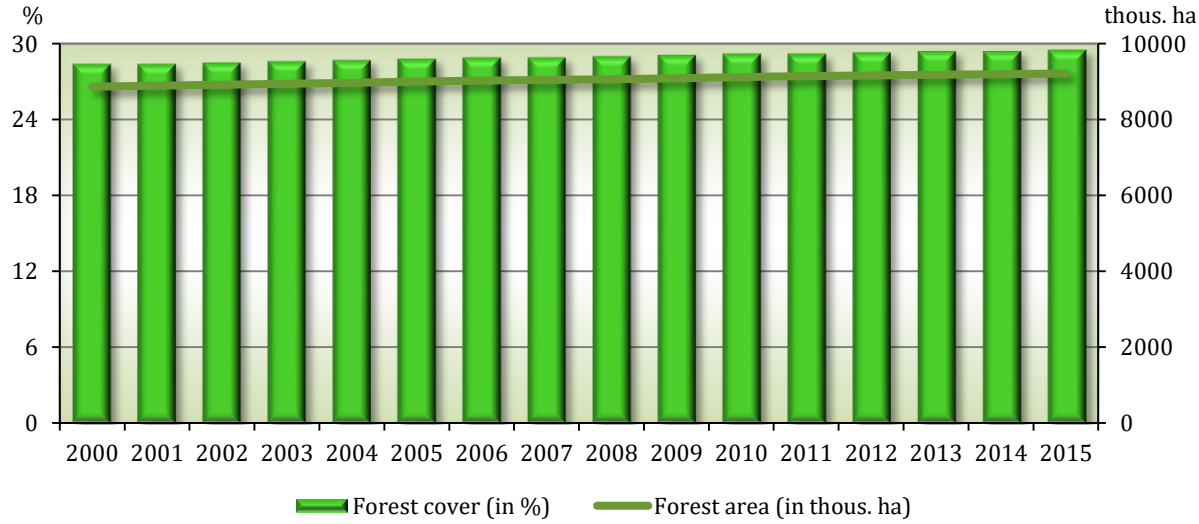
## 2.3. FOREST RESOURCES

***Forest area*** *means compact area of at least 0,10 ha, covered by forest vegetation (wooded area) or temporarily devoid of forest vegetation (non-forested area).*

Forests are the most natural environmental formation and have been inextricably linked to Polish landscape for ages. They are of an undeniable ecological importance and perform a wide scope of ecosystem functions – not only do they provide natural habitat for plant and animal wildlife, but also protection against soil erosion and floods, carbon dioxide sequestration, climate regulation. They also fulfil important social functions – create favourable conditions for health and recreation, and perform productive functions – supply wood and other forestry products. They constitute an indispensable part of environment sustainability and green economy.

In 2015, forests in Poland covered 9214,9 thous. ha, which means that their area increased in comparison to 2014 and 2000 by 0,2% and 3,9% respectively (graph 4). In 2015, forest cover was 29,5% and grew in comparison to both the previous year (by 0,1 pp) and to the year 2000 (by 1,1 pp). The increase of forest area in Poland is a result of the state forest policy, which plans the state forest cover increase to 30% in 2020 and 33% after 2050.

***Graph 4. Forest cover and forest area***




Apart from the state forest cover, growing stock plays an important role in characterizing forest condition and implementing forest policy of the country. The main source of information on growing stock of standing wood in Poland from 2009 is the National Forest Inventory (NFI) conducted by the Bureau for Forest Management and Geodesy. According to the measurements of the NFI, growing stock in 2015 reached the volume of 2491,5 mln $m^3$ of timber gross (a 6,6% increase in comparison to 2009), of which 72,2% referred to coniferous trees and 27,8% – to broadleaved trees.

As a result of a constantly growing forest area and growing stock, it is possible to gradually increase wood harvest. In 2015, wood harvest amounted to 38,3 mln $m^3$ of wood, which means more than a year before and in 2000, by 1,8% and 47,3% respectively. It is important to keep the balance between volume increment of timber gross and wood harvest to preserve the forest heritage for future generations.

While analysing forest resources, their health state cannot be overlooked. Area of damaged forests in Poland in 2015 equalled 3334,9 ha, which constituted 37,8% of their total area. The dominant reasons of damage included, apart from "other agents" category (28,1%), the categories as follows: caused by game (4,2%), fungi (1,7%), and insects (1,3%).

## 2.4. FRESHWATER RESOURCES

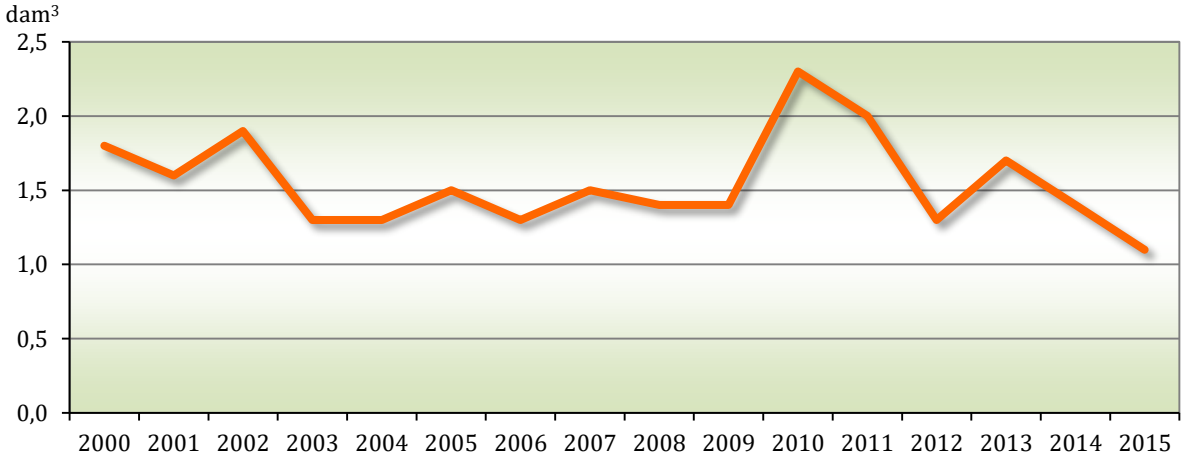
***Water resources*** *mean resources of surface waters and underground waters, available or those which may be available for use in the region, marked with the quantity and quality, in the given period.*

Water is one of the most important resources on the Earth, playing a vital role for all forms of life. It influences civilization development of a country, constituting a factor affecting the standard of living in a significant way. Freshwater resources sufficient in terms of quantity and quality are crucial for ecosystem development, human life, and for undertaking various economic activities.

Poland is a country of limited freshwater resources, whose main part constitute surface water resources, and the remaining part – underground waters.

The most commonly used measurement of establishing the amount of water resources is the indicator of surface waters availability. It states the per capita amount of surface water run-off (from Polish territory, including foreign tributaries) within a year. In 2015, this indicator amounted to 1,1 dam$^3$, which means that it was lower in relation to 2014 and 2000 by respectively 0,3 pp and 0,7 pp (graph 5).

***Graph 5. Indicator of surface waters availability per capita***




*Source:* data of the Institute of Meteorology and Water Management – National Research Institute.

Surface waters are a main source of supplying national economy with water. Surface water withdrawal in 2015 was 8771,6 hm$^3$, accounting for 83,5% of total withdrawal. It means a decrease by 4,1% in relation to 2000. Surface water abstraction from rivers and lakes is used mainly for production purposes – in 2015 it represented 82,1%.

Underground waters as waters of a much better quality are mainly treated as drinking water supply. Exploitable resources of underground waters, by the end of 2015, amounted to 17697,1 hm$^3$, which is more than in 2014 and 2000 by 0,6% and 10,3% respectively. Their withdrawal was 1675,8 hm$^3$ (16,0% of total withdrawal), so in the last 16 years it has decreased by 4,1%.

To illustrate the entire water country demand in relation to available water resources a Water Exploitation Index (WEI) is used. It presents the share of mean annual total abstraction of freshwater in the longterm average freshwater resources. WEI value exceeding 20% means that there is a water stress phenomenon. In the case of Poland this index in a given period was lower than the 20%. In 2014, it equalled 17,9% and was by 1,1 pp lower than in 2000.

Agriculture, industrial infrastructure, urbanization and individual needs of a growing population lead to the increase in freshwater demand, therefore it is important both to monitor its quality and quantity and to use it in an effective way.

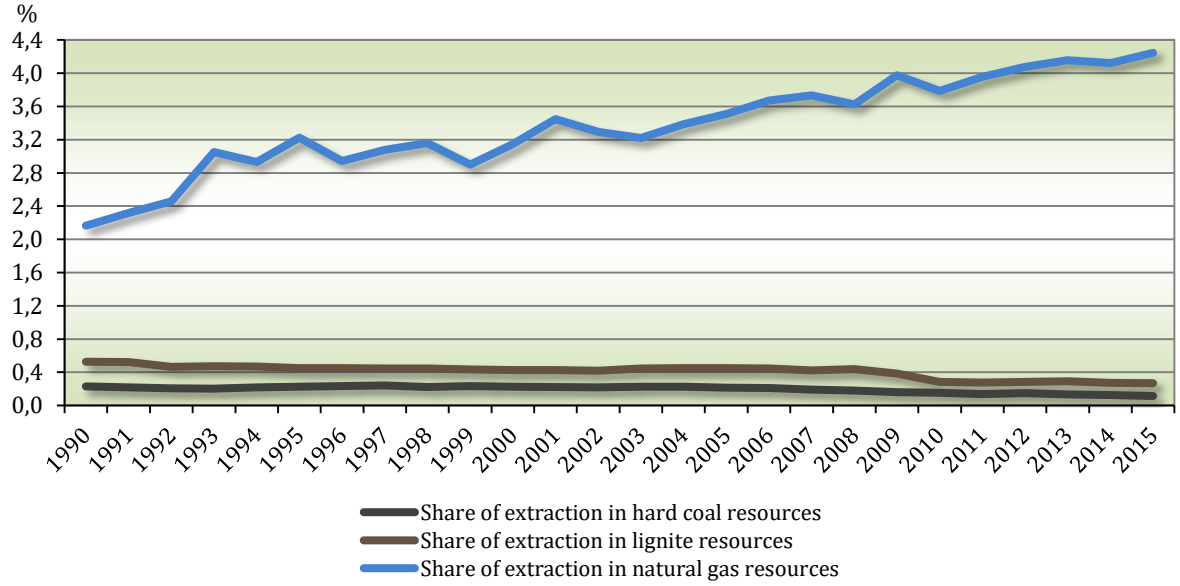
## 2.5. MINERAL RESOURCES

***Mineral resources**, included in the group of non-renewable natural resources, are minerals being elements of the natural environment: earth's crust, hydrosphere, biosphere and atmosphere, delineated from them and adapted for use by a certain branch of technique or specific technology.*

So as to ensure a high standard of living in developed countries and to maintain constant economic growth, fossil fuels and non-metallic minerals play a key role in economy. They safeguard access to energy, warmth, building material resources and they constitute a basis for industry and technological development.

As we are facing a problem of limited and diminishing resources such as hard coal, lignite, and natural gas, achieving green economy objectives should ensure meeting the needs of not only the present but also the future generations. Keeping a relative balance between the volume of non-renewable resources and their extraction is an important factor affecting the stability of economic growth and green growth.

***Graph 6. Share of extraction in balance deposit resources of selected minerals***

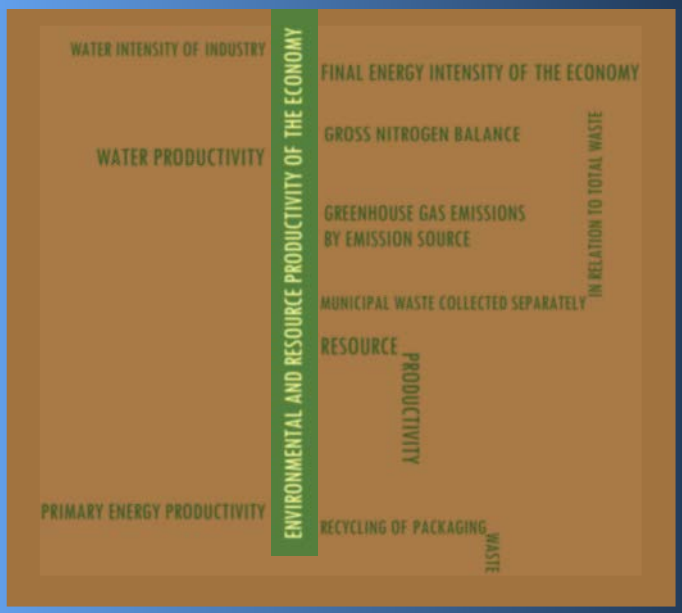



*Source:* data of the Polish Geological Institute – National Research Institute.

In 1990–2015 geological resources of hard coal (balance-sheet and off-balance-sheet) diminished from 86,0 billion tonnes to 72,6 billion tonnes (by 15,6%), which was mainly caused by exploitation and changes in balance criteria. Its exploitation fell from 151,3 mln tonnes to 65,1 mln tonnes (by 57,0%). In 2015, the share of extraction in balance resources of hard coal was 0,1% and was lower by 0,1 pp in relation to 1990 (graph 6).

Lignite, in comparison to hard coal, is a lower ranking type of coal, with a much lower calorific value. In 2015, its geological resources (balance-sheet and off-balance-sheet) were 27,0 mln tonnes, which means that they increased by 58,2% in relation to 1990. The increase was mainly connected with the documentation of new deposits. Due to the fact that coal matter location on the Polish area is identified to a great degree, it can be assumed that the chances for finding new large lignite resources are limited, however, it is possible to discover small and medium deposits of economic significance in the area of carbon deposits. The volume of lignite extraction fell down from 1990 to 2015 from 67,7 mln tonnes to 63,1 mln tonnes (by 6,7%). In 2015, the share of lignite extraction in its balance-sheet resources was 0,3% (in 1990 – 0,5%).

Natural gas, due to its high calorific value, unchangeable chemical composition (the possiblity of even combustion), the ease to regulate the source, smoke-, soot- and ash-free combustion, is the most valuable fuel. It is used in many branches of industry and in households. It is also used to produce electric energy, as fuel for engines, and it is an important raw material for chemical industry. Geological resources of natural gas (balance-sheet and off-balance sheet) diminished since 1990 from 164,1 billion $m^3$ to 125,0 billion $m^3$ in 2015, i.e., by 23,8%. At the same time, environmental sustainability of gas, as well as the wide scope of its use resulted in the fact that its extraction increased by almost one and a half times from 3,5 billion $m^3$ in 1990 to 5,2 billion $m^3$ in 2015, which means that the share of extraction in balance-sheet resources of natural gas was respectively 2,2% and 4,2%.




# ENVIRONMENTAL AND RESOURCE PRODUCTIVITY OF THE ECONOMY

## 3.1. WATER PRODUCTIVITY

***Water productivity*** *is calculated as the gross domestic product (in constant prices) divided by the consumption of water for the needs of national economy and population. The indicator presents GDP per water consumption unit and is used to assess the efficiency of water management.*

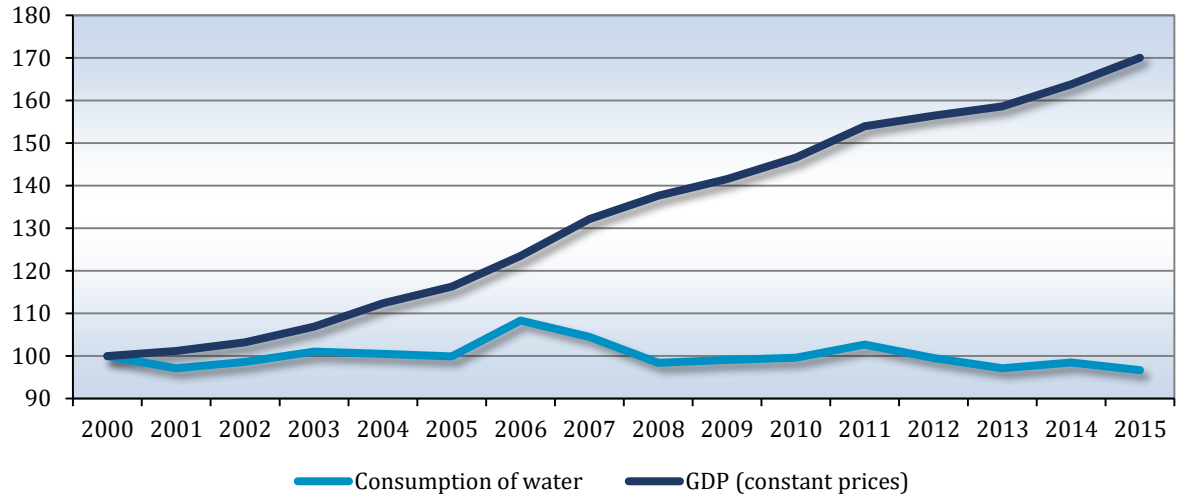
Water plays an important role in processes taking place in ecosystems, constituting an abiotic component of environment, vital for ecosystem functioning. It is a very valuable, distinctive and renewable material, whose resources vary in time. It fulfils different functions in economic activity, therefore it is necessary to protect water against pollution as well as to ensure its rational and efficient use. Water resources are unevenly distributed in the country area and are subjected to seasonal and yearly fluctuations, which makes it necessary to monitor their consumption.

