Statistical analyses

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Green economy indicators in Poland 2019

Warsaw, Białystok 2019

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Statistics Poland
Statistical Office in Białystok

Warsaw, Białystok 2019

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Preface

We would like to present you with the third edition of the publication "Green economy indicators in Poland 2019". It is the first edition of this publication after the survey "Green economy in Poland" has been included in the Programme of Statistical Surveys of Public Statistics and in the Statistical Analyses series.

The publication incorporates recommendations of the Organisation for Economic Cooperation and Development (OECD) concerning green economy survey methodology. Green economy, viewed in the light of these guidelines, is understood by Polish public statistics as such that supports economic growth and development while 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.

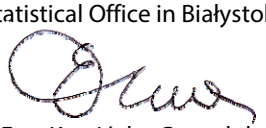
Information regarding green economy is presented in four thematic groups that are used in monitoring the economy's state, i.e. natural asset base, environmental and resource productivity of the economy, environmental quality of life as well as economic opportunities and policy responses. Moreover, context indicators constituting the background and the source of basic information on the socio-economic state of the country are included so as to give an additional dimension to the issues covered by the publication.

The suggested set of indicators to monitor the state of green economy includes, apart from public statistics information, extensive data from various national authorities. What is more, this edition also contains international comparisons carried out on the basis of Eurostat, OECD, the World Bank, the United Nations and the European Environment Agency databases.

Reliable, properly selected, and current data from the scope of green economy are an important element of introducing environment policies, implementing economic instruments or activities stimulating ecological innovations and investments in green technologies as well as monitoring the efficiency of these activities. It should be noted, however, that the set of indicators presented in this report will be assessed with new phenomena, instruments and changes in data availability.

Presenting "Green economy indicators in Poland 2019", we would like to sincerely thank all institutions for the data and suggestions which have enriched the contents of this publication. We do hope that information will be useful for those interested in the subject-matter of this work, will also support decision-making process and will make it possible to follow changes taking place in environment, economy, and society in the light of green economy.

Director
Statistical Office in Białystok



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Warsaw, Białystok, December 2019

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Symbols

Symbol	Description
Dot (.)	data not available or not reliable
Zero (0,0)	magnitude not zero, but less than 0,5 of a unit
„In wchich"	indicates that not all elements of the sum are given

Major abbreviations

Abbreviation	Meaning
µg	microgram
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
cont.	continued
pp	percentage point
DMC	domestic material consumption
PPS	Purchasing Power Standard
GDP	gross domestic product
Dz. U.	Journal of Law
EEA	European Environment Agency
EPO	European Patent Office
EUROSTAT	Statistical Office of the European Union
FAO	Food and Agriculture Organization
OECD	Organisation for Economic Co-operation and Development
UE	European Union
UNEP	United Nations Environment Programme
EMAS	Eco-Management and Audit Scheme
EMEP	European Monitoring and Evaluation Programme
ESA	European System of Accounts
EU ETS	European Union Emissions Trading System
IPCC	Intergovernmental Panel on Climate Change
WISL	National Forest Inventory
PROW	Rural Development Programme
IPC	International Patent Classification
WHO	World Health Organisation

Executive summary

Poland, taking up various activities aimed at protecting the environment, tries to move towards greening the economy and reach sustainable development.

Green economy monitoring has been carried out through indicators grouped in four thematic groups: natural capital, environmental and resource productivity of the economy, environmental quality of life as well as economic opportunities and policy responses.

Natural capital indicators describe the state of natural environment, i.e. existing natural resources and their changes. In 2018, areas of special nature value under legal protection comprised 32.6% of the total area of the country, which placed Poland among the top European countries with the highest share of sea and land area under legal protection. In 2018, the area of forests in Poland was 9254.9 thousand hectares and forest cover indicator amounted to 29.6%. In 2017, Forest Bird Index equalled to 1.29 and was one of the highest throughout the entire survey in comparison with the base year 2000, for which the value of 1 has been accepted. However, in the case of Farmland Bird Index, it reached its lowest value – 0.8. In 2002–2018, human activity brought about changes in land use. Land under built-up and urbanized areas increased by 12.7%, forest, wooded and bushy area by 6.8%, as well as land under waters by 1.8%, at the expense of other areas and agricultural land by a 25.8% and 3.2% decrease respectively.

Environmental and resource productivity of the economy indicators, dealing with the efficiency of natural resources use in economic processes, show that in many domains there is a relative and even absolute decoupling between economic growth and pressure on environment. In 2000–2018 a water exploitation index value increased. In 2018, its growth was observed in comparison with 2017 and 2000 by 9.6% and 227.8% respectively. Similar tendencies were noticed in the case of a primary energy productivity indicator. Since 2000 (excluding 2016), it gradually increased. In 2017 in relation to 2016 and 2000 it rose by 0.6% and 141.1% respectively. In the last years a small decrease was observed in the case of resource productivity index (domestic material consumption). In 2018 it was lower than in 2017 by 1.5%, but higher than in 2000 by 106.1%. Reaching a 15% share of renewable energy in gross final energy consumption in 2020 may pose a challenge for a Polish energy policy. In 2017 this share was 10.9% and was by 0.4 pp lower than in the previous year.

Environmental quality of life indicators deal with population access to basic services in the scope of water and sewage management that simultaneously protect the environment as well as with population exposure to pollutants and health conditions resulting from this exposure. These values show improvement in the following: reducing excessive noise (especially industrial one), access to sewage network and water supply network, and supply with water meeting quality requirements. On the other hand, environmental quality indicators prove exceeding emission limits for particulate matter. National $PM_{2.5}$ average exposure indicator in 2017 was 22 $\mu g/m^3$, which means it was higher than exposure concentration obligation amounting to 20 $\mu g/m^3$ that was set in 2015. The indicator exceeds the national exposure reduction target (18 $\mu g/m^3$) to be reached to 2020. Moreover, although the percentage of persons exposed to excessive road traffic noise dwindled in 2017 in comparison with 2012, the situation is still far from satisfactory. As a result of rapid road infrastructure development as well as the growing number of vehicles used, in 2017, 44.1% of population of cities with over 100 thousand of inhabitants was exposed to excessive noise exceeding 55 dB in the day-evening-night time. In the night-time 26.7% of city population was exposed to noise exceeding 50 dB.

Economic opportunities and policy responses indicators characterize instruments affecting economy and society, which are used to create desired development trends in greening the economy. Organic farming is one of activities helping to green the economy. In spite of an initial fast development of this type of agriculture, a steady decrease in the share of organic ecological area in total agricultural area has been noted since 2014. It can result from a diminishing payments received by farmers within the Rural Development Programme for farms carrying out organic farming. Another instrument of an environment protection policy are environmental taxes. In 2017, revenues from environmental taxes in Poland constituted 7.7% of total revenues from taxes and contributions, and their share in relation to GDP amounted to 2.7%.

Among environmentally related taxes, energy taxes were of greatest fiscal importance with 86.9% revenues and transport taxes with their 8.5% revenues. In the period of 2000–2017 the share of environmental taxes in total revenues from taxes and contributions as well as in relation to GDP remained fairly stable. Activities aimed at greening the economy require, among others, implementing new technologies. In 2018, the Patent Office of the Republic of Poland granted 143 environmental technology patents. Their share in total number of patents amounted to 4.8% and was the highest since 2000. Environmental aspect is taken into consideration by institutions dealing with public procurement. As data from the Public Procurement Office coming from contracting authorities show, in 2018, 1.4 thousand public procurement included ecological criteria and their share in total number of public procurement equalled 1.0%. Total green public procurement (excluding Value Added Tax) value was 9.3 billion PLN, i.e. 4.6% total value of public procurement contracts.

Chapter 1

Socio-economic context

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 the country.

Poland is 6th country in Europe in terms of area, which is 312 695 km^2. Land use structure is dominated by agricultural land (60.0% of total area).

As of 31st December 2018, population equalled 38.4 million, of which the majority lived in urban areas (60.1% of total population). It means that 123 persons lived in 1 km^2.

In 2018, natural increase was negative and amounted to minus 26022 persons. Life expectancy in Poland is gradually elongating and in the analysed year equalled 77.6 years, and it was longer for females (81.7 years) than for males (73.8 years).

Taking into consideration the division by economic groups of age, it can be noticed that in 2018 in relation to 2000, the share of persons at pre-working age and working age was reduced (by 6.3 pp and 0.2 pp respectively), while the percentage of post-working age population increased (by 6.6 pp). It is reflected in the age dependency ratio, which in 2018 was 65 persons at non-working age per 100 persons at working age.

In 2018 in Poland there were employed 16.0 million persons, the most of which were in the industry sector (20.5% of total employed). Registered unemployment rate in 2018 has been the lowest one since 2000 and equalled 5.8%.

In 2018, according to the LFS, 4.8% 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 5.7%. Public expenditure on education amounted to 4.3% GDP and was by 0.4 pp lower than in 2000.

In 2017 in comparison to 2000, gross real disposable income of household sector increased by 55.6%, however, at-risk-of-poverty rate after social transfers was lowered from 20.5% in 2005 to 14.8% in 2018.

In 2018, 84.2% of households and 95.6% of enterprises had access to Internet.

Investment outlays in national economy, which in 2018 in current prices amounted to 294.6 billion PLN almost doubled in comparison to 2000.

Gross domestic product (in current prices) per capita increased from 19.5 thousand PLN in 2000 to 55.1 thousand PLN in 2018 (according to preliminary data). 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 2018 equalled 1851.2 billion PLN (according to preliminary data). The section that dominated the share in gross value added, amounting to 25.0%, was industry.

Specification	2000	2005	2010	2015	2016	2017	2018
Population (as of 31 XII) in millions	38.3	38.2	38.5	38.4	38.4	38.4	38.4
urban areas	23.7	23.4	23.4	23.2	23.1	23.1	23.1
rural areas	14.6	14.7	15.1	15.3	15.3	15.3	15.3
Population per 1 km^2 of total area (as of 31 XII)	122	122	123	123	123	123	123
Natural increase in thousands	10.3	–3.9	34.8	–25.6	–5.8	–0.9	–26.0
Population of age in % of total population:							
pre-working age	24.4	20.6	18.8	18.0	17.9	18.0	18.1
working age	60.8	64.0	64.4	62.4	61.9	61.2	60.6
post-working age	14.8	15.4	16.8	19.6	20.2	20.8	21.4

Specification	2000	2005	2010	2015	2016	2017	2018
Age dependency ratio (non-working age population per 100 persons of working age)	64	56	55	60	62	63	65
Life expectancy	73.7	75.0	76.2	77.5	77.8	77.8	77.6
males	69.7	70.8	72.1	73.6	73.9	74.0	73.8
females	78.0	79.4	80.6	81.6	81.9	81.8	81.7
Employed persons [a] in thousands	15488.8	12890.7	14106.9	14829.8	15293.3	15710.8	16020.0[b]
of which in % of total in section:							
agriculture, forestry and fishing	.	16.6	16.8	16.1	15.6	15.2	14.8
industry	.	22.2	20.6	20.3	20.2	20.3	20.5
of which in division water supply; sewerage, waste management and remediation activities	.	0.9	1.0	1.0	1.0	1.0	1.0
transportation and storage	.	4.9	5.0	5.2	5.4	5.6	5.7
Registered unemployment rate (as of 31 XII) in %	15.1	17.6	12.4	9.7	8.2	6.6	5.8
Early school leavers [cd] in %	.	5.3	5.4	5.3	5.2	5.0	4.8
Lifelong learning [ce] in %	.	4.9	5.2	3.5	3.7	4.0	5.7
Spendings on Human Resources (public expenditures on education) in relation to GDP in %	4.74	5.08	4.66	4.44	4.36	4.30	4.33
Total gross real disposable income of households sector (2000=100)	100.0	105.0	129.7	142.3	150.8	155.6	.
At-risk-of-poverty rate after social transfers in %	.	20.5	17.6	17.6	17.3	15.0	14.8
Households [f] in % of total households equipped with:							
Internet access	.	30.4	63.4	75.8	80.4	81.9	84.2
broadband Internet	.	15.6	56.8	71.0	75.7	77.6	79.3
Enterprises [g] in % of total enterprises equipped with:							
Internet access	.	86.1	95.8	92.7	93.7	94.8	95.6
broadband Internet	.	42.3	69.0	91.9	93.2	94.6	95.0
Investment outlays (current prices) in million PLN	133160	131055	217287	271839	244429	257881	294572
in % of total of:							
public sector	34.8	34.9	43.5	37.3	30.4	30.3	.
private sector	65.2	65.1	56.5	62.7	69.6	69.7	.
Gross domestic product (current prices) per capita in PLN	19527	25955	37524	46814	48433	51776	55066[b]
Gross value added (current prices) in billion PLN	662.9	870.3	1271.5	1597.2	1644.0	1747.1	1851.2[b]
of which in % of total in section:							
agriculture, forestry and fishing	3.5	3.3	2.9	2.5	2.7	3.1	2.4
industry	24.3	25.2	24.7	26.1	26.5	25.4	25.0
of which in division water supply; sewerage, waste management and remediation activities	1.1	1.1	1.2	1.3	1.4	1.3	1.3
transportation and storage	5.2	5.6	5.3	6.5	6.5	6.8	7.1

a Including employed persons in budgetary entities conducting activity within the scope of national defence and public safety. b Preliminary data. c 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. d 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. e Percentage of the population aged 25–64 continuing education or attending vocational trainings to the total population of the same age group. f Data concern households with at least one person aged 16–74 having the Internet access at home. g Data concern economic entities employing more than 9 persons.