In 2015, consumption of water for the needs of national economy and population was 10058,7 $hm^3$, of which 7471,7 $hm^3$ (74,3% of total water consumption) was for production purposes, exploitation of water supply network – 1595,1 $hm^3$ (15,9%), as well as both irrigation in agriculture and forestry and filling and completing fish ponds – 991,8 $hm^3$ (9,9%). In relation to 2000, positive changes took place, namely a decrease of water consumption by 3,4%, and of which, in the case of exploitation of water supply network – by 9,0%, in agriculture and forestry – by 6,5%, and in industry – by 1,6%. The decrease was noted also in water consumption for the needs of national economy and population per capita (from 272,1 $m^3$ in 2000 to 261,6 $m^3$ in 2015).

The main factor affecting the quantity of used water is economic growth, and production intensity together with the amount and individual consumption patterns. Analyzing the growth of water consumption and GDP in the years 2000–2015 it can be stated that there was a positive trend – an almost constant water consumption level (excluding 2006 and 2007) with a constatnt gradual GDP increase (graph 7).

***Graph 7. Indices of consumption of water for the needs of national economy and population as well as GDP***

2000=100




Efficient water consumption constitutes a base for proper water management. In the years 2000–2015 there was an increase in water productivity index. In 2015, it was 177,71 zl/$m^3$, which means that it increased both to the year 2014 and 2000 by 6,4% and 162,8% respecively.

Since 2001 there have been positive tendencies in Poland in terms of a gradual decrease in the water intensity of industry (excluding the following three years: 2002, 2006, and 2011). In 2015, it reached 18,1 $m^3$/thous. zl, i.e. lower in relation to 2014 and 2001 by 9,5% and 61,2% respectively. Household sector is characterized by a much lower water intensity index, which also decreased gradually. In 2015, it was 2,7 $m^3$/thous. zl, and it remained the same as in 2014, however, in relation to 2003 it decreased by 46,0%.

## 3.2. DOMESTIC MATERIAL CONSUMPTION

***Domestic material consumption (DMC)*** *is defined as the quantity of raw materials extracted from the natural environment in the domestic territory of the economy during the year for further processing or direct consumption, plus all physical imports of raw materials minus all physical exports of raw materials. It measures the total amount of materials directly used by a national economy.*

Domestic material consumption is a basis for economy functioning and is also an important source of both income and employment. Yet, all these three: the extraction, processing and the consumption of produced goods result in a multidimensional pressure on all components of environment. Therefore it is important to make the resource management process in the entire life of a product as little harmful and as efficient as possible and to ensure access to these resources to future generations.

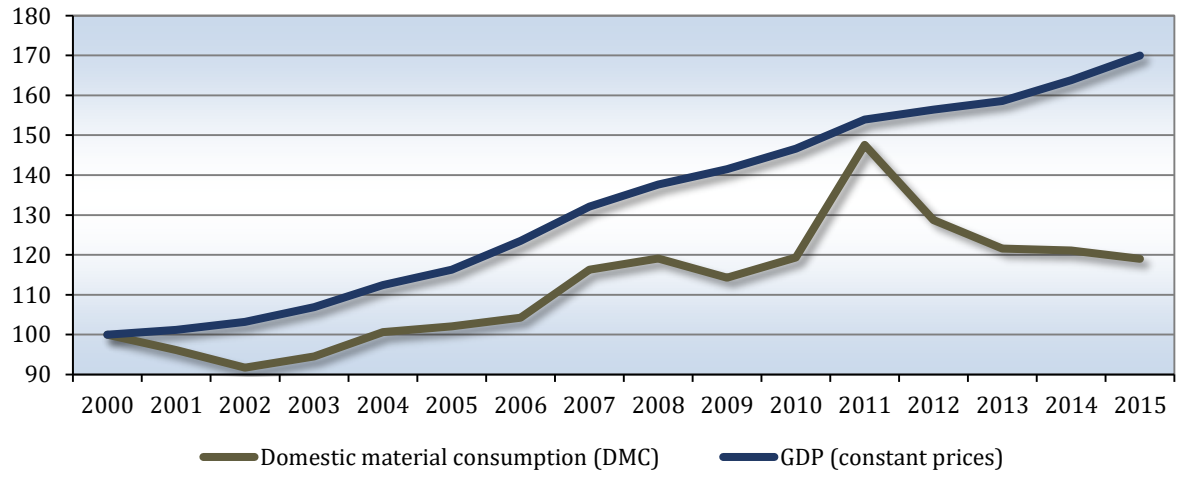
In Poland domestic material consumption in 2015 was 643,2 mln tonnes, which is 16,9 tonnes of materials per capita yearly. In relation to 2014, the consumption was lower by 1,6% and in relation to 2000 there was growth by 20,4%.

In DMC structure, the biggest share have non-metallic minerals (45,9%), whose consumption in the analysed year was 295,1 mln tonnes. The share of remaining materials, i.e., biomass, fossil energy materials, metal ores in the total consumption was 24,8%, 23,7% and 6,4% respectively. In relation to 2000, the consumption of non-metallic minerals increased most, by 72,3%. It is largely connected with the realisation of infrastructure projects financed from EU funds. Yet, the greatest decrease was noted in the consumption of fossil energy materials – by 8,7%.

To measure the efficiency of materials in economy a resource productivity index is used, i.e. a relation of gross domestic product (in constatnt prices) to domestic material consumption. The higher the value of this index, the lower material consumption to produce a unit of GDP. In 2015, the domestic material consumption index for Poland was the highest since 2000 and amounted to 2,78 zl/kg. Within the last sixteen years the efficiency of material consumption has gradually increased, excluding the years 2004 and 2007, when a small increase of material consumption was noted and also excluding 2011, when the increase was considerable.

***Graph 8. Indices of domestic material consumption (DMC) and GDP***

2000=100




*Source:* data regarding domestic material consumption – Eurostat database.

In 2000–2011, with GDP exceeding 50%, domestic material consumption increased almost by 50% (graph 8). It proves the relation between national economic growth and resource use. The tendency was slightly better in 2012–2015, when a trend to increase the domestic material consumption was put to a stop and the GDP increase was maintained.

## 3.3. WASTE MANAGEMENT

***Waste*** *means any substance or object which the holder discards or intends or is required to discard. It includes waste generated in production processes (excluding municipal waste) and municipal waste.*

***Waste (excluding municipal waste)*** *is defined as solid and liquid substances as well as useless items generated in production processes without additional technological treatment.*

***Municipal waste*** *is defined as the waste generated in households (excluding end of life vehicles) as well as waste which does not contain hazardous substances, coming from other waste producers, which in their nature or composition is similar to waste generated in households.*

Waste management can significantly affect environment and human health. Limiting waste generation in the era of increasing production and consumption is an important condition of reducing a negative effect on environment and one of the challenges of today's world. Waste recovery through landfilling is an example of an inefficient resource management, leading, additionally, to pollutant emissions to air, land and water, to wasting land on landfilling sites or damaging the natural beauty of landscape. Only the re-use of waste, its recovery or recycling make it possible for the waste to become a resource-to-be, helping to reduce the use of raw materials for the production of goods, and to a more efficient resource management.

### Waste (excluding municipal waste)

In 2015, in Poland 141,8 mln tonnes of waste were produced, of which 92,3% was waste other than the municipal one.

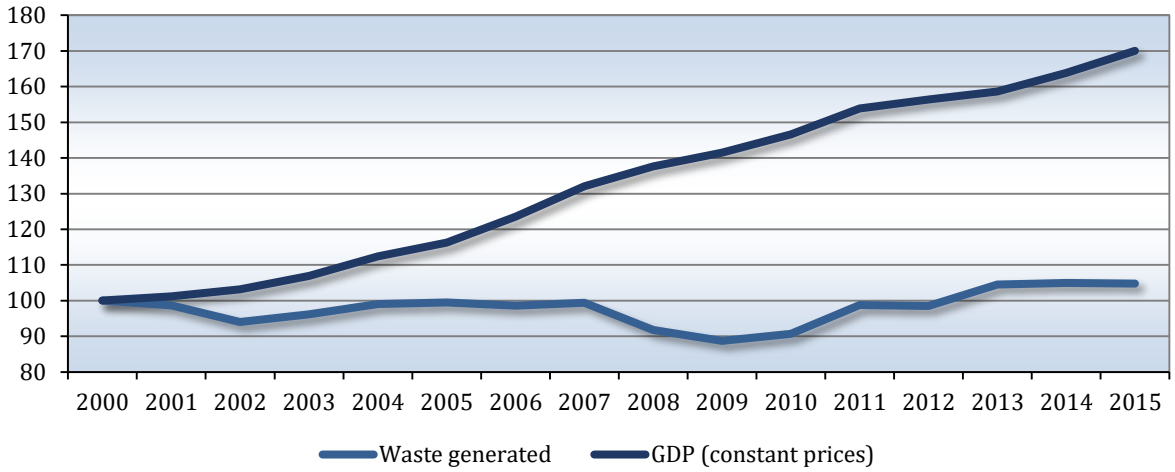
In the period 2000–2007 and 2011–2012 the amount of generated waste (excluding municipal waste) was relatively stable and fluctuated around 120 mln tonnes. Its lowest value, within 111–115 mln tonnes, was noted in the years 2008–2010, which could have been a result of, among others, the economic slowdown. In 2015, 131,0 mln tonnes of waste were produced, which is a decrease by 0,2% in comparison with the previous year but an increase by 4,4% in relation to 2000. The main source of waste generation were entities belonging to the following sections: mining and quarrying (53,4% of total amount of generated waste excluding the municipal one), manufacturing (21,3%), as well as electricity, gas, steam and air conditioning supply (16,2%).

Recovery processes play a meaningful role in waste management. In 2015, waste packaging producers themselves recovered 21,9% of generated waste (in 2014 – 21,0% of overall mass of waste other than municipal waste) and disposed of 20,2% of waste, mainly by transferring it to landfills (in 2014 – 20,3%). It is a favourable tendency resulting from, among others, activities undertaken to improve waste management in Poland.

When analyzing the dynamics of the changes in the amount of waste generated in relation to GDP (graph 9), in the years 2000–2015, there can be noted a positive trend, namely a 70% increase in GDP is accompanied by a relatively stable waste production level.

***Graph 9. Indices of waste generated (excluding municipal waste) and GDP***

2000=100




## Municipal waste

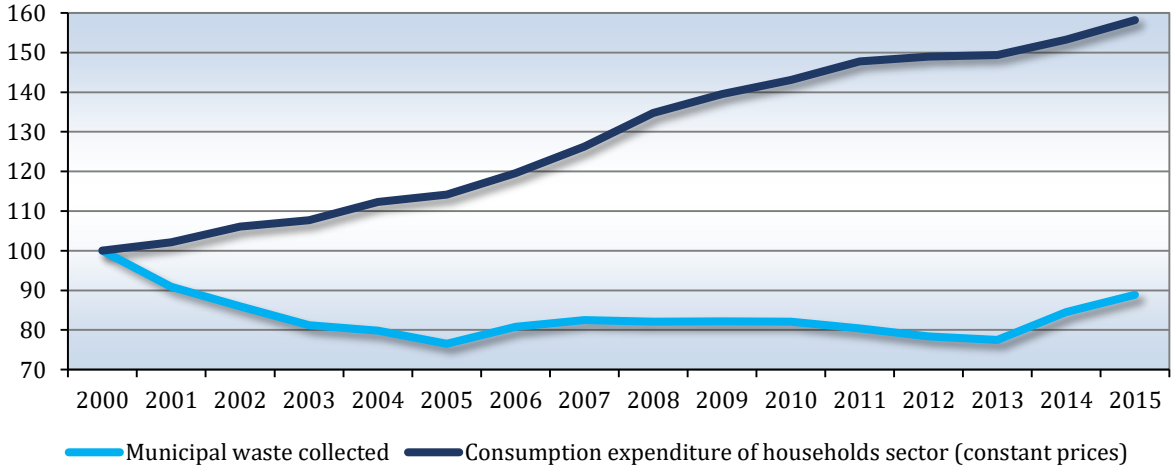
The most important tasks in municipal waste management, resulting from the need to protect the environment, boil down to minimising waste production and to maximizing their management as well as to limiting to the necessary minimum waste landfilling in environment.

In 2015, in the country 10,9 mln tonnes of municipal waste were collected, which means an increase both in relation to 2014 and 2003, by 5,2% and 9,5% respectively. In 2015, an average resident of Poland produced 282,5 kg of waste, which is 8,7% more (by 22,7 kg) than in 2003.

In 2015 in Poland, 2,5 mln tonnes of municipal waste were collected separately. The proportion of waste collected separately in the total mass of collected municipal waste from 2003 has been gradually growing, reaching 23,4% in 2015. This positive trend can result from, among others, a steady rise of society's ecological awareness, as well as from the implementation of programmes of managing municipal waste. Yet, although the amount of waste collected without selecting is falling, it has a high share there, amounting to 76,6% in 2015.

***Graph 10. Indices of municipal waste collected and consumption expenditure of households sector***

2000=100




It is noteworthy that, in relation to 2000, the increase in consumption in household sector by almost 60% (graph 10) was accompanied by the decrease by 11,1% in the dynamics of

municipal waste collected. It can be indicative of positive trends in municipal waste management.

## Recycling of packaging waste[1]

One of the main methods of reducing the amount of waste is recycling, whose main task is to maximize the re-use of materials. The share of packaging waste actually recycled in size of packaging launched into the market in the last eleven years has changed dramatically. In the period of 2004–2007, a year by year growth was noted, and in the next two years –a decrease, while from 2010 (with 2013 being the exception) an increase was noted again. In 2014, recycling rate for packaging waste was 55,4% and returned to an upward path in relation to 2013 and 2004 by 19,3 pp and 27,1 pp respectively.

[1] Data for the years 2004–2014 have been changed in comparison with the data published in the previous edition of the Report.

## 3.4. NITROGEN AND PHOSPHORUS BALANCES

***Gross nitrogen and phosphorus balance*** *means the difference between the quantity of nitrogen / phosphorus introduced on agricultural land and obtained from agricultural land. Gross nitrogen balance sheet consists of, apart from emission of its compounds to land and water, gas "losses" in the form of ammonia and nitric oxide, in the livestock production processes, including the processes of storage and application of manure, as well as mineral nitric fertilizers.*

Modern agriculture has a significant effect on environment. It is important to keep the balance between nature protection and economic benefits so as to ensure the restoration of natural resources necessary for further production activities. Agricultural activity interferes in natural nutrient cycles, giving rise to the danger of toppling ecosystem balance.

Biogenic compounds of nitrogen and phosphorus that remain unused are among the most serious dangers generated by agriculture. They can be released to groundwater and open water and in the case of nitrogen ones they can be released to air. Their deficit can, in turn, lead to a lower productivity and soil degradation.

Nowadays it is difficult to imagine agriculture without fertilizing. Fertilizer application is a main yield factor, influencing agricultural production development. Economic effects are largely dependent on the amounts of fertilizers used. However, overdosing and misapplication of fertilizers lead to the accumulation of harmful components in soil and transferring them to animal and human food chain.

Consumption of nitric fertilizers (in pure ingredient – N) in the economic year 2015/2016 was 1,1 mln tonnes and was higher in relation to the previous year and to the 1999/2000 economic year by 4,8% and 22,1% respectively. The figure of nitrogen fertilizers per 1 ha of agricultural land in the economic year 2015/2016 was 73,1 kg, while a year before – 69,0 kg, and in the economic year 1999/2000 – 48,4 kg.

In the case of the use of phosphoric fertilizers in the economic year 2015/2016, which amounted to 0,3 mln tonnes (in pure ingredient – $P_2O_5$), there was an increase in relation to the previous year by 8,1% and an increase by 10,6% in comparison to the economic year 1999/2000. In the analysed year, the use of phosphoric fertilizers per 1 ha of agricultural land was 22,8 kg, in the previous year-– 20,9 kg, and in the economic year 1999/2000 – 16,7 kg.