Chapter 2

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 2018, these areas comprised 10.2 million hectares, i.e. 32.6% of the total area of the country. In comparison to 2000, the percentage increased slightly, by 0.1 pp. There were 2651 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%).

According to the World Bank data, in 2018, terrestrial and marine protected areas in 28 countries of the European Union constituted 23.4% of total territorial area of the EU. The following countries were in the group of states with the highest share of protected area: Slovenia (55.1% of total territorial area), Luxembourg (40.9%), Germany (38.8%) and Poland (38.1%). Countries with the lowest share, however, were Cyprus (1.7%), Ireland (4.0%) and Malta (6.4%).

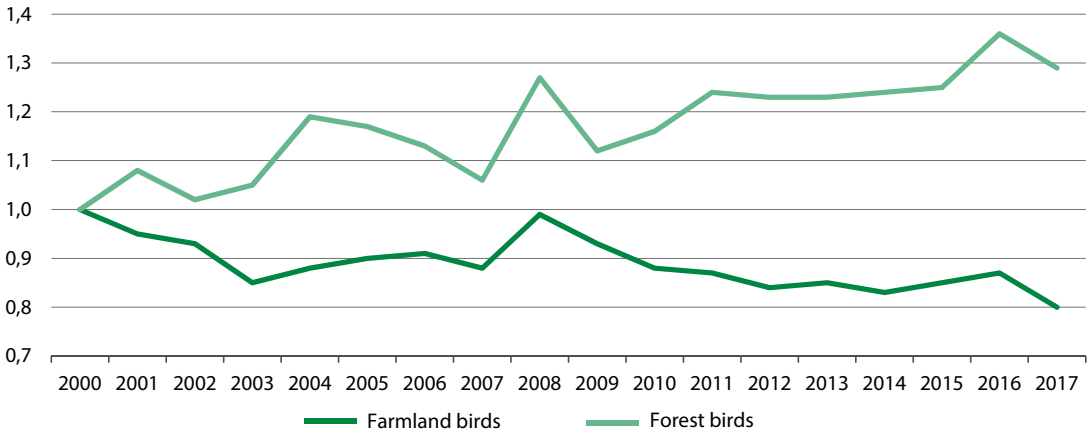
Environment state of ecosystems related to agricultural and forest land may be evaluated on the basis of aggregated Farmland Bird Index (FBI) and Forest Bird Index. Changes in the bird population on a regional or national level are important factors providing information concerning either the improvement,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

Farmland Bird Index (FBI) is one of official environment state indices in the member states of the European Union, used to assess farmed environment. Farmland Bird Index is an aggregated index of population number of 22 farmland bird species. In Poland to calculate FBI the following bird species are taken into consideration: the white stork, the kestrel, the lapwing, the godwit, the turtledove, the hoopoe, the crested lark, the skylark, the barn swallow, the meadow pipit, the western yellow wagtail, the winchat, the stonechat, the common whitethroat, the red-backed shrike, the starling, the tree sparrow, the seedeater, the linnet, the bunting, the ortolan bunting and the corn bunting.

Forest Bird Index is used to describe the population of birds (avifauna) typical of national forest ecosystems. Forest Bird Index aggregates changes in the number of population for 34 most common bird species connected with forest areas: the stock dove, the black woodpecker, the middle spotted woodpecker, the woodlark, the tree pipit, the Eurasian wren, the dunnock, the European robin, the redstart, the blackbird, the song thrush, the mistle thrush, the Eurasian blackcap, the wood warbler, the chiffchaff, the willow warbler, the goldcrest, the common firecrest, the red-breasted flycatcher, the European pied flycatcher, the long-tailed tit, the marsh tit, the willow tit, the European crested tit, the coal tit, the great tit, the European nutatch, the Eurasian treecreeper, the short-toed treecreeper, the Eurasian jay, the chaffinch, the Eurasian siskin, the bullfinch, the hawfinch.

In the years 2001–2003 there was a decrease in farmland bird population number by about 15% (chart 1). In the years that followed (apart from 2007) their number increased and in 2008 it reached the reference state from the year 2000. Since 2009 the index has been 12–20% lower than in the base year, which means that the population number at this time has been ranged from 80% to 88% of the 2000 year value. The lowest Farmland Bird Index in its history was noted in 2017. It was lower by 20.0% than in the base year.

Chart 1. Farmland Bird Index and Forest Bird Index



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

Changes in the number of common species of forest birds indicate the reverse tendency, their populations are in good condition and their number is increasing in general. Since 2000, the highest value of the indicator in relation to the reference year was recorded in 2016 at 1.36. In 2017, the value of forest bird index equalled 1.29.

According to Eurostat, on the basis of data prepared by the Pan-European Common Bird Monitoring Scheme (PECBMS), in the period 2001–2016, aggregated Farmland Bird Index for the European Union decreased steadily in comparison with the base year (2000=100) and in 2016 amounted to 83.7%. In the case of aggregated Forest Bird Index in 2001–2015 the values were lower than the reference value for the year 2000. In 2016, the index for the first time exceeded the base value (by 0.2%).

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 database, 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).

On the basis of OECD database, the greatest percentage of endangered species of mammals among European Union countries (for which data are available) was noticed in Slovenia (38%) and Germany (34%). In the case of endangered bird species with habitats in a given country, their highest share was in the Czechia (47%) and Germany (36%), and endangered reptiles – in Slovenia (75%) and the Netherlands (71%). Austria (46%) and Hungary(43%) were among countries with the highest share of endangered fish. The highest percentage of endangered vascular plants was observed in France (52%) and Austria (33%).

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, wasteland 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 soil quality in terms of its richness in nutrients and carbon storage as well as influences 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.

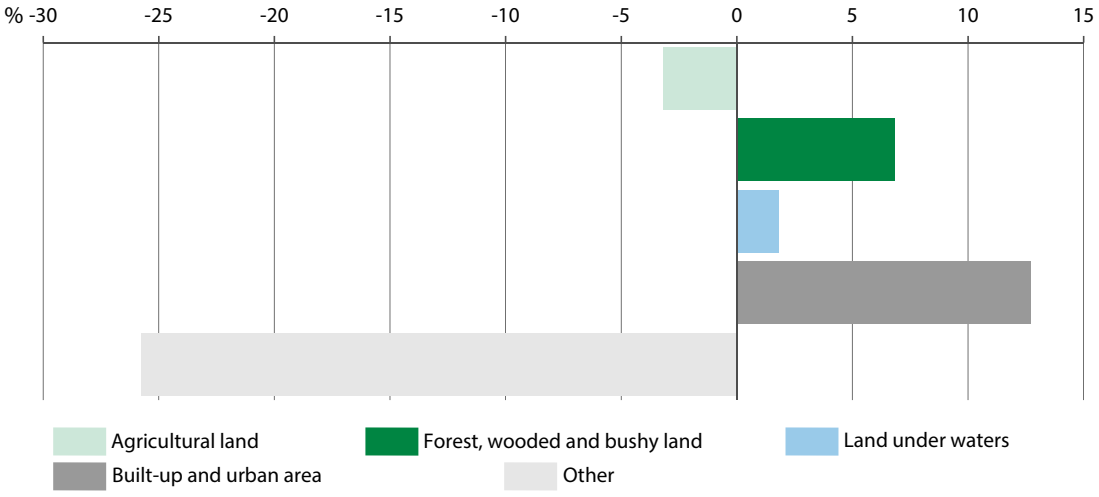
According to a geodesic inventory, in 2018, agricultural land comprised 60.0% (18.8 million hectares), forest, wooded and bushy land – 30.5% (9.5 million hectares), and built-up and urban areas – 5.5% (1.7 million hectares) out of the total area of the country, equalling 31.3 million hectares.

Data from Food and Agriculture Organization (FAO) database show that, in 2017, in the EU Member States, the total area of agricultural land within agricultural holdings amounted to 181.6 million hectares, which constituted 41.1% of total EU area. Among European Union countries the one with the highest share of agricultural land within agricultural holdings in total country area was Great Britain – 71.7%, and with the lowest Finland – 6.7%. Poland, with its share of agricultural land within agricultural holdings equalling 46.3%, ranked 10th in EU countries.

Human by changes in land use influences biodiversity and ecosystem state. As built-up and urban areas are increasing, 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 leads to traffic increase and land fragmentation.

In the years 2002–2018 an increase was noted in built-up and urban areas (by 12.7%), forest, wooded and bushy land (by 6.8%), as well as land under waters (by 1.8%) to the detriment of other area and agricultural land, for which there was a decrease by 25.8% and 3.2% respectively (chart 2).

Chart 2. Land use changes in the years 2002–2018[a]

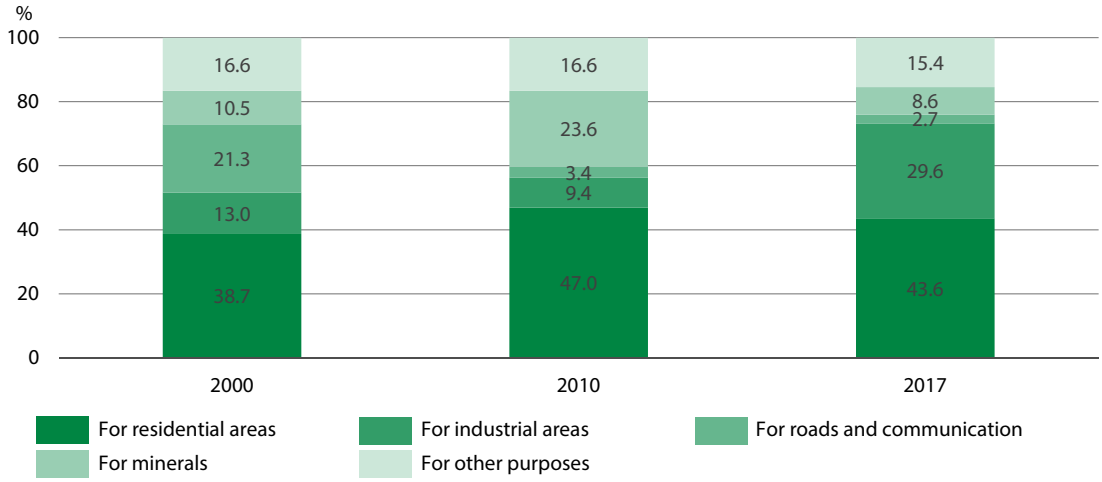


a In order to maintain data comparability, data for 2018 regarding wooded and bushy land on agricultural land were included in forest, wooded and bushy land.

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

In 2017, 5.1 thousand hectares of agricultural and forest land were designated for non-agricultural and non-forest purposes, which means an increase in relation to the previous year and 2000 by 15.3% and 76.3% respectively. The highest proportion of excluded land was designated for residential areas – 43.6% and industrial areas – 29.6% (chart 3).

Chart 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 2017, devastated and degraded land comprised in total 62.0 thousand hectares, of which reclaimed land was solely 1.3 thousand hectares, including for agricultural purposes – 0.8 thousand hectares. Land development comprised 0.5 thousand hectares, of which the majority was also designated for agricultural purposes – 0.3 thousand hectares. Until now the degree of reclamation and development of devastated and degraded land has been low for many years. In 2017, it accounted for 2.1% and 0.8% of total devastated and degraded land respectively.