Nitrogen and phosphorus balances, as an example of many agri-environmental indicators, are a very important source of information on agricultural influence on environment conditions. A comprehensive evaluation of gross nitrogen and phosphorous balances is carried out on the basis of at least a 3-year cycle, which is to reduce data variation caused by weather conditions.

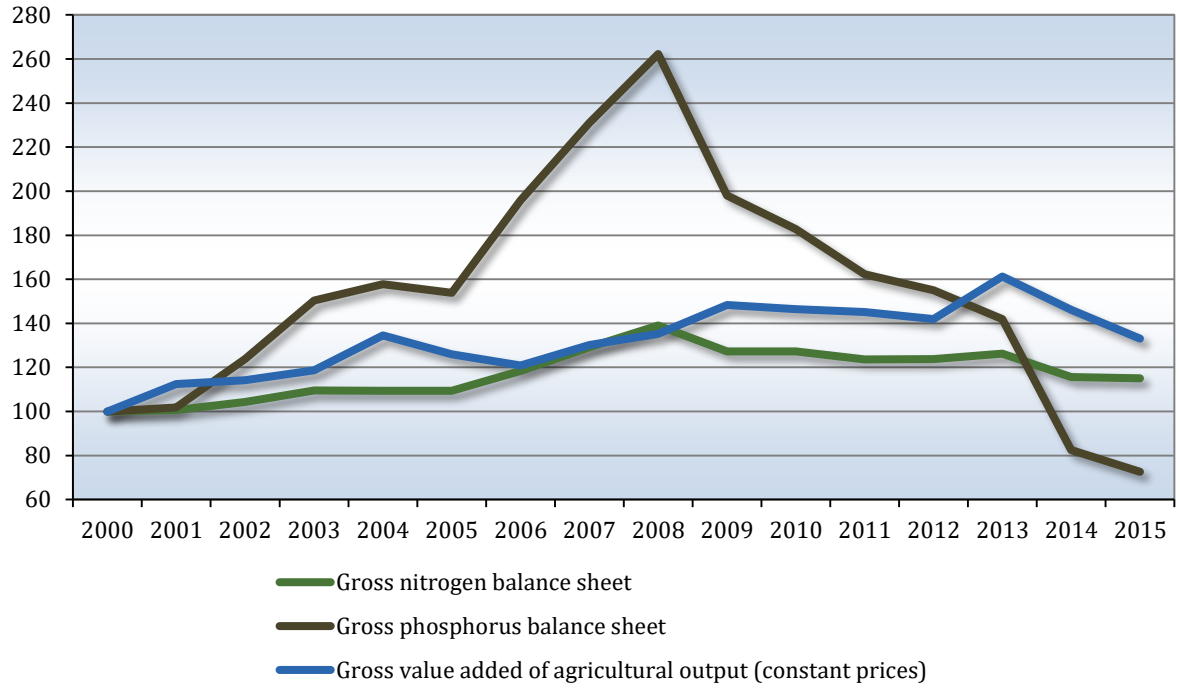
In nitrogen plant fertilization, nitrogen balance is in general disturbed, due to inevitable losses to air or leaching nitrates to lower levels of soil and groundwater. It is assumed that because of the yield and the quality of groundwater, the gross nitrogen balance sheet should amount to 30–70 kg per 1 ha of agricultural land.

Analysing data concerning the last 16 years, it can be noted that for Poland the average gross nitrogen balance per 1 ha of agricultural land grew from 41,1 kg in the period of 1998––2000 to 47,4 kg in 2013–2015. This value is, however, kept at a safe level – below 70 kg per 1 ha of agricultural land.

Although the gross nitrogen balance from the year 2000 has been constantly growing, the dynamics of its growth (excluding 2008) was decisively lower than the growth rate of gross value added of agricultural output (graph 11), which is indicative of relative decoupling between agricultural output and nitrogen balance.

***Graph 11. Indices of gross nitrogen and phosphorus balance sheet[a] as well as gross value added of agricultural output***

2000=100




*a* Data for given years are calculated as 3-year averages, e.g., for the year 2000 as an average for the years 1998–2000.

*Source:* data regarding gross nitrogen and phosphorus balance sheet – the Institute of Soil Science and Plant Cultivation – National Research Institute (Jerzy Kopiński, Beata Jurga), prepared within the framework of 2.1 PW IUNG-PIB 2016–2020 task according to "Nutrient Budgets" methodology OECD/Eurostat, on the basis of CSO and Institute of Environmental Protection data collected within the State Environmental Monitoring and National Centre for Emissions Management (KOBiZE).

Phosphorus balance is a basic measure to assess the following: efficiency of plant output, making use of limited phosphate resources and environmental protection. As Polish soil is poor in this macroelement, its supplementation in the form of fertilization is necessary. It is assumed that phosphorus balance, with an average phosphorus soil content should be nearing zero, however, with a low phosphorus soil content – to 5 kg per 1 ha of agricultural land. Within the last 16 years, an average gross phosphorus balance per 1 ha of agricultural land for Poland decreased from 3,0 kg in the period of 1998–2000 to 2,2 kg in the years 2013–2015.

Within last sixteen years phosphorous balance dynamics was gradually growing, and since 2002 (except for 2013) it has exceeded gross value added of agricultural output (graph 11). The highest increase was noted in 2008, and in the years that followed it was gradually slowing down. In 2015, just like a year before, phosphorus balance was lower than the one observed in 2000.

Taking into consideration data presented in graph 11, it can be stated that in the period of 2000–2012 the gross value added of agricultural output and phosphorus balance were interrelated. After 2012, this relationship has changed.

## 3.5. ENERGY PRODUCTIVITY

***Primary energy*** *is energy embodied in the primary energy carriers that are acquired directly from renewable and non-renewable natural resources, necessary to cover the demand for final energy, having regard to the efficiency of the entire chain of processes related to production, conversion and transport to final costumer.*

***Total primary energy consumption*** *(gross inland consumption of energy) expressed in tonnes of oil equivalent (toe) is the sum of consumption of five energy types: coal, electricity, oil, natural gas and renewable energy sources.*

***Toe*** *– tonne of oil equivalent (conventional) is the energy measurement unit from different energy carriers, using conversion rates, and used in international balances. It means the amount of energy that can be produced by burning one metric tonne of crude petroleum. One tonne of conventional oil equals 41,868 GJ (11,63 MWh).*

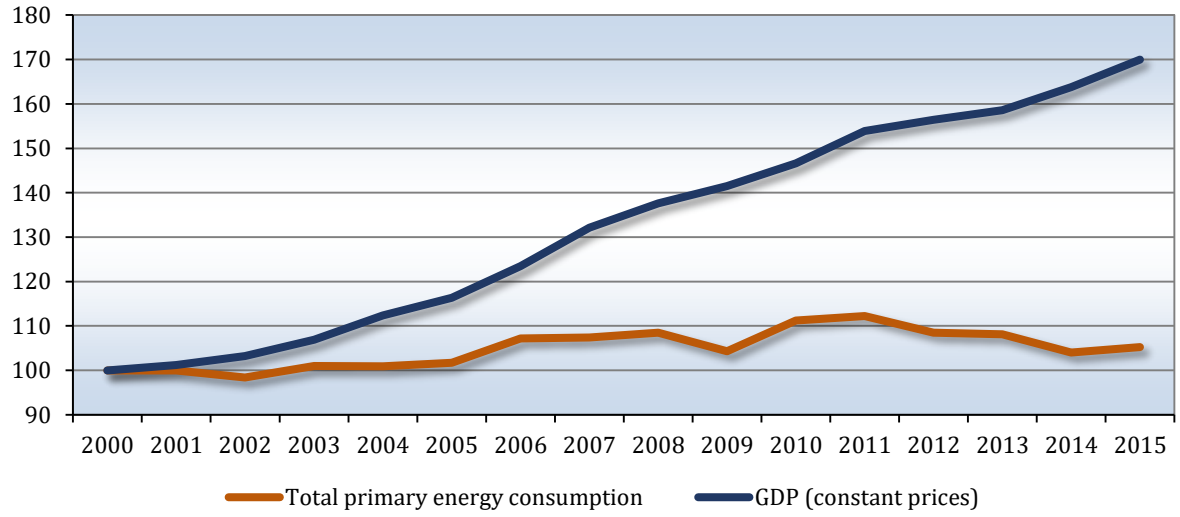
Energy is used in production processes and in households. Its efficient use in economy constitutes an important factor influencing production costs and product competetiveness on international market. Careless use of energy leads to problems with pollution of natural environment (through greenhouse gas emissions) and to energy resources depletion. Energy demand is constantly growing, therefore the main objectives of green economy include, among others, the need for improvement of energy efficiency and the need for the efficient use of existing energy resources.

In 2015, the total primary energy consumption was 95,1 Mtoe and was higher in relation to the previous year and in comparison to 2000 by 1,2% and 5,2% respectively. Among primary energy carriers in 2015, hard coal and lignite held a dominating position (55,7% of total consumption). Their share in the total consumption in relation to 2000 was reduced by 9,0 pp.

Although the consumption of primary energy in economy from 2000 increased (with 2002 being the exception), its growth rate was much lower than GDP growth rate, which means a relative decoupling between economic growth and energy consumption (graph 12).

***Graph 12. Indices of total primary energy consumption and GDP***

2000=100



To assess the energy policy of the country a primary energy productivity indicator, which is a relation between gross domestic product (constant prices) and a total primary energy consumption, can be used. A higher value of the indicator means a lower energy consumption to produce a GDP unit. In 2015, this measure was 18,80 zl/kgoe and grew in relation to 2014 and 2000 by 3,3% and 141,2% respectively, which is a positive fact.

In the analysed period changes in the structure of final energy consumption structure, i.e. used by final customers (exclusively for energy purposes without processing into other energy carriers) also took place. In 2015, the biggest consumers were households with a 30,9% share, a transport sector – 27,6%, and industry – 23,3%. In industry in relation to 2000, a fall of 8,4 pp was noted in the share of final energy consumption, which can result from, among others, this sector restructuring and introducing new energy-efficient technology. The greatest increase in the final energy consumption structure was noted in transport by 10,7 pp, i.a., as a result of a dynamic development of road transport and services.

During the years 2000–2015 a gradual decrease of final energy intensity of Polish economy was observed. In 2015, it was 34,2 kgoe/thous. zl, which means a decrease in relation to 2014 and to 2000 by 3,2% and 55,6% respectively.

In the case of households, the final energy intensity of this sector, depicting the relation between final energy consumption and gross value added (in constant prices) produced in this sector, is gradually falling from 2000 (except for 2010). In 2015, it amounted to 41,3 kgoe/thous. zl and was lower in relation to 2014 by 2,6% and in comparison with 2000 – by 51,6%.

In the period of 2001–2015 also in industry there were positive trends such as the decrease in the final energy intensity indicator of this sector, presenting the relation between final energy consumption in industry and gross value added (in constant prices) of this sector. In 2015, this indicator was 34,6 kgoe/thous. zl and in comparison with the previous year and 2001, a decrease was noted by 7,6% and by 65,3% respectively.

Final energy intensity of transport is measured as a relation of final energy consumption of transport sector to GDP (in constant prices) and in 2015 it was 9,4 kgoe/thous. zl. It was higher in comparison with 2014 by 1,1% and in comparison with 2000 it was lower by 27,6%.

## 3.6. RENEWABLE ENERGY

***Renewable energy*** *is the energy derived from natural, repetitive environmental processes, obtained from renewable non-fossil energy sources (energy: hydro, wind, solar heat, geothermal heat, waves, sea currents and tides and energy obtained from biomass, biogas, biofuels) as well as natural environment energy used by heat pumps.*

Growing demand for energy, resulting from civilizational growth and care for environment, and for air quality in particular, the need to limit the impact on climate change, as well as the finite amount of resources together with the price rise of conventional energy carriers lead to the increase of renewable energy consumption.

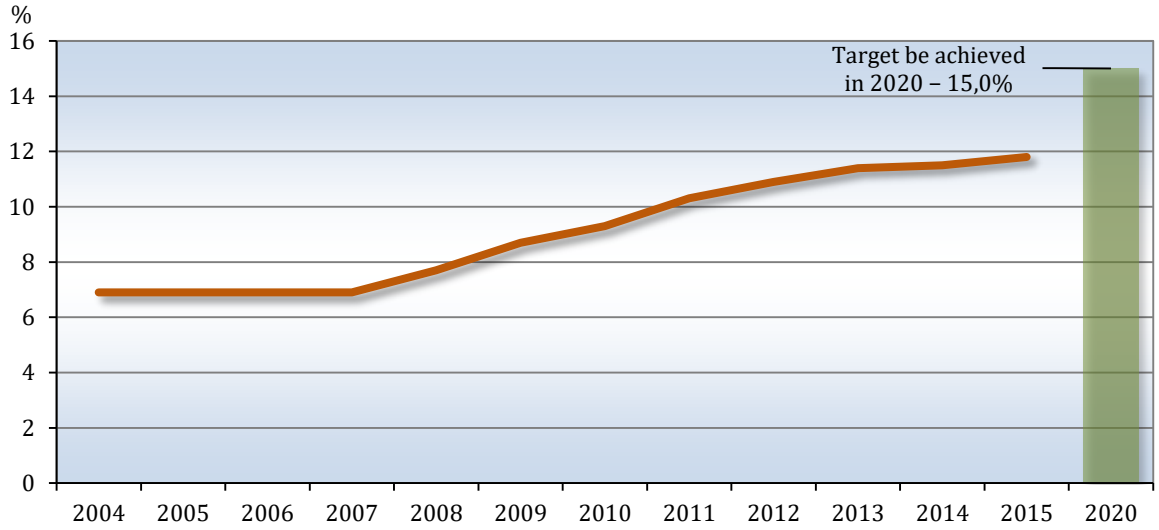
In recent years renewable energy sources (RES) have been used as an alternative to traditional energy resources. The main reason for their growing popularity is the fact that they can be treated as inexhautibe and, at the same time, decisively less dangerous to environment than traditional energy carriers, primarily because of the reduced emission of harmful substances. Energy generation with the use of traditional sources is one of the causes of alarming climate changes, and global resources of traditional carriers are constantly diminishing.

Within the last 12 years there has been a constant increase in the amount of renewable energy, from 4,3 Mtoe in 2004 to 8,6 Mtoe in 2015. Biomass occupied the first position in Poland (72,6%) in the structure of energy generation with the use of renewable sources by type of carriers. The share of remaining carriers was as follows: biofuels and wind energy (10,8% each), biogas (2,6%) as well as hydro energy (1,8%).

The increase in the share of renewable energy in gross final energy consumption is a part of energy policy of the European Union, Poland included. For the latter the goal concerning this issue was established at 15% to be achieved in 2020. What is more, it is assumed that the share of renewable energy in all means of transport by the year 2020 will constitute at least 10% of energy consumption in transport.

In 2015, the share of renewable energy in gross final energy consumption was 11,8%, which is indicative of growth in relation to the previous year and the year 2004 by 0,3 pp and 4,9 pp respectively (graph 13).

***Graph 13. Share of renewable energy in gross final energy consumption***



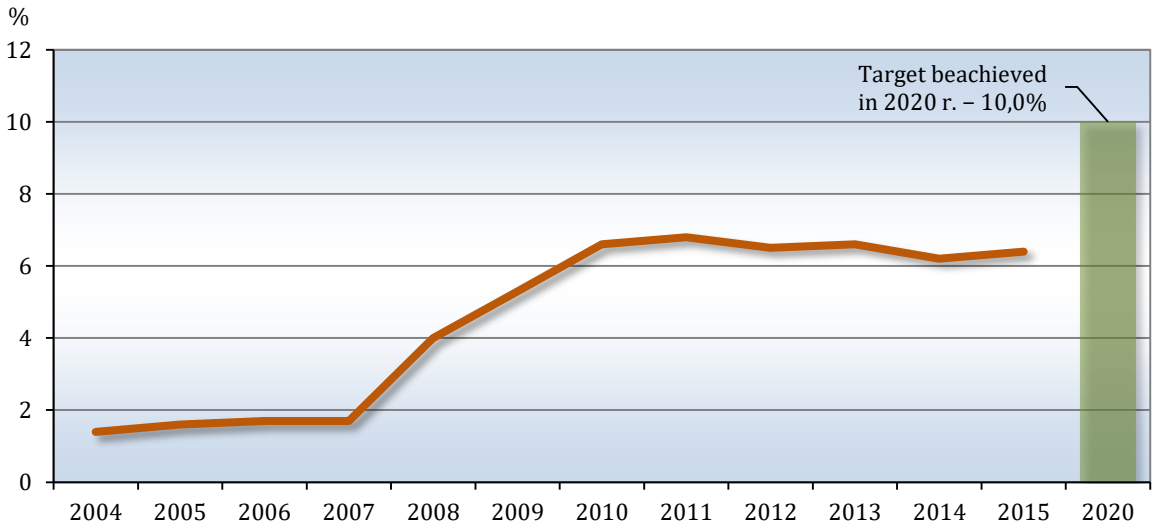

*Source:* Eurostat database.