2.3. Forest resources

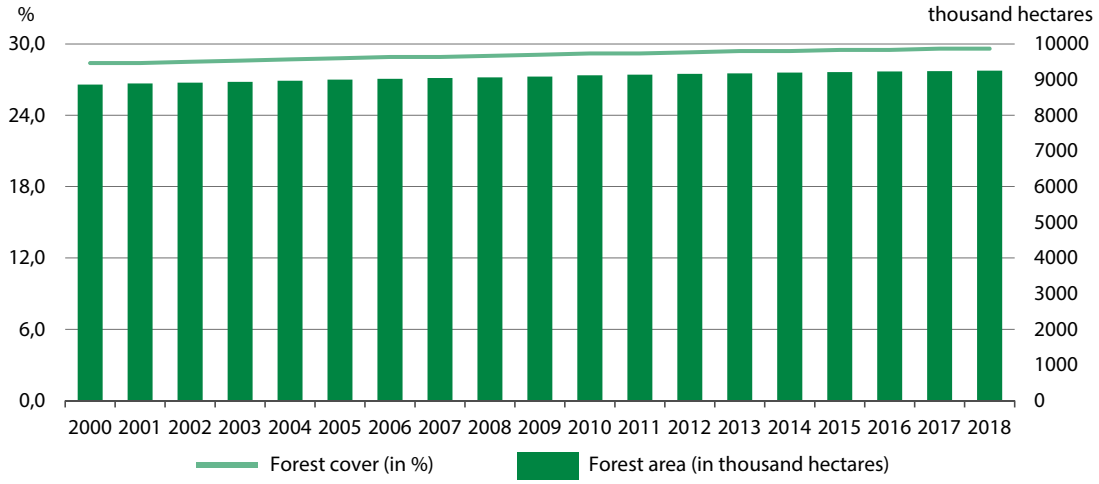
Forest is a land of compact area of at least 0.10 ha, covered by forest vegetation (wooded area) or temporarily devoid of forest vegetation (felling sites, blanks, irregularly stocked open stands, coniferous tree and bush plantations, hunting grounds). These are lands designated for silviculture production, constituting a nature reserve or integral part of a national park or registered as monuments of nature.

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 2018, forests in Poland covered 9254.9 thousand hectares, which means that their area increased in comparison to 2017 and 2000 by 0.1% and 4.4% respectively (chart 4). Forest cover (the percentage ratio of the area of forest to the total area of a country) in 2018 was 29.6% and did not change in comparison to the previous year, but grew in relation to the year 2000 (by 1.2 pp). The increase of forest area in Poland is a result of the state forest policy, which plans the state forest cover increase, as lands unsuitable for agriculture are transferred to afforestation, to 30% in 2020 and 33% after 2050.

According to FAO database, in European Union countries in 2017, the share of forest area in land area amounted to 38.2%. Countries with its highest value were Finland (73.1%), Sweden (68.9%) and Slovenia (62.0%), and the country with the lowest one was Malta (1.1%). Poland, with the value of 30.9%, held 19th position among 28 EU Member States.

Chart 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) carried out continuously (in a full cycle of 5 years) by the Bureau for Forest Management and Geodesy. According to the measurements of the NFI in the years 2014–2018, growing stock reached the volume of 2617.9 million m^3 of timber gross (a 13.6% increase in comparison to the measurements in the years 2005–2009), of which 72.4% referred to coniferous trees and 27.6% – to broadleaved trees.

On the basis of FAO database, in 2015, the estimation of wood resources of the European Union amounted to 26534.4 million m^3 of timber. Among EU countries, Poland was placed in the group of four countries with the highest share of wood resources, following Germany (3663.0 million m^3 of timber), Sweden (2988.5 million m^3) and France (2860.0 million m^3).

As a result of a constantly growing forest area and growing stock, it is possible to gradually increase wood harvest. In 2018, wood harvest amounted to 43.9 million m^3 of wood, which means more than a year before and in 2000, by 2.9% and 68.8% respectively. It is important to keep the balance between volume increment of timber and wood harvest to preserve the forest heritage for future generations.

As Eurostat data show, in 2017, European Union countries harvested 470.3 million m^3 of wood. The most was harvested in Sweden (72.9 million m^3) and Finland (63.3 million m^3). Poland ranked 5th among EU-28 Member States.

While analysing forest resources, their health state cannot be overlooked. Area of damaged forests in Poland in 2018 equalled 3353.7 thousand hectares, which constituted 37.1% of their total area. The dominant reasons of damage included, apart from "other agents" category (29.4%), the categories as follows: caused by game (3.9%), fungi (1.5%) and insects (0.7%).

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.

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 quantity and quality as well as to use it in an effective way.

Poland is a country of limited freshwater resources. Most of them are surface water resources. As Eurostat data show, freshwater resources (as a long-period average) in Poland equal 60 billion m^3. It is hardly 1.6 dam^3 water per capita, which places Poland together with Malta (0.2 dam^3), Cyprus (0.4 dam^3) and Czechia (1.5 dam^3) in the group of EU countries mostly threatened by a shortage of water. The top EU countries with the highest freshwater resources are Sweden (196 billion m^3), France (191 billion m^3) and Germany (188 billion m^3). Freshwater resources per capita are the highest in Finland (20.0 dam^3), Sweden (19.7 dam^3) and Latvia (17.3 dam^3).

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 2018, this indicator amounted to 1.4 dam^3. In the period from 2000 it ranged from 1.1 dam^3 in 2015 and 2016 to 2.3 dam^3 in 2010 (chart 5).

Chart 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 2018 was 8065.0 hm^3, accounting for 81.6% of total withdrawal. It means a decrease by 1.9% in relation to 2017 and by 11.9% in comparison to 2000. Surface water abstraction from rivers and lakes is used mainly for production purposes – in 2018 it represented 81.0%.

Underground waters as waters of much better quality are mainly treated as drinking water supply. Exploitable resources of underground waters, by the end of 2018, amounted to 18133.3 hm^3, which is more than in 2017 and 2000 by 0.6% and 13.0% respectively. Their withdrawal was 1772.5 hm^3 (17.9% of total withdrawal), so in comparison to the previous year it increased by 5.7% and during the last 19 years – by 1.4%.

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 long-term average freshwater resources. WEI value exceeding 20% means that there is a water stress phenomenon, i.e. stress caused by water shortage. In 2017, in the case of Poland, this index was 17.7%, and from 2000 it reached 20% in 2006 (20.4%) and 2007 (20.0%). Among the EU countries, the worst situation in this respect was recorded in Cyprus (67.4%) and Malta (51.2%).

2.5. Mineral resources

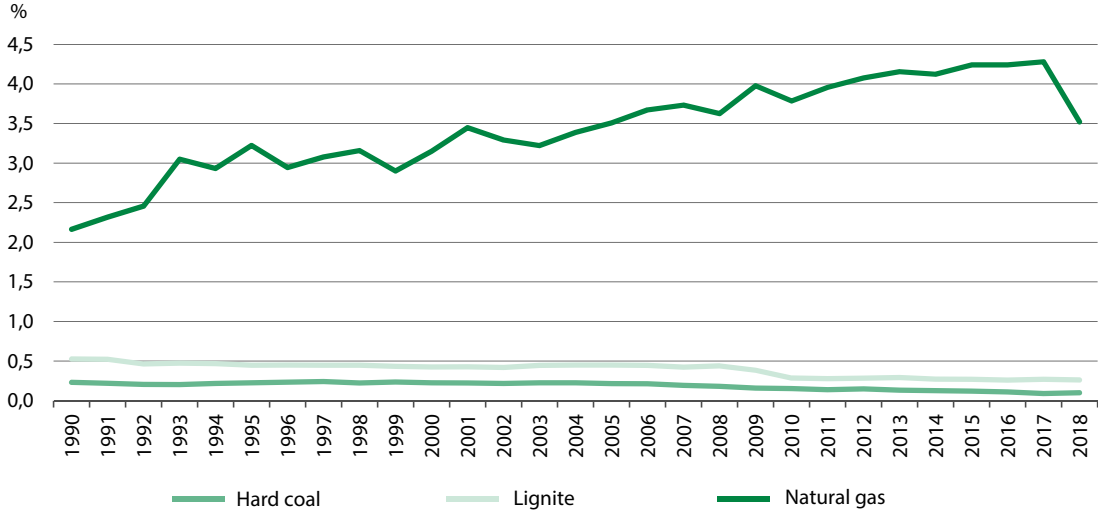
Mineral resources, included in the group of non-renewable natural resources, are minerals being elements of the natural environment: earth's crust, hydrosphere, biosphere and atmosphere, delineated from them and adapted for use by a certain branch of technique or specific technology.

A key role to ensure a high standard of living in developed countries and to maintain constant economic growth play fossil fuels and non-metallic minerals. They safe-guard 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.

In 1990–2018 geological resources of hard coal (balance-sheet and off-balance-sheet) diminished from 86.0 billion tonnes to 76.0 billion tonnes (by 11.7%), which was mainly caused by exploitation and changes in balance criteria. Its annual exploitation fell from 151.3 million tonnes in 1990 to 63.9 million tonnes in 2018 (by 57.8%). In 2018, the share of extraction in balance-sheet resources of hard coal was 0.1% and was lower by 0.1 pp in relation to 1990 (chart 6).

Chart 6. Share of extraction in balance-sheet deposit resources of selected minerals



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

According to Eurostat, in 2017, only 5 from 28 European Union Member States mined hard coal. In total, 78.9 million tonnes were mined. The highest share in total extraction in EU was noted in Poland (83.0%).

Lignite, in comparison to hard coal, is a lower ranking type of coal, with a much lower calorific value. In 2018, its geological resources (balance-sheet and off-balance-sheet) were 26.8 billion tonnes, which means that they increased by 57.0% 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 annual lignite extraction fell down from 1990 to 2018 from 67.7 million tonnes to 61.1 million tonnes (by 9.7%). In 2018, the share of lignite extraction in its balance-sheet resources was 0.3% (in 1990 – 0.5%).

As Eurostat data show, in 2017, lignite was extracted in 9 from 28 countries of the European Union with the amount equalling 382.7 million tonnes. Countries with the greatest extraction were Germany (171.3 million tonnes) and Poland (61.2 million tonnes).

Natural gas, due to its high calorific value, unchangeable chemical composition (the possibility 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 142.2 billion m^3 in 2018, i.e. by 13.3%. At the same time, ecological properties of gas, as well as the wide scope of its use resulted in the fact that annual gas extraction increased by 42.5% from 3.5 billion m^3 in 1990 to 4.9 billion m^3 in 2018. The share of extraction in balance-sheet resources of natural gas was 3.5% in 2018 (in 1991 – 2.2%).

Eurostat data show that in 2017 natural gas was produced by 18 from 28 EU countries. The production amounted to 132.0 billion m^3. The highest production was noted in the Netherlands (46.3 billion m^3), Great Britain (42.1 billion m^3) and Romania (10.6 billion m^3).

Chapter 3

Environmental and resource productivity of the economy

3.1. Water productivity

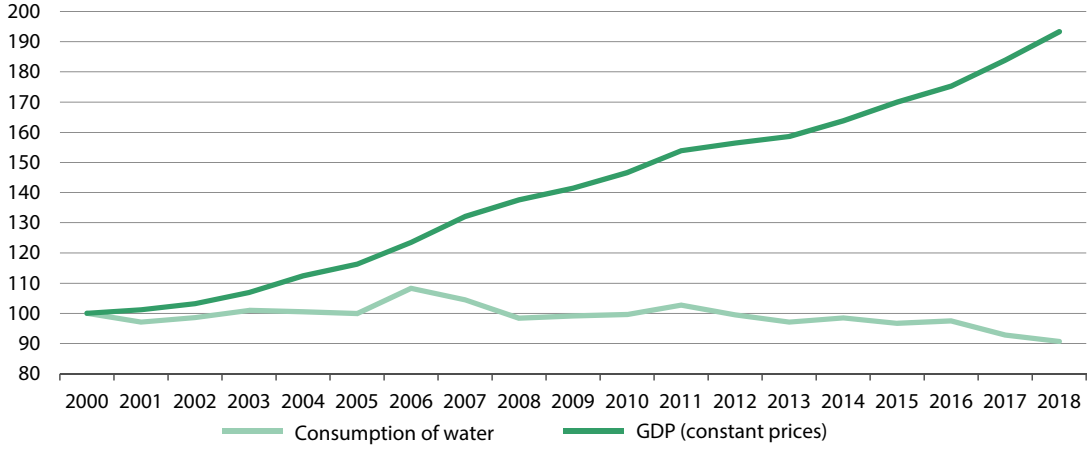
Water productivity is calculated as the gross domestic product (in constant prices) divided by the consumption of water for needs of the national economy and population. The indicator presents GDP per water consumption unit and is used to assess the efficiency of water management.

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 2018, consumption of water for needs of the national economy and population was 9434.6 hm^3, of which 6812.3 hm^3 (72.2% of total water consumption) was for production purposes, exploitation of water supply network – 1665.8 hm^3 (17.7%), as well as irrigation in agriculture and forestry as well as filling and completing fish ponds – 956.4 hm^3 (10.1%). In relation to 2000, positive changes took place, namely a decrease of water consumption by 9.4%, and of which, in industry – by 10.3%, in agriculture and forestry – by 9.8%, in the case of exploitation of water supply network – by 5.0%. 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 245.6 m^3 in 2018).