The growth of the number of cars and the development of the transport sector lead to the growing demand for energy, including crude petroleum. It generates problems connected

with the increase in natural environment pollution and with crude petroleum depletion, additionally, it makes it necessary to enhance alternative fuels (i.a. biofuels) use in transport.

In the period 2004–2011, a constant increase of the share of renewable energy in fuel consumption of transport was noted and its highest level (6,8%) was reached in 2011 (graph 14). In the years that followed this indicator was slightly lower and equalled 6,4% in 2015.

***Graph 14. Share of renewable energy in transport***




*Source:* Eurostat database.

Biofuel production for transport grew from 13,4 thous. toe in 2004 to 935,6 thous. toe in 2015. In the structure of energy generation from biofuels, from 2004 a dominating position belonged to biodiesel (in 2015 – 87,8% of the total energy production from biofuels), the remaining part – to bioethanol (in 2015 – 12,0%).

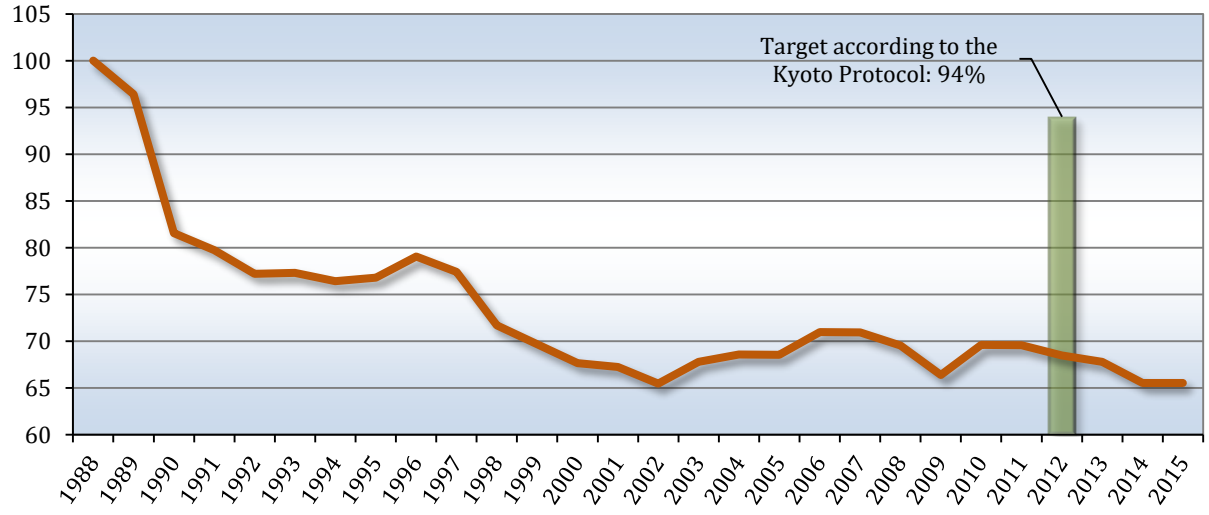
## 3.7. GREENHOUSE GAS EMISSIONS

***Greenhouse gases*** *are gases preventing the emission of infrared radiation from Earth, causing surface warming. They are emitted to atmosphere as a result of natural processes and human activity. According to the Kyoto Protocol greenhouse gases (the Kyoto basket) refer to carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$) and industrial gases: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride ($SF_6$) and nitrogen trifluoride ($NF_3$).*

The Republic of Poland has entered international activities aiming at preventing climate change by ratifying in 1994 the United Nations Framework Convention on Climate Change (1992) as well as in 2002 the Kyoto Protocol (1997). One of the main obligations arising from signing the Kyoto Protocol by Poland is the greenhouse gas emission reduction in the years 2008–2012 by 6% in relation to the base year, which is the year 1988 for Poland. In 2012, greenhouse gas emission in Poland was 399,1 mln tonnes of $CO_2$ equivalent, which means a significant fall by 31,2% in comparison to 1988 (graph 15). This reduction substantially exceeded the Polish obligation. It is necessary, however, to reduce greenhouse gas emissions further on. According to the Doha amendment and "Europe 2020" strategy in the period of 2013–2020, countries jointly with the European Union plan to reduce the emission by at least 20% in relation to the base year (for the majority of countries it is 1990). According to the data of the National Centre for Emissions Management in 2015 in Poland it was reduced by 17,5% in comparison with 1990 (by 33,5% in relation to 1988).

***Graph 15. Indices of greenhouse gas emissions***

1988=100

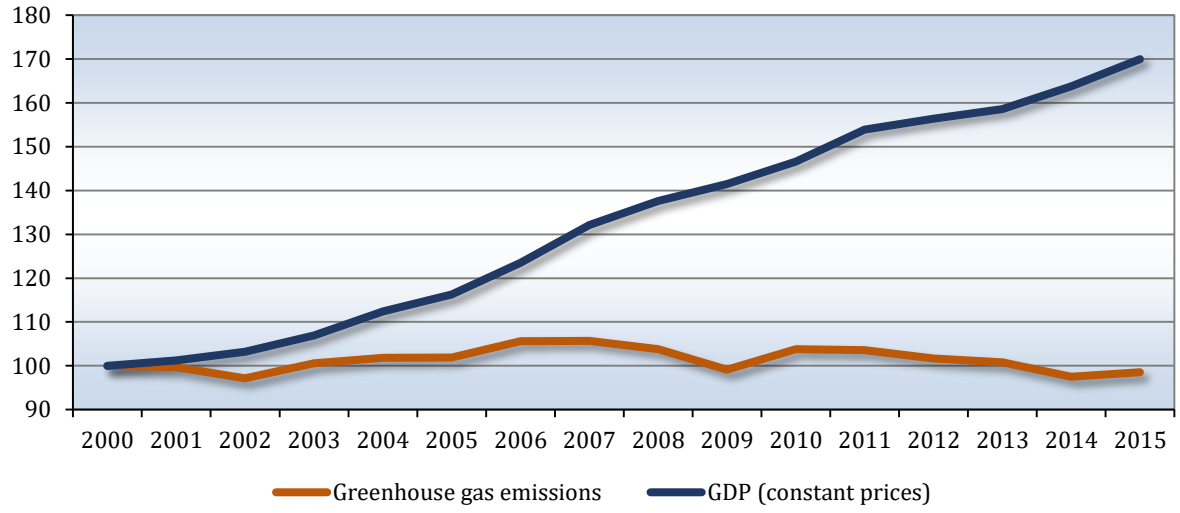



*Source:* data of the National Centre for Emissions Management.

During the years 2000–2015 the GDP growth rate was decisively faster than the greenhouse gas emission rate. In 2015, in comparison to 2000, there was a fall in gas emissions by 1,5% at 70% GDP increase (graph 16).

***Graph 16. Indices of greenhouse gas emissions and GDP***

2000=100




*Source:* data of the National Centre for Emissions Management.

In 2015, the largest share of greenhouse gas emission in Poland had carbon dioxide (80,5% of total emission), followed by methane (12,2%), nitrous oxide (4,9%) and HFCs, PFCs, $SF_6$ and $NF_3$ (2,3%). In accordance with the classification prepared by Intergovernmental Panel on Climate Change (IPCC), in 2015 the sector most responsible for greenhouse gas emission was the energy one (81,9% of total emission) and in a smaller scope – agriculture (7,7%), industrial processes and product use (7,4%) followed by waste management (3,0%). Carbon dioxide emission was mainly affected by energy sector (93,6%), industrial processes and product use (6,0%).

In 2007, the European Commission presented the so-called 2020 climate and energy package, which, among other things, diversifies greenhouse gas emission reduction targets in 2020 in relation to emission levels in 2005 for sectors in and not in the European Union Emissions Trading System. For sectors not covered by the ETS, the so-called non-ETS sectors, for Poland there was a proposal of a 14% increase in the greenhouse gas emissions in 2020 in comparison to 2005 (the EU average – a 10% reduction). According to Eurostat data, in 2015, the total greenhouse gas emission expressed in $CO_2$ equivalent in non-ETS sectors in Poland was 181,6 mln tonnes, which is a 2,3% increase in comparison to 2005.


# ENVIRONMENTAL QUALITY OF LIFE

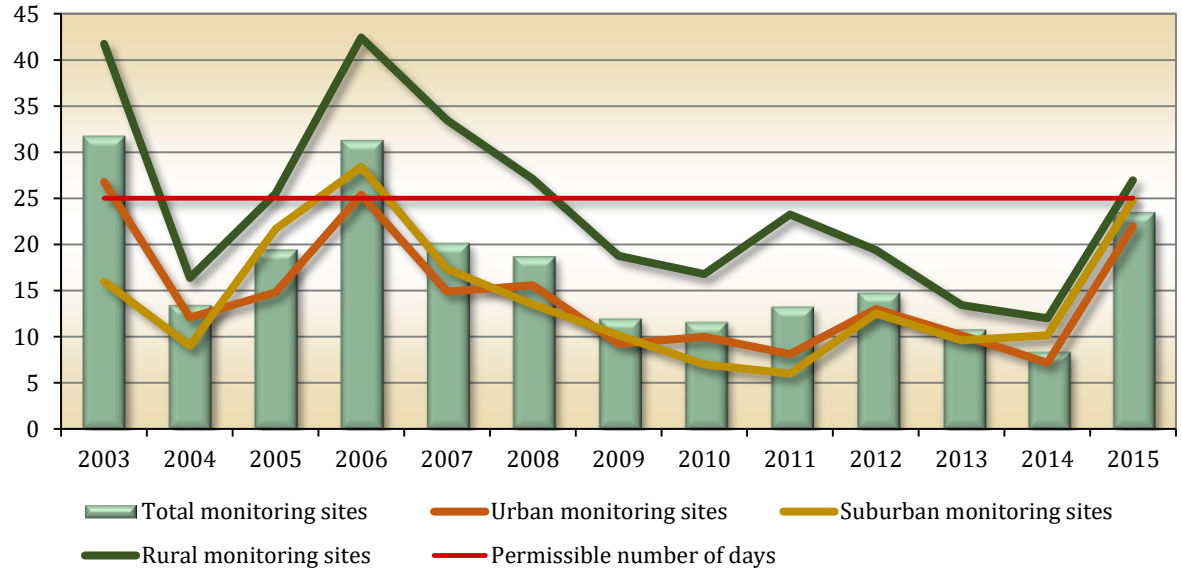
## 4.1. GASEOUS AIR POLLUTANTS

***Tropospheric ozone (ground-level $O_3$)*** *is secondary pollution, released in the ground level of the atmosphere as a result of photochemical transformations (upon exposure to solar radiation) in the air polluted with the so-called ozone precursor substances: nitrogen oxides, carbon oxides (CO), methane ($CH_4$), non-methane volatile organic compounds (NMVOCs). Ozone concentration level is also affected by such weather conditions as: high air temperature, high insolation and a lack of precipitation.*

Air pollutants are a main cause of threat to environment. They affect all these: the environment, health condition and quality of life of a population. They cannot be restricted by area, so that they can contaminate vast distance areas. One of the most important negative results of air pollution in Poland is the increase in tropospheric ozone concentration in the ground layer of the atmosphere (ground-level $O_3$), especially in a summer season.

Due to health protection, the target value determined for ozone amounts to 120 µg/m$^3$ and is calculated on the basis of maximum daily 8-hour mean of ozone concentration from all monitoring sites. 25 days exceeding the target value within a calendar year is allowed. In 2015, the average number of days with the exceeded target value calculated on the basis of measurements taken at all sites that were used to assess oyone air pollution amounted to 24 and was one of the highest ones since 2003 (graph 17). The year with the highest number of days exceeding the limit was 2003 – 32 days and 2006 – 31 days. In the years 2007–2014 this indicator did not exceed 20 days.

***Graph 17. Average number of days with exceeded value of 120 µg/m$^3$ by 8-hour ozone concentration by type of monitoring site*** [a]




*a* Data from full data series from monitoring sites within the State Environmental Monitoring (SEM) framework.

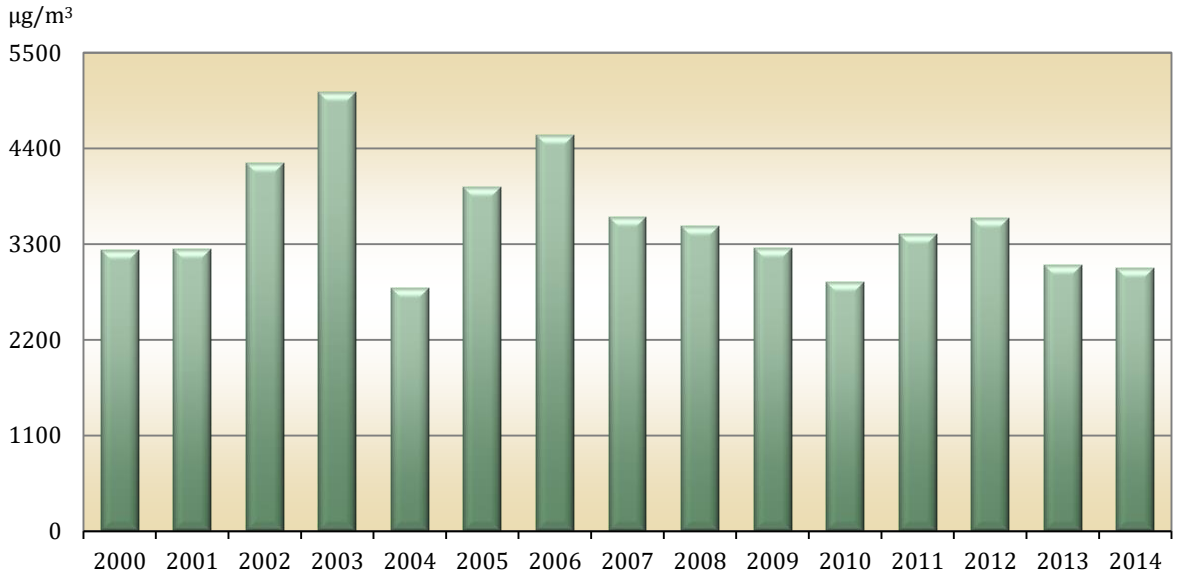
*Source:* own elaboration on the basis of the data of the Chief Inspectorate of Environmental Protection.

Taking into consideration the type of the ozone concentration monitoring site (urban background, sub-urban background, rural background), the least favourable situation was noted at rural background sites. It means that the residents of rural areas are exposed to higher ozone concentration levels than city residents.

The exposure of city residents to ozone can also be assessed on the basis of SOMO35 indicator. It presents the yearly sum of means of daily maximum 8-hour $O_3$ concentrations over 70

µg/m³. The accepted value of this indicator is not stated, however, the higher the level, the higher the threat to human health. In 2014 this indicator equalled 3028 µg/m³ and was one of the lowest values noted since 2000 (graph 18).

***Graph 18. Urban population exposure to air pollution by ozone (SOMO35)***




*Source:* data of the European Environment Agency (EEA).

Exposure of humans (children, the elderly, and people spending much time outdoors especially) to high concentrations of tropospheric ozone causes numerous negative health conditions. It can lead to eye irritation, an increased susceptibility to infections, reduced lung capacity, deterioration of asthma and other lung disorders, moreover to premature mortality. The European Environment Agency estimated (on the basis of SOMO35 indicator) that air pollution with ozone caused 1150 premature deaths in Poland in 2013.

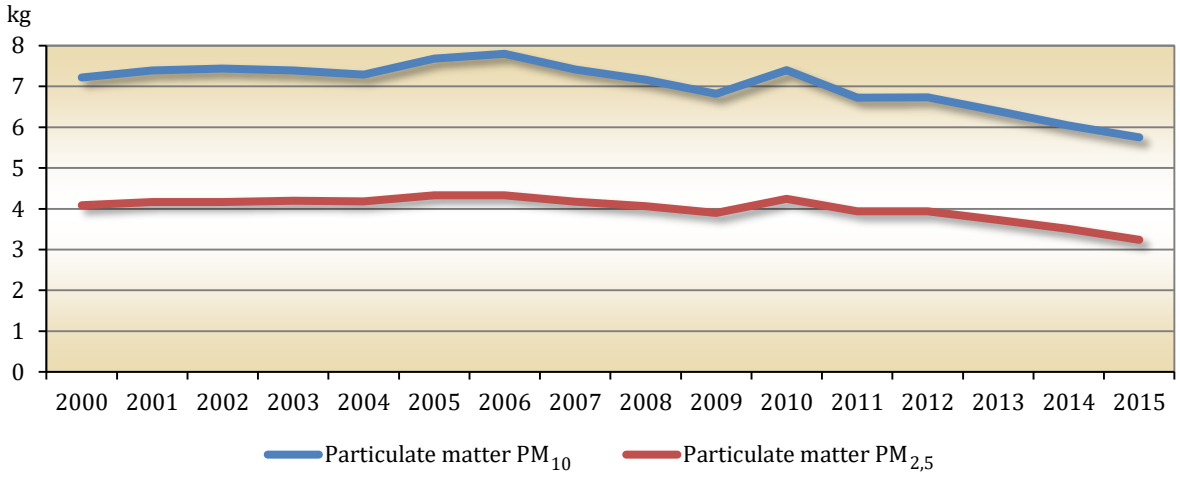
## 4.2. PARTICULATE AIR POLLUTANTS

***Particulate matter*** *is air pollution that is a mixture of fine solid and liquid particles, consisting of both organic and inorganic compounds. The surface of particulate matter is a carrier of chemical compounds toxic to human health, such as heavy metals (arsenic, nickel, cadmium, lead) and polycyclic aromatic hydrocarbons (e.g. benzo(a)pyrene).*

A serious problem connected with air quality in Poland is exceeded norms for particulate matter, especially in winter season, which mainly influences comfort of living of population of inner-city areas of big cities and agglomerations. Particulate matters come from direct emission (primary particles) or as a result of a reaction between substances in the atmosphere (secondary particles). Secondary particle precursors are mainly sulphur dioxide, nitrogen oxides, non-methane volatile organic compounds and ammonia. Particulate matter contains fraction of grains below 10 micrometres ($PM_{10}$), including the fraction below the diameter of 2,5 micrometres ($PM_{2,5}$). The PM composition largely depends on where it comes from, the season of the year and weather conditions.

In 2015, $PM_{10}$ emission in Poland was 221,1 thous. tonnes and was by 1,0% lower than in the previous year and by 18,5% lower than in 2000. In the case of $PM_{2,5}$, its emission equalled 124,6 thous. tonnes and was lower than both in 2014 and in 2000 by 0,8% and 16,8% respectively. Per capita, the emission of $PM_{10}$ was 5,8 kg, of which $PM_{2,5}$ – 3,2 kg and the figures for these indicators were lower than the ones noted in 2000 (graph 19).

***Graph 19. Emissions of $PM_{10}$ and $PM_{2,5}$ per capita***



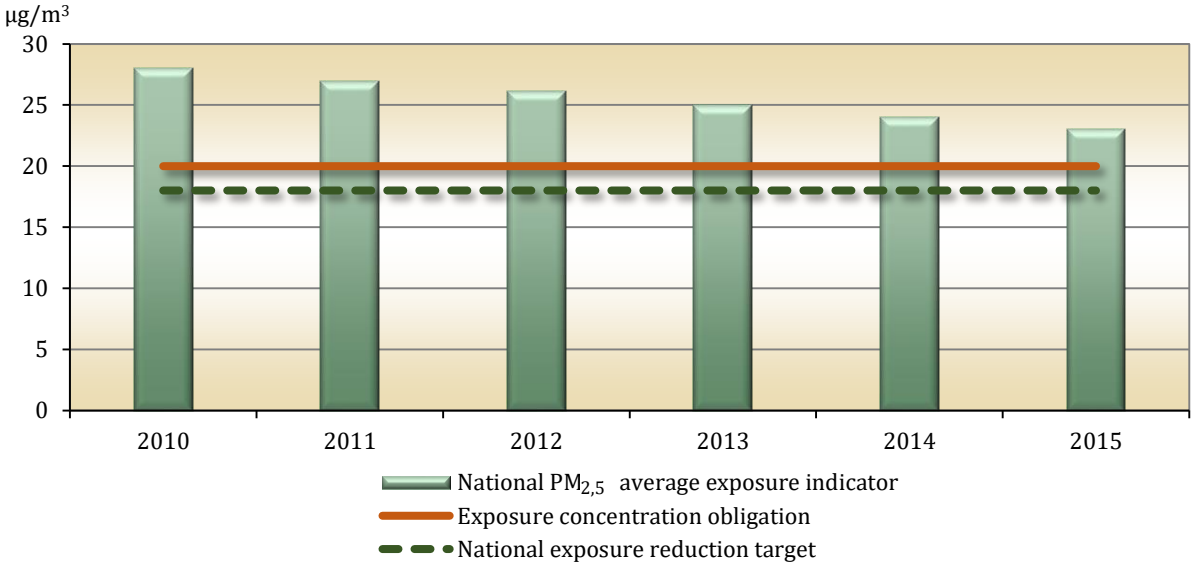

*Source:* data concerning particulate matter emission – EMEP Centre on Emission Inventories and Projections (CEIP).

The highest direct emission of $PM_{10}$, including $PM_{2,5}$, is caused by combustion processes outside industry. In 2014, their share in the national $PM_{10}$ emission was 48,5% (including $PM_{2,5}$ – 49,7%). Their main source was a municipal and residential sector, and the emission connected with building heating in particular. Road transport produced 9,0% and 13,5% of total emission and in city centres with high vehicle traffic it could have been the reason for exceeding criteria values set forth for particulate matter. The emission source is also industry, especially such branches as energy, chemistry, mining, and metallurgy, but due to the height of the devices emitting particulate matter to the atmosphere, binding laws stating the acceptable limits of emission together with the location usually outside residential areas, these sources usually have a much smaller influence on the quality of life of population.

In the period 2000–2014, the indicator of population exposure to $PM_{10}$ measured at urban background monitoring sites in Poland was about 35 µg/m³ and did not exceed the acceptable level indicated for the mean annual concentration – 40 µg/m³, apart from 2003 – 42,8 µg/m³ and 2006 – 42,6 µg/m³.

Atmospheric pollution most harmful for human health is $PM_{2,5}$. Grains of such minute size can reach upper airways, lungs and enter blood, and as a result of a longer exposure to high concentration, they can have a considerable influence on the course of heart diseases (hypertension, heart attack) or on the increase of the risk of contracting cancer diseases, especially the lung one. The European Environment Agency estimated that in 2013 $PM_{2,5}$ exposure led to over 48 thous. premature deaths in Poland.

***Graph 20. Urban population exposure to air pollution by $PM_{2,5}$***




*Source:* data of the Chief Inspectorate of Environmental Protection obtained under the State Environmental Monitoring.

Since 2010 the noted levels of the national $PM_{2,5}$ average exposure indicator were continually getting lower and lower and in 2015 the indicator amounted to 23 µg/m³ (graph 20), which is a positive factor. However, it still exceeds both the exposure concentration obligation – 20 µg/m³, which was set to be achieved until 2015, and the national exposure reduction target – 18 µg/m³ – to be achieved until 2020.

## 4.3. NOISE

***Noise** is defined as every sound that causes nuisance, is undesirable or harmful to human health, caused by means of transport in road, rail, and air traffic as well as coming from an economic activity area.*

Noise is one of the main environmental factors affecting the quality of life and comfort of living. The problem of excessive noise in environment, especially the urban one, is increasing and leading to human fatigue, stress, cardiovascular diseases, the weakening of both the immune system and the autonomic nervous system.

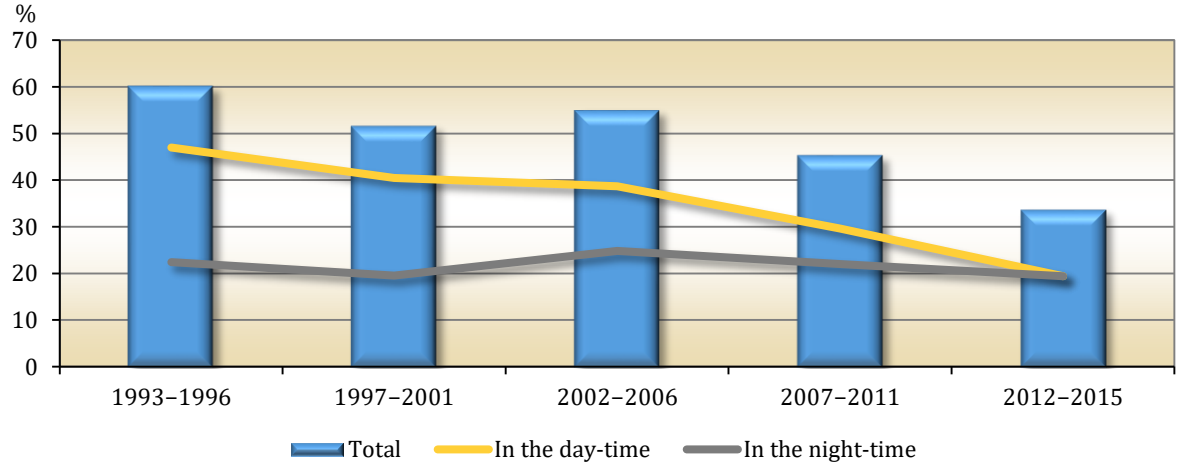
Reducing noise in environment is a long-term process. Limitation of noise to the permissible levels is one of the greatest challenges that Poland is facing.

### Industrial noise

Industrial noise measurement is performed mainly as a response to residents' complaints about activity causing disturbance, mainly by the entertainment, recreation and sports, service and industry sectors carried out by both small district businesses as well as medium and large plants.

In the case of industrial noise, within the last twenty-two years, positive trends have been noted in terms of the percentage of plants exceeding industrial noise limits (graph 21). In given periods of noise monitoring, when the assessment of acoustic climate changes takes place, a significant fall in this percentage was noted (from 60,2% in the period of 1993–1996 to 33,7% within the years 2012–2015), and in the day-time in particular (similarly – from 47,0% to 19,4%).

***Graph 21. Percentage of plants exceeding industrial noise limits***

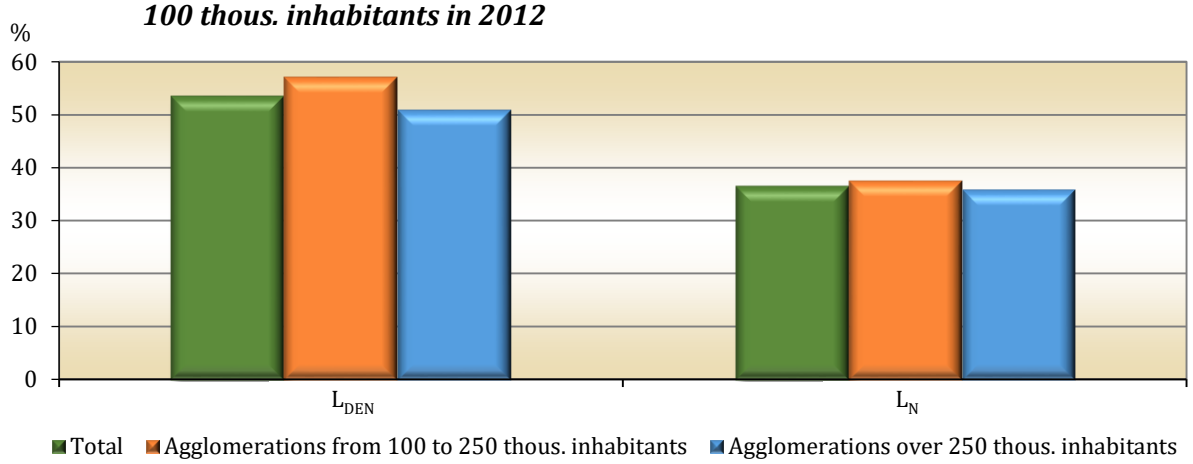



*Source:* data of the Chief Inspectorate of Environmental Protection obtained under the State Environmental Monitoring.

### Road traffic noise

Road traffic noise connected with car traffic constitutes a main threat in the urbanized areas. As a result of rapidly developing transport infrastructure, and the road network and the growth in the number of vehicles used in particular, in 2012, 53,5% of population of cities with over 100 thous. of population were exposed to exceeding noise, over 55 dB in the day-evening--night time ($L_{DEN}$ indicator). In the night-time ($L_N$ indicator) the situation was a bit better, although still unsatisfactory as 36,6% of city population was exposed to the noise exceeding 50 dB (graph 22).

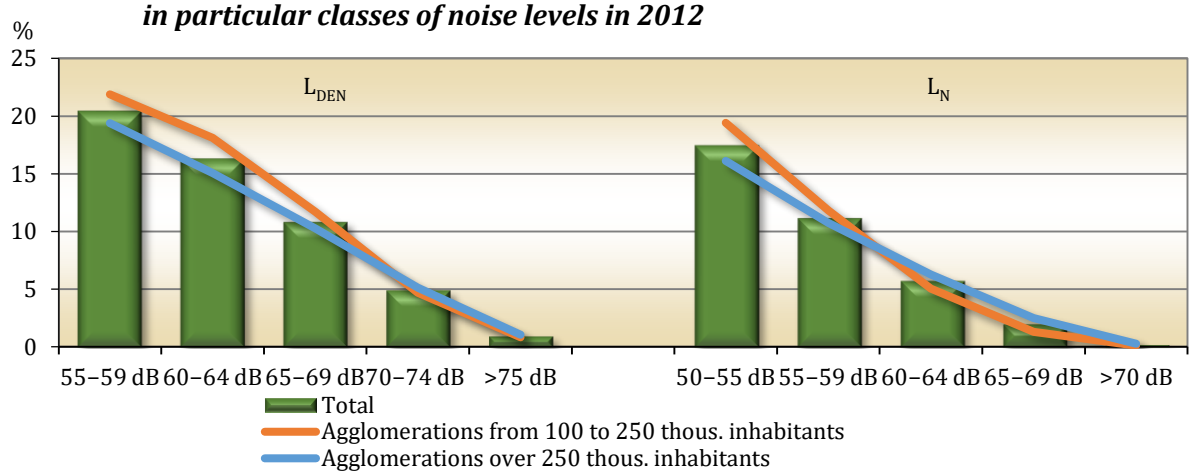
***Graph 22. Percentage of population exposed to road traffic noise in agglomerations over 100 thous. inhabitants in 2012***




*Source:* data of the Chief Inspectorate of Environmental Protection obtained under the State Environmental Monitoring.

Monitoring of road traffic noise in agglomerations carried out in 2012 proves that at both day and night time, the highest percentage of population was exposed to excessive noise within 5 dB limit (20,4% – in day-evening-night time and 17,5% – in night time) (graph 23).

***Graph 23. Percentage of population exposed to road traffic noise in agglomerations in particular classes of noise levels in 2012***




*Source:* data of the Chief Inspectorate of Environmental Protection obtained under the State Environmental Monitoring.

Data form the European Union Statistics on Income and Living Conditions (EU-SILC) will provide complementary information on noise. This survey specifies, among others, the percentage of households experiencing subjectively, in relation to their place of residence, excessive noise in their flats, coming from neighbours or from the street (caused by road traffic, by industrial plants, by economic activity).

The results of this survey show that the percentage of households affected by excessive noise is diminishing year by year (from 21,4% in 2005 to 12,4% in 2015), which can be indicative of the fact that population is getting used to surrounding noise. It is noteworthy that households with dependent children experience noise in a lesser degree than households without dependent children – the former – 21,0% in relation to the latter – 22,1% in 2005 and the former – 11,2% in relation to the latter – 13,9% in 2015.