The main factors affecting the quantity of used water are production intensity together with the volume and patterns of individual consumption. Analyzing the indices of water consumption and GDP in the years 2001–2018 in relation to 2000, it can be stated that there was a positive trend – almost constant water consumption level (excluding 2006 and 2007) and even its decrease in recent years, with a constant gradual GDP increase (chart 7).

Chart 7. Indices of consumption of water for needs of the national economy and population as well as GDP[a]
2000=100



a GDP for 2018 – preliminary data.

Efficient water consumption constitutes a base for proper water management. In the years 2000–2018 the water productivity index was becoming more and more favorable. In 2018, the ratio of GDP to cubic

meter of water consumed was 221.71 PLN/m^3, which means that it increased both to the year 2017 and 2000, by 9.6% and 227.8% respectively.

According to Eurostat data, for 20 countries of the European Union for which data are available, the highest value of water productivity index in 2016 was in Luxembourg (where the value of generated GDP was 1040.9 PPS units per cubic meter of freshwater abstracted), Malta (303.6 PPS/m^3), Denmark (285.1 PPS/m^3) and Slovakia (219.3 PPS/m^3), and the lowest in Estonia (16.9 PPS/m^3), Bulgaria (18.0 PPS/m^3) and Greece (19.0 PPS/m^3). Poland with 68.7 PPS/m^3 was in the 13th position.

To assess the effectiveness of water management, in addition to water productivity index, it is also possible to use water intensity indicators, such as water use intensity of industry (illustrating the ratio of industry water consumption to gross value added of industry) or water use intensity of households (the ratio of consumption of water from water supply system in households to gross value added of households).

Since 2000 there have been positive tendencies in Poland in terms of a gradual decrease in the water use intensity of industry (excluding the following three years: 2002, 2006 and 2011, when a slight increase was observed in relation to the previous year). In 2018, it reached 14.7 m^3/thousand PLN, i.e. was lower in comparison to 2017 and 2000 by 7.0% and 70.6% respectively. Household sector was characterized by a much lower water use intensity index, which also decreased. In 2018, it was 2.5 m^3/thousand PLN, i.e. just like in 2017, while in relation to 2000 it decreased by 62.1%.

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. However, 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.

Domestic material consumption in 2018 was 773.4 million tonnes, which is 20.4 tonnes of materials per capita yearly. In relation to 2017 and 2000, the consumption was higher by 8.6% and 43.4%, respectively.

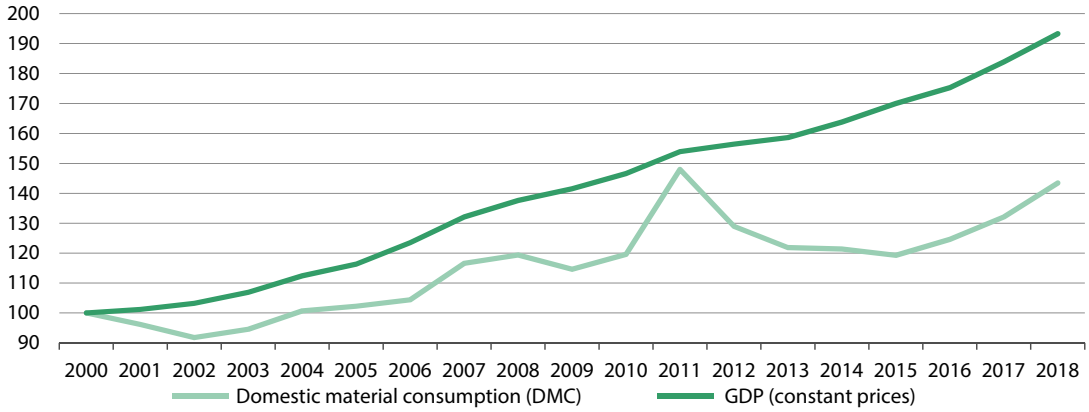
As Eurostat data show, domestic material consumption in 28 Member States of the European Union in 2018 amounted to 7.1 billion tonnes, and per capita in the EU – 13.8 tonnes. The highest material consumption per capita was in Finland (35.0 tonnes) and Estonia (34.3 tonnes), and the lowest in Italy (8.3 tonnes) and Great Britain (8.6 tonnes).

In DMC structure, the biggest share have non-metallic minerals (47.1%), whose consumption in the analysed year was 364.5 million tonnes. The share of remaining materials, i.e. biomass, fossil energy materials/carriers and metal ores in the total consumption was 26.2%, 21.9% and 5.5% respectively. In relation to 2000, the consumption of non-metallic minerals increased the most, by 112.9%. It is largely connected with the realisation of infrastructure projects, among others financed from European Union funds.

In the period 2001–2018 DMC dynamics fluctuated in comparison with 2000. However, in the entire analysed period, apart from the years 2001–2003, it was higher than in the base year, with a constantly growing GDP (chart 8). It proves a relative decoupling between GDP and material consumption.

Chart 8. Indices of domestic material consumption (DMC) and GDP[a]

2000=100



a GDP for 2018 – preliminary data.
Source: data regarding domestic material consumption – Eurostat database.

To measure the efficiency of materials in economy a resource productivity index is used, i.e. a relation of gross domestic product (in constant prices) to domestic material consumption. The higher the value of this index, the lower material consumption to produce a unit of GDP. In the years 2000–2015, the efficiency of resource use gradually increased from 1.31 PLN/kg to 2.78 PLN/kg (except for the years: 2004, 2007 and 2011, when the analysed indicator assumed lower values compared to the previous year). Since 2016 the resource productivity index slightly decreased from 2.76 PLN/kg to 2.70 PLN/kg in 2018.

According to Eurostat, w 2017, the resource productivity index in countries of the European Union was 2.2 PPS/kg. Member States with the highest index were the Netherlands (4.1 PPS/kg), Great Britain (3.7 PPS/kg) and Italy (3.5 PPS/kg), and the ones with the lowest – Bulgaria and Estonia (0.8 PPS/kg each). Poland with the index value of 1.1 PPS/kg ranked 24th among 28 countries of the European Union.

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.
Municipal waste is defined as waste generated in households, excluding end-of-life vehicles or generated by other waste producers (excluding hazardous waste) which on the account of its character and composition is similar to waste from 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.