## 4.4. ACCESS TO DRINKING WATER

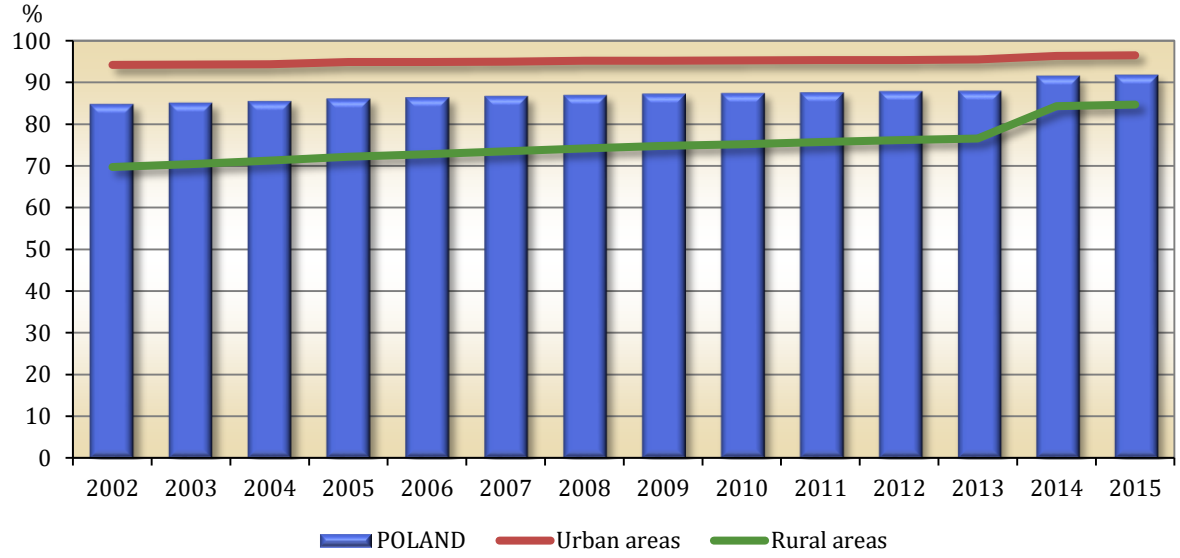
***Population using water supply network*** *concerns the estimated number of population inhabiting residential buildings and collective accommodation facilities connected to water supply network as well as population using water supply systems via street and yard outlets (devices installed to street water supply conduits).*

Water, as one of the main constituents of natural environment, plays an economic, environmental and social role. Universal access to water from water supply network is one of the basic human needs and greatly influences health and quality of living.

A basic measurement of the state of greening the economy in terms of water economy is the indicator concerning population using water supply network.

In 2015, 91,8% of population in Poland used water supply network, which is an increase in relation to 2014 and 2002 by 0,2 pp and 7,0 pp respectively (graph 24).

***Graph 24. Percentage of population using water supply network***




In the period of 2002–2015 a positive trend in using the water infrastructure was noted, especially in rural areas. In 2002, water supply network was used by 94,2% of urban population and only 69,7% of rural population. In 2015, the indicator in mind equalled 96,5% and 84,7% respectively, so the disparity between the city and the country was greatly reduced.

From the point of view of the living conditions of population, not only does access to water play an important role, but also this water quality. Water supplied to population must meet the requirements of drinking water and production purpose standards. Water supply plants have an obligation of constant quality control of delivered water so as to minimize the risk of its polluting. During the years 2002–2015 positive changes were noted in terms of water quality. There was an increase in the percentage of population supplied with water meeting requirements from 89,5% in 2002 to 98,9% in 2015.

## 4.5. MUNICIPAL SEWAGE TREATMENT

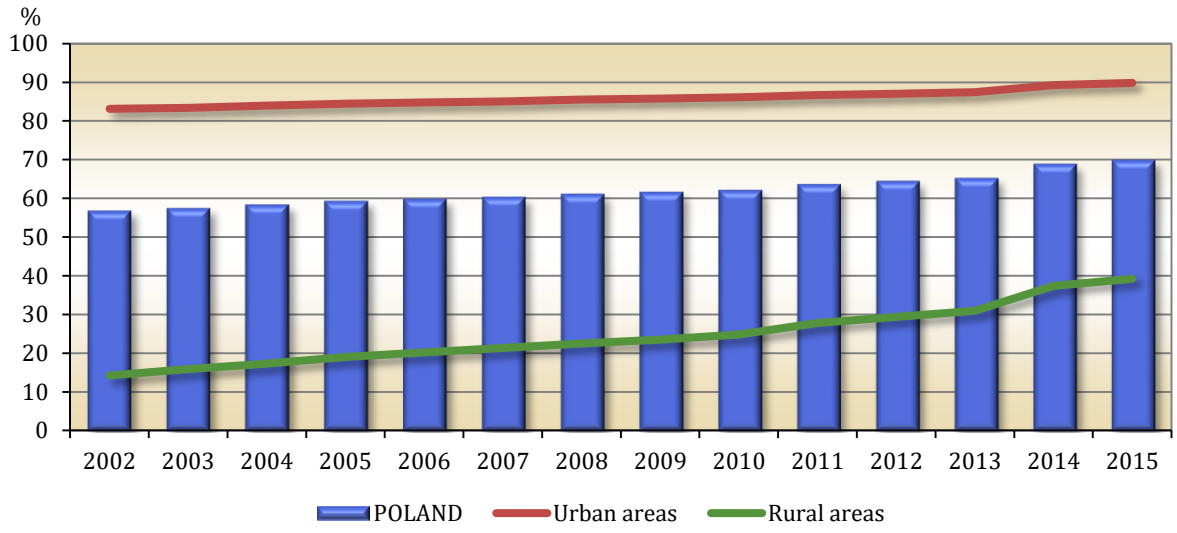
***Population using sewage network*** *concerns the estimated number of population inhabiting residential buildings and collective accommodation facilities connected to sewage network as well as population using sewage system via sewage inlets.*

Sewage treatment plays an environmental, social, and economic role. Sewage produced by population is one of the main sources of environmental pollution. It can affect the quality of drinking and public bath water and additionally contribute to the loss of biodiversity. Insufficient access to sanitary installations can influence health and well-being of population. One of the challenges connected with environmental protection is ensuring sufficient public availability of sewage treatment.

To evaluate the level of greening of economy in terms of sewage management, one can use, among others, data concerning the percentage of population using sewage network.

In the period 2002–2015 in Poland the percentage of population using sewage network (graph 25) grew constantly. In 2015, 69,7% of population used this form of waste disposal and in comparison to 2002, the share increased by 13,0 pp. Greater changes were noted in rural rather than urban areas. In 2015, this indicator in the cities amounted to 89,8% and was by 6,7 pp higher than in 2002. In rural areas the percentage of population using sewage network more than doubled over the years, from 14,2% in 2002 to 39,2% in 2015.

***Graph 25. Percentage of population using sewage network***




In the case of a lack of possibility of connecting sanitation to a residential building, e.g. in dispersed housing areas, there are other solutions to be used. Population can use cesspools (i.e. collecting wastewater in leak-proof septic tanks) or wastewater treatment facilities (so as to treat waste on their own). Using the other solution enables the environmentally friendly neutralisation of harmful waste at the place of its production and offers greater comfort for the user as it does not require so many operational activities as in the case of cesspools. It is worth noting that in Poland the number of wastewater treatment facilities increased from 51,9 thous. pieces in 2008 to 202,8 thous. pieces in 2015. This number calculated per 1000 population not using sewage network grew almost five times (from 3,49 in 2008 to 17,40 in 2015).

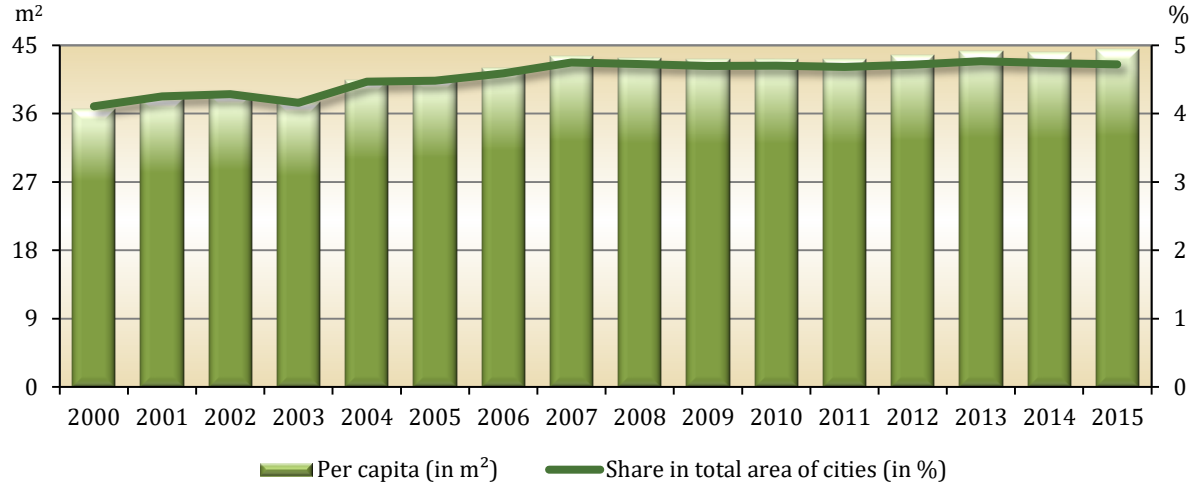
## 4.6. GREEN AREAS

***Green areas in cities*** *mean gmina forests within cities as well as green areas including technical infrastructure and adjacent auxiliary buildings, covered with plants, which fulfil aesthetic, recreational, therapeutic or shelter functions and in particular: strolling-recreational parks, lawns, green areas near municipal communication infrastructure, green areas of the housing estate, cemeteries as well as other ones.*

Green areas have a positive and long-term influence on health and the quality of living of population. A problem with access to these areas affects mainly city residents, whose quality of living and health state is greatly dependent on the quality of urban environment. They are exposed to increased air pollution emission connected with car transport intensification and accumulation of economic activity in urban areas.

Green areas in cities, in this context, play an important role, as they provide many environmental, social and economic benefits, fulfilling, among others, protective, health, recreational or aesthetic functions. These areas improve the local quality of air by absorbing $CO_2$ and releasing oxygen to the atmosphere, affect inhabitants' general well-being in a positive way, reduce stress and annoyance caused by noise, are a place of recreation and create job places.

***Graph 26. Green areas in cities***[a]




*a* Since 2004 together with other area, which includes i.a. plants in airports, railway and industrial zones, and since 2005 – cemeteries.

In 2015, urban areas were inhabited by 60,3% population of Poland and there were 44,4 m² of green areas per capita (graph 26). This area was increased by 7,8 m² in comparison to 2000 when this indicator amounted to 36,6 m². The increase results from the inclusion of cemeteries into green areas since 2005 and from enhancing street greenery areas. In the period 2000–2015 urban green area in the total city area increased slightly, from 4,1% in 2000 to 4,7% in 2015.

While including the area of family allotment gardens[2] to urban green areas, in 2015 the green area per capita was 59,3 m² and the urban green area in the total city area was 6,3%.

[2] Family allotment gardens with city status, managed by the Polish Gardeners Association, are not always located within city administrative borders.


# ECONOMIC OPPORTUNITTIES AND POLICY RESPONSES

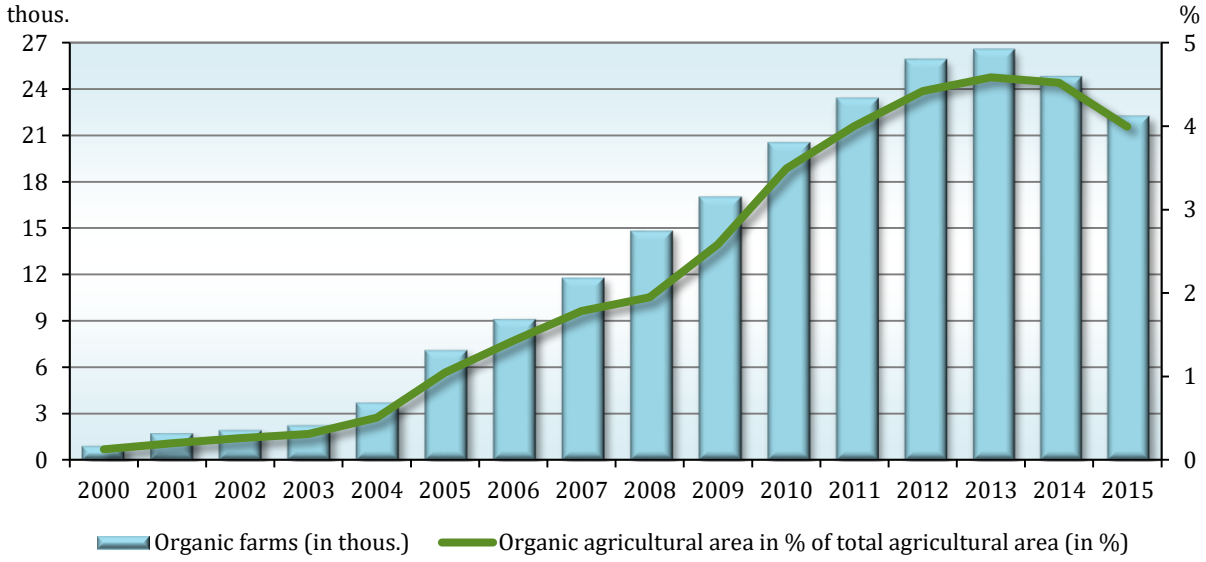
## 5.1. ORGANIC FARMS

***Organic farm*** *is an agricultural holding, which has a certificate granted to it by a certification body or which is under conversion to organic methods of agricultural production under control of a certification body.*

Organic farming is environmentally friendly sustainable agricultural output. Due to controlled production methods and producing crops without synthetic fertilizers and chemical plant protection products it exerts a positive effect on natural environment – it helps to maintain biodiversity and to protect natural resources. It is also a response to consumers' demand of high-quality food produced in an organic farm system in accordance with ecological production methods.

Organic farming is nowadays one of the fastest developing type of agriculture in Poland.

***Graph 27. Organic farms and organic agricultural area***




*Source:* data regarding number of organic farms and organic agricultural area – Agricultural and Food Quality Inspection (IJHARS).

Years 2000–2013 were characterised by a constant growth in the number of organic farms and organic agricultural area (graph 27). In the analysed period, their number grew over 28 times (from 949 in 2000 to 26598 in 2013), and their area almost 30 times (from 22,7 thous. ha in 2000 to 670,0 thous. ha in 2013). Since 2014 this tendency reversed. In 2015 the number of farms and the area of agricultural area decreased by 10,3% and 11,7% respectively in comparison to the previous year. In the analysed period the area of agricultural land where organic farming was carried out constituted 4,0% of the total agricultural land in Poland and in relation to 2000 the share was higher by 3,9 pp.

The dynamic organic farming development may have been affected by, among others, aid granted to farmers since 2004 from the Rural Development Programme (RDP 2004–2006, RDP 2007–2013, and RDP 2014–2020), financed by the European Agricultural Fund for Rural Development and co-financed by the national budget, aiming at stimulating market organic output. In 2015 the amount of payment for farms carrying out organic farming was 341,7 mln zl and increased almost 10 times in relation to 2004, but decreased in relation to the previous year by 4,5%. Its share in the total amount of subsidies for farms realising an agri-environmental programme was 35,7% and was by 10,4 pp higher in relation to 2014.

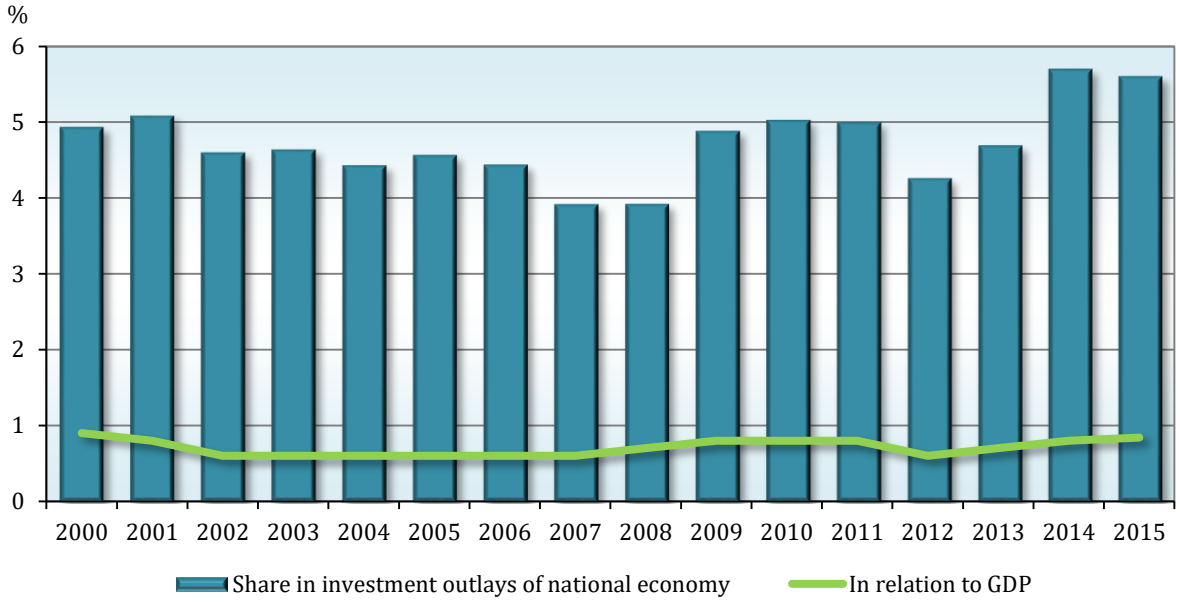
## 5.2. OUTLAYS ON ENVIRONMENTAL PROTECTION

***Outlays on environmental protection*** *is the sum of outlays on fixed assets for environmental protection and current costs borne by public and economic sectors as well as by households.*

The intensification of natural resource exploitation by a man, connected with progressive urbanization, growing consumption, industrial and agricultural production, and transport development lead to resource depletion and to environment deterioration. Making use of environment and its resources requires incurring outlays, whose fundamental objective is to reduce the negative impact of humans on environment. From the point of view of green economy, monitoring outlays on fixed assets (investment outlays), which constitute a financial base for environmental protection, is very important.

In 2015 outlays on fixed assets for environmental protection (in constant prices) amounted to 15160,0 mln zl, which is an increase in relation to 2014 and 2000 by respectively 7,4% and 62,6%. Their share in relation to GDP in the period of 2000–2015 showed slight variations and in 2015 the share equalled 0,8% (graph 28).

***Graph 28. Outlays on fixed assets for environmental protection***




In 2015 the share of outlays on fixed assets for environmental protection in investment outlays of national economy reached 5,6%, i.e. by 0,1 pp less than in the previous year and by 0,7 pp more in relation to 2000.

In 2015, economic entity own funds were prevailing in the financing structure and amounted to 41,6% of the total outlays on fixed assets for environmental protection, the next financing sources were, among others, funds from abroad – 26,9%, ecological funds – 17,8%, domestic credits and loans – 6,1%. The majority of financial means were allocated to wastewater management and protection of water (43,8%), protection of air and climate (28,1%) as well as waste management (20,2%).

Households also incur expenditures on environmental protection. They are not subsidised and as a whole constitute a burden on a household budget. In 2015 the expenditures per capita were 507,3 zl (in constant prices) and were higher than in relation to 2014 (by 13,1%), but lower than the ones incurred in 2000 – by 13,1%.

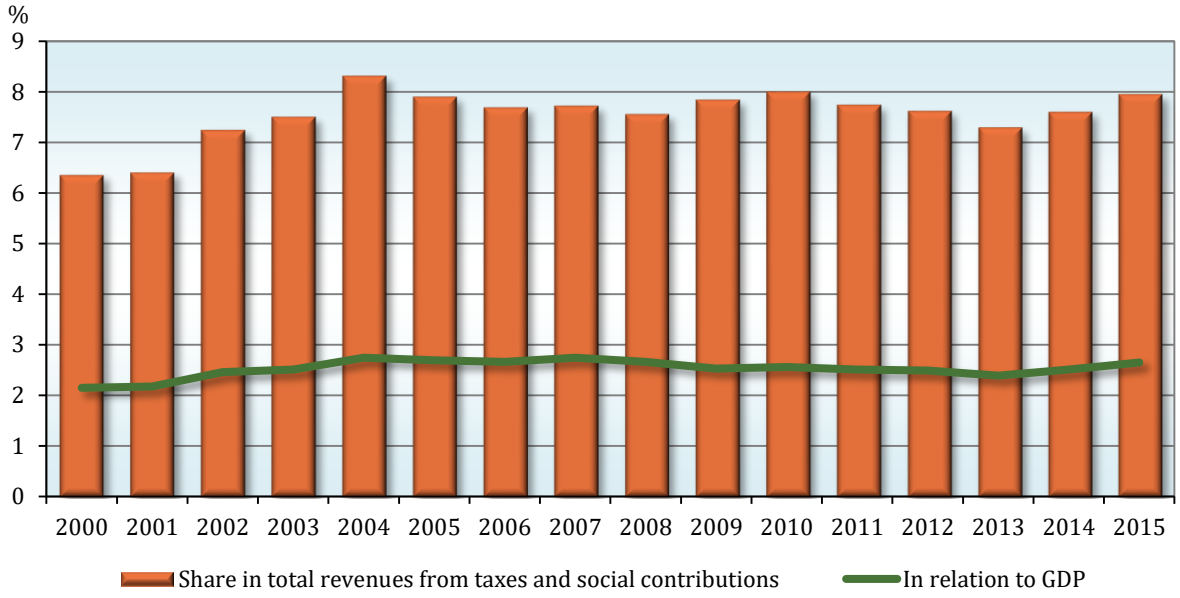
## 5.3. ENVIRONMENTAL TAXES

***Environmental tax*** *is a tax whose tax base is a physical unit (or a proxy of it) of something that has a proven, specific negative impact on the environment, and which is identified in ESA 2010 as a tax.*

Taxes related to environment (environmental taxes) are a basic economic instrument of environmental protection policy. Apart from their fiscal function ensuring tax revenue, they are to stimulate legal persons and society to undertake specified activities to reduce excessive pressure on the environment. According to Eurostat methodology, environmental taxes distinguish four different categories of taxes in division by type, i.e. energy, transport, pollution and resources.

In 2015 revenues from environmental taxes in Poland amounted to 47678 mln zl and constituted 8,0% of the total revenue from taxes and social contributions (graph 29). They were higher for both, the previous year and the year 2000 by 0,2 pp and 1,6 pp respectively. The major fiscal impact exerted energy taxes, which contributed 85,7% of the revenue from environmental taxes, and transport taxes – 8,0% of the revenue.

***Graph 29. Environmental taxes***




*Source:* Eurostat database.

In 2015, the ratio of environmental taxes to GDP was 2,7% and was by 0,1 pp higher than a year before, and by 0,5 pp higher than in 2000.

## 5.4. RESEARCH AND DEVELOPMENT (R&D) ACTIVITY

***Research and development activity (R&D)*** *comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.*

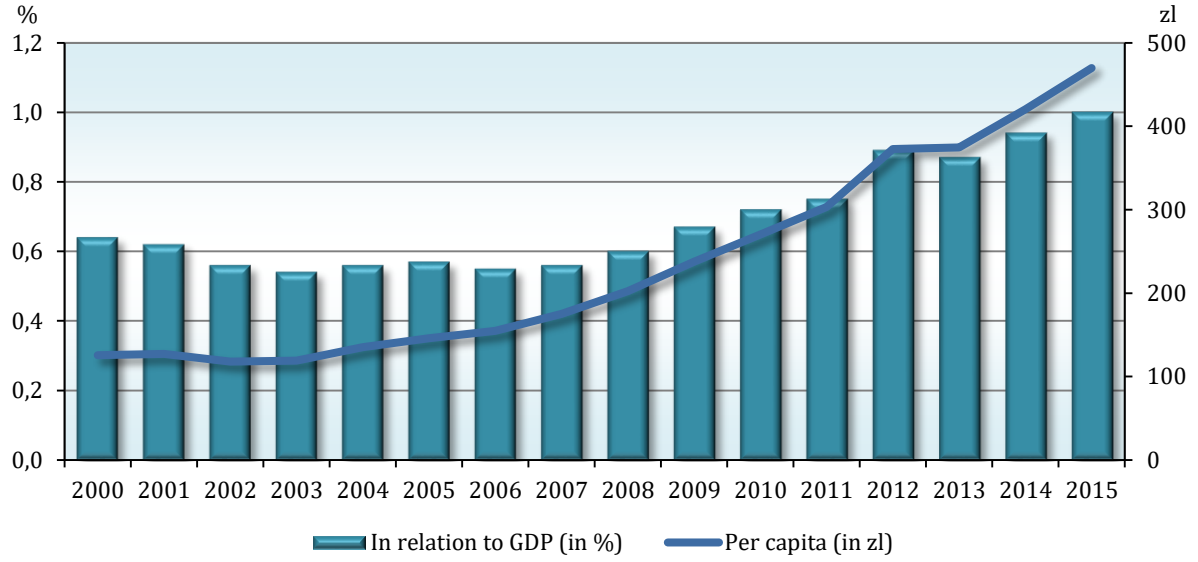
***Expenditures on R&D activity*** *comprise all expenditures for R&D performed within statistical unit or sector of the economy during a specific period, whatever the source of funds. They include current expenditures and capital expenditures on fixed assets connected with R&D activity, excluding depreciation of fixed assets.*

Research and development activity (R&B) plays an important role not only in economic growth but also in the economy greening process, because, apart from driving innovation and economy competitiveness forward, it can encourage, among others, activities aiming at improving efficiency of resource use in economy or reducing a negative impact of human activity on environment.

In 2015, expenditure on R&B activity amounted to 18060,7 mln zl and increased by 11,7% in relation to 2014 and more than doubled in relation to 2000. Business enterprise sector designated the majority of funds on R&B – 46,6% of the total expenditure in this category. The higher education sector comprised 28,9%, whereas the government sector – 24,4%.

Research and development intensity, measured by the percentage ratio of research and development expenditure to GDP, is relatively low in Poland, but it shows a growing trend (graph 30). In 2015, this indicator equalled 1,00%.

***Graph 30. Research and development (R&D) expenditure***




While analysing R&B expenditure per capita, since 2003 a growing tendency has been noted. In 2015, it amounted to 469,7 zl, i.e. by 11,8% more than in the previous year and more than twice as much as in 2000.

Activity to protect components of environment so as to restore or maintain environmental sustainability require financial means. In 2015, within research and development activity framework it was spent as much as 3926,1 thous. zl on fixed assets for environmental protection. From 2000 to 2015 the highest outlays within research and development activity, equalling 15364,1 thous. zl, were noted in 2009 and constituted 0,14% of the total expenditure on fixed assets for environmental protection.

## 5.5. INVENTIONS AND PATENTS

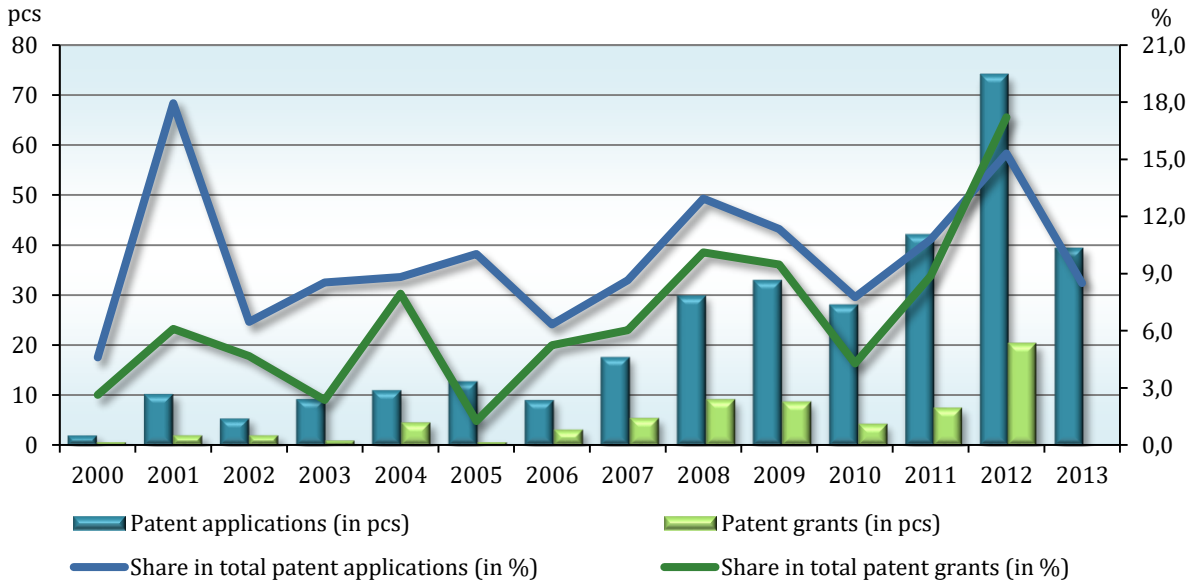
***Patentable invention*** *is a new solution of a technical problem which involves an inventive step (i.e. it is not directly derived from the state-of-the-art – it is not obvious) and is industrially applicable.*

***Patent*** *is the exclusive right granted for inventions by a competent international body (e.g. the European Patent Office) or a national authority (in Poland – by the Patent Office of the Republic of Poland).*

Patent applications and grants are classified according to the International Patent Classification. They are presented also by fields of technology based on WIPO IPC-Technology Concordance Table, on the basis of which environment-related technologies comprise such fields that are within the scope of, among others, air and water pollution abatement, waste management, soil remediation, environmental monitoring, renewable energy generation, capture, storage, sequestration or disposal of greenhouse gases, climate change mitigation technologies related to transportation, buildings.

Inventions in environment-related technologies play an important role in green economy, being a significant green growth factor. They make it possible to use natural resources in an efficient way, reduce a negative influence of production and services on environment, and they can also lead to the creation of new products, job places, technology innovations, and as a result of these, to the increase in the economy competitiveness. Patents, however, constitute a basis for efficient knowledge management in technology and support development potential of innovative economy.

***Graph 31. Patent applications and grants in environment-related technologies[a] – the European Patent Office***




*a* The indicator is based on fractional counting to eliminate multiple counting of patent applications / grants with several inventors from different countries (e.g. a patent application submitted by two authors, one of whom is a Polish resident, is counted in the data as 0,5).

*Source:* data of the European Patent Office / OECD Statistics.

In 2013, according to the European Patent Office (EPO), Polish residents filed 39 patent applications within the field of environment-related technologies (graph 31). The best result achieved by Poland was in 2012 and it amounted to 74 patent files. The percentage of patent

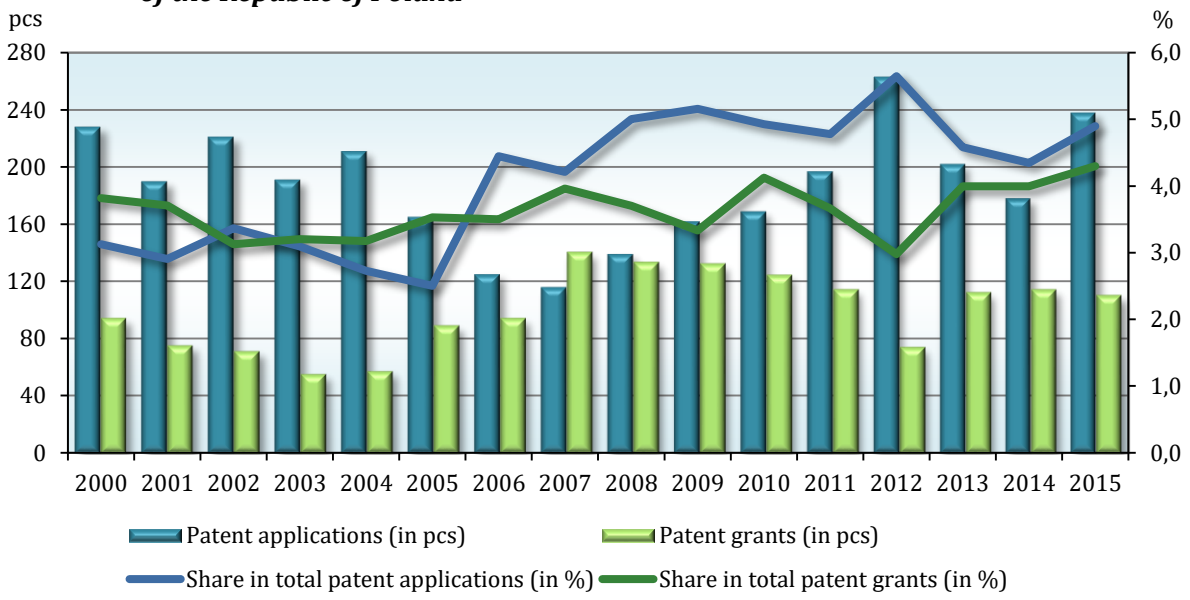
applications in environment-related technologies in comparison to the total patent applications filed by Polish residents in 2013 comprised 8,5% and was lower by 6,8 pp than in the previous year and by 3,9 pp higher than in the year 2000.

In 2012, EPO granted 20 patents in environment-related technologies to Polish residents, which is a 66,7% increase in comparison to the previous year. These patents constitued 17,2% of the total number of patents granted to Polish residents.

From the perspective of the development of Polish green economy, patent applications filed to the Patent Office of the Republic of Poland and patents granted by this authority seem equally important (graph 32).

In 2015 the total patent application number in environmental technologies submitted to the Patent Office of the Republic of Poland equalled 238, which constituted 4,9% of the total patent applications. It is an increase in relation to the previous year and to the year 2000 by 33,7% and by 4,4% respectively. From 2000 to 2015 the highest number of this type of inventions was noted in 2012 – 263 (5,6% of the total patent applications). The greatest number was submitted by domestic entities – 253.

***Graph 32. Patent applications and grants in environmental technologies – the Patent Office of the Republic of Poland***




*Source:* data of the Patent Office of the Republic of Poland.

The Patent Office of the Republic of Poland in 2015 granted 110 environmental technology patents, of which 104 ones to domestic entities. Their share in the total patent number constituted 4,3%, and it has been one of the highest scores since 2000.

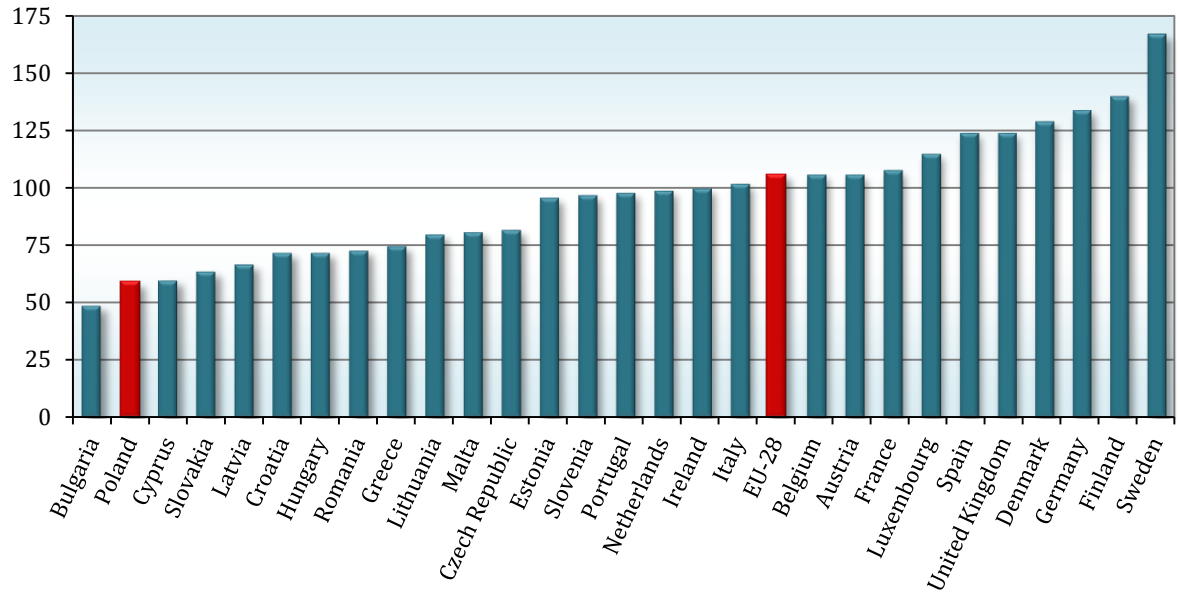
## 5.6. ECO-INNOVATION

***Eco-innovation*** *is a new or significantly improved product (goods or service), process, organizational or marketing method, which brings benefits to the environment.*

Eco-innovations help to improve efficiency of resource use in economy and to reduce the negative impact of human activity on environment. Apart from the ecological aspect, there is also an important economic aspect – eco-innovation application helps to reduce operating expenses, to use new development possibilities, to create a positive image of an entity, and, as a result of these, to increase this entity's competitiveness.

So as to make it possible to compare various aspects of eco-innovation, the European Union set up the Eco-Innovation Observatory, responsible for gathering data within this scope. On the basis of 16 indicators grouped according to 5 thematic fields, the eco-innovation index, the so-called the Eco-Innovation Scoreboard, was established, which comprehensively compares eco-innovation results achieved by individual EU-28 member states with the EU average.

***Graph 33. Eco-innovation index for the EU Member States in 2015***

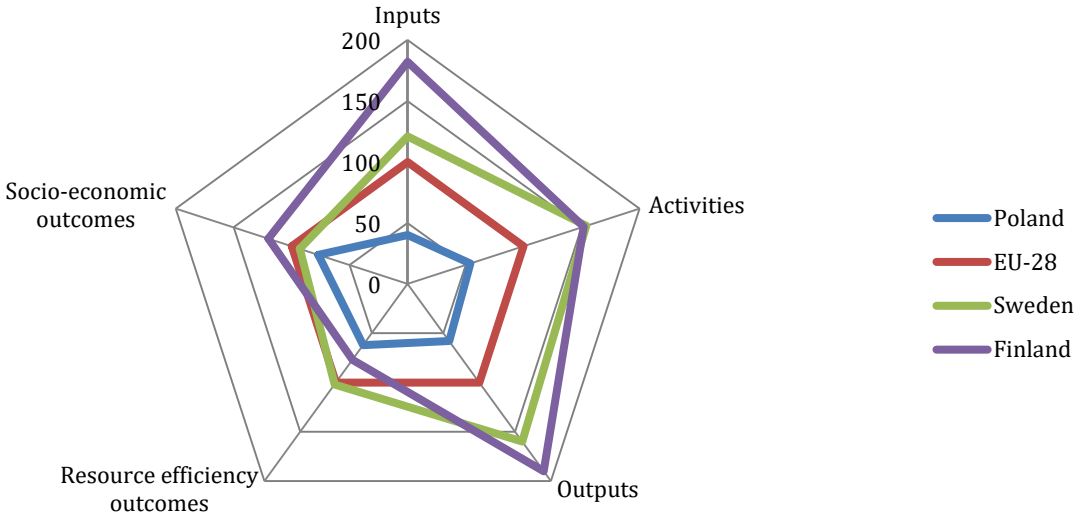



*Source:* data of Eco-Innovation Observatory.

According to the ranking presented in the graph, Poland is one of the countries with the lowest eco-innovation index among EU member states (graph 33). In 2015, similarly to 2013, it ranked last but one, whereas in 2014 it was 25th among 28 EU states.

While analysing the results in the individual indicator groups that are generated for Poland (graph 34), it can be stated that the relatively strongest point of Polish eco-innovation on the background of EU countries is socio-economic outcomes, being the result of introducing eco--innovations (20th position) and achieved outputs (21st position). In the case of the three remaining areas, i.e. activities undertaken within the eco-innovation area and resource efficiency outcomes in 2015 Poland ranked 26th, whereas within eco-innovation inputs – 22nd.

***Graph 34. Poland on the background of the 28 EU Member States and countries with the highest eco-innovation index in 5 thematic areas in 2015***




*Source:* data of the Eco-Innovation Observatory.

The unfavourable position of Poland in this ranking can be a result of many factors, among others, financial barriers encountered by entrepreneurs and consumers, together with their insufficient awareness of the benefits coming from introducing eco-innovations, low government inputs on R&D, including the environmental one.

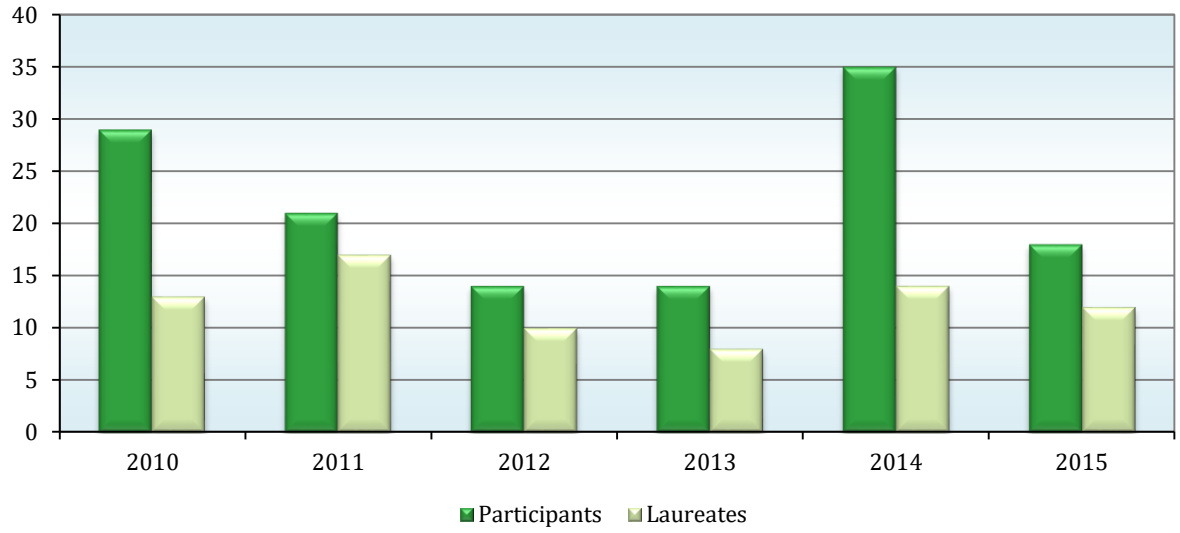
## 5.7. GREEN TECHNOLOGY

***Green Technology Accelerator (GreenEvo)*** *is an innovative project of the Ministry of Environment whose aim is both to promote the development of environment protection technology sector offered by Polish entrepreneurs and to transfer green technologies within Poland and abroad.*

The main aim of the Accelerator is to create conditions to improve environment by encouraging the programme participant activity and by promoting environmental technologies offered by the project laureates. Entities taking part in the Accelerator are given aid in different forms, among others, trainings on international sales, on promoting and presenting technologies as well as organisational support in international trade events or foreign trade missions. Entities can apply for funds to cover the costs of these activities within the available instruments supporting export, offered by the Ministry of Economy (the Ministry of Energy at present) and the Polish Agency for the Enterprise Development. The Accelerator also helps to identify trends with the greatest needs and the highest absorption potential of particular environmental technologies.

This programme essence is to spread global technical concepts so as to create conditions to support sustainable development and to build green economy.

***Graph 35. Participants and laureates of GreenEvo Technology Accelerator***




*Source:* data of the Ministry of Environment.

In 2015, GreenEvo project had 18 participants – companies from a green technology sector dealing with water and sewage management, energy saving, air protection, waste management, renewable energy sources and biodiversity conservation (graph 35). Their highest number was noted in 2014 – 35. Since the beginning of the programme, i.e. from 2010, there have been chosen 74 GreenEvo laureates – the authors of innovative, unique Polish environmental technologies.

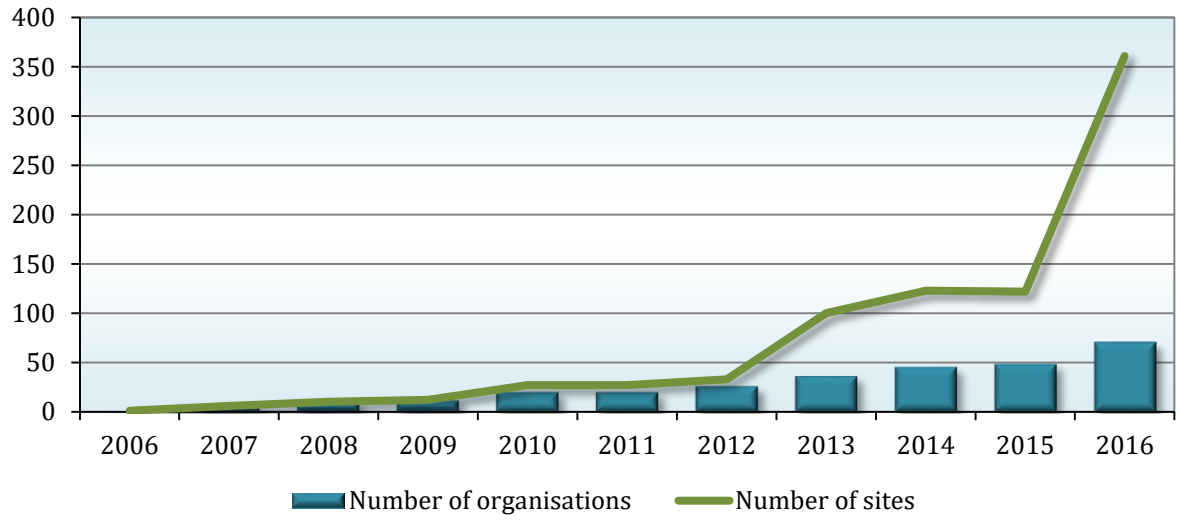
## 5.8. ECO-MANAGEMENT AND AUDIT SCHEME (EMAS)

***EMAS** – Eco-Management and Audit Scheme is a European Union environmental protection management system integrated with ISO 14001 – the environmental quality management. Organisations that are willing to achieve best results in improving natural environment protection can participate in the scheme voluntarily.*

EMAS is an important tool for environmental protection aiming at the constant improvement of environmental activity of an organisation in compliance with the European Union and national laws on environmental protection. It assumes active participation of employers in the process of improving relations between the organisation and the environment, and informing the publicity of the results of the works carried out by the entities obliged to prepare annual environmental declarations. EMAS can be joined by entities of all economy sectors, i.e., firms and companies carrying out production and service activity, public and self-government administration authorities, as well as non-profit institutions.

Due to the implementation of this system requirements, organisations optimise resource and energy use and confirm that they abide laws within environment protection and minimise the risk of fines for non-compliance with the laws. They also create their own "green image", confirming it with a trustworthy certificate, in Poland issued by the General Director for Environmental Protection.

***Graph 36. Organisations and their sites with Eco-Management and Audit Scheme (EMAS) registration***




*Source:* Eurostat database.

It was in 2006 that the first national organisation was recorded in the EMAS in Poland (graph 36). Since that moment their number has been growing. By the end of 2016, EMAS certificate was given to 70 organizations (an increase by 45,8% in relation to 2015) and 361 sites of these organizations (almost twice as much as in the previous year).

## 5.9. GREEN PUBLIC PROCUREMENT

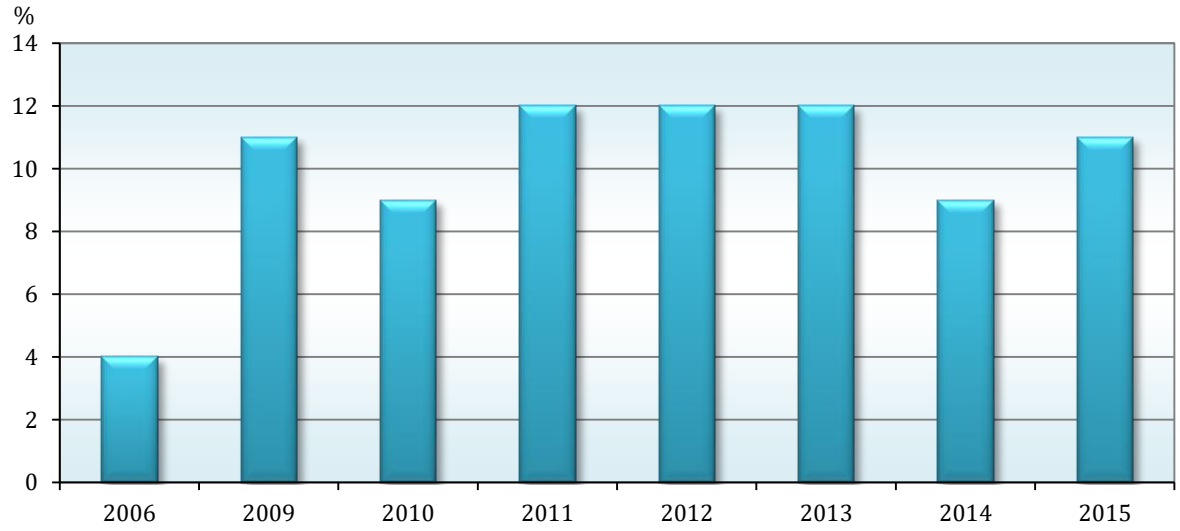
***Green public procurement*** *is the one in which public entities include ecological criteria and/or requirements to the purchase process (procedures of conduction public procurement) and aim at solutions that minimize negative impact of products / services on the environment.*

Green public procurement is an important instrument to encourage entrepreneurs to produce new, greener products and to deliver services that take into account environmental aspects. It should lead to the purchase of products or services that are environmentally friendly, namely such that exert a smaller negative effect on natural environment than other similar conventional products / services that fulfil the same functions.

The percentage of green public procurement is set by the Public Procurement Office on the basis of the analysis of public procurement advertisement (a random sample) published in the national official publication, the Polish Public Procurement Bulletin, and in the European Union official publication, the Supplement to the Official Journal of the European Union. On the basis of this, the number of advertisements with a 'green' object of the procurement or containing environmental criteria in relation to all analysed advertisements is established.

In 2015 the share of green public procurement in the total number of public procurement constituted 11%, which is a fall by 2,0 pp in comparison with the previous year, but an increase – by 7,0 pp in relation to the one noted for the first time in 2006 (graph 37).

***Graph 37. Green public procurement in % of total public procurement***




*Source:* data of the Public Procurement Office.

Public procurement sets production and consumption trends. Paying more attention to the environmental criteria in public procurement may support putting into practice the state environmental policy. A significant demand of public authorities on greener products can lead to the creation or to the growth of environmentally friendly product and service market.

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