In 2018, 127.8 million tonnes of waste were produced, of which 90.2% was waste other than the municipal one.

Waste (excluding municipal waste)

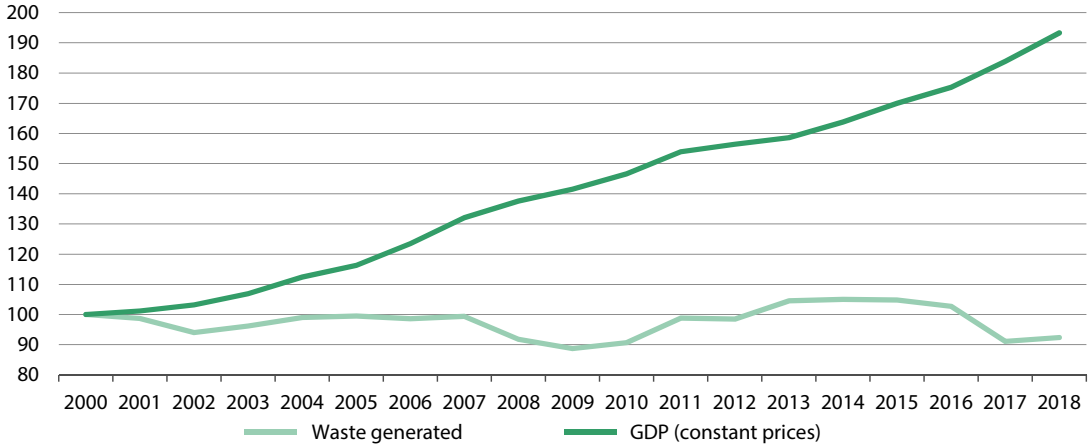
In the period 2000–2007 and 2011–2012 the amount of generated waste (excluding municipal waste) was relatively stable and fluctuated around 120 million tonnes. Its lowest value – 111.1 million tonnes, was noted in the year 2009, which could have been a result of, among others, the economic slowdown. In 2018, 115.3 million tonnes of waste were produced, which is an increase by 1.4% in comparison with the previous year but a decrease by 8.1% in relation to 2000. The main source of waste generation were entities belonging to the following sections: mining and quarrying (53.2% of total amount of generated waste excluding municipal one), manufacturing (22.6%), as well as electricity, gas, steam and air conditioning supply (15.9%).

Recovery processes play a meaningful role in waste management. In 2018, recovered waste by waste producer on its own as well as transferred to other recipients for recovery processes was 58.4 million tonnes, which accounted for 50.7% of total generated waste (in 2017 – 49.1%).

Analysing the dynamics of the amount of generated waste and GDP in the period of 2001–2018 in relation to 2000, a positive trend can be observed (chart 9), namely a constant growth of GDP with a stable dynamics of the amount of generated waste, below the base year value 2000=100 (apart from the years 2013–2016).

Chart 9. Indices of waste generated (excluding municipal waste) and GDP[a]

2000=100



a GDP for 2018 – preliminary data.

Municipal waste[1]

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 the environment.

In 2018, 12.5 million tonnes of municipal waste were collected, which means an increase both in relation to 2017 and 2003, by 4.3% and 25.8% respectively. In 2018, an average resident of Poland produced 325.0 kg of waste, which is more in relation to the previous year and 2003, by 4.3% (by 13.5 kg) and 25.1% (by 65.2 kg).

Eurostat data show that in 2017 the amount of municipal waste per capita in Poland is decisively lower that the European Union average (486 kg) and is one of the lowest (preceded only by Romania – 272 kg)

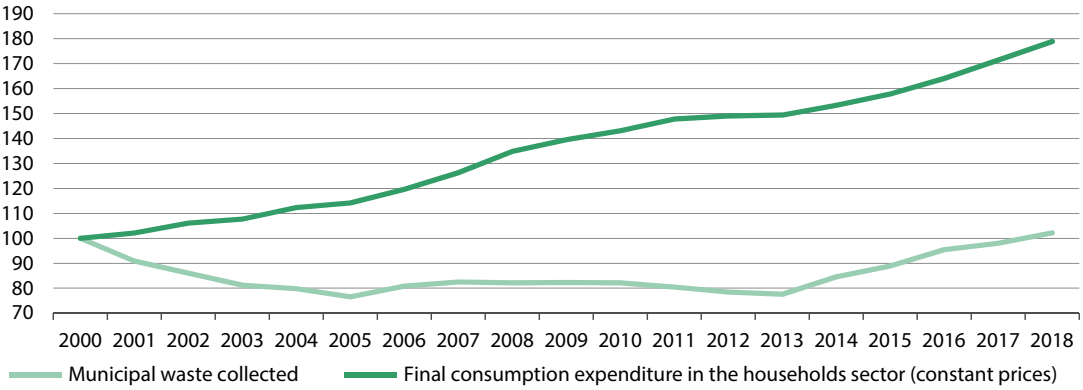
[1] From 2014 municipal waste collected as a result of changes in the municipal waste management system (from 1st July 2013 municipalities covered all real-estate owners with the system) includes waste collected from all inhabitants and is considered as waste generated.

in EU countries. The highest analysed value was recorded in Denmark (781 kg), Cyprus (637 kg) and Germany (633 kg).

It is noteworthy that, in the years 2001–2018 the growth of final consumption expenditure in the household sector in Poland in relation to 2000 was steadily rising (chart 10). On the other hand, the dynamics of the amount of municipal waste collected in the years 2001–2017 was below the base year level (2000=100), which was a positive phenomenon. In 2018, it exceeded the level of 2000 by 2.2%.

Chart 10. Indices of municipal waste collected and final consumption expenditure in the households sector[a]

2000=100



a Final consumption expenditure in the households sector for 2018 – preliminary data.

One of the main methods of reducing the amount of waste is recycling, whose main aim is to re-use of materials. Selective waste collection is necessary to facilitate recycling processes. In 2018, 3.6 million tonnes of municipal waste were collected separately. The proportion of waste collected separately in the total mass of collected municipal waste from 2003 was gradually growing, reaching 28.9% in 2018. 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 (in 2018 – 71.1%).

According to Eurostat data, recycling rate of municipal waste (share of waste designated for recycling and biological treatment in total municipal waste) in European Union countries in 2017 was 46.4%. Germany (67.6%), Slovenia (57.8%) and Austria (57.7%) had the highest value of the indicator and Malta (6.4%) – the lowest. Poland with the recycling rate of municipal waste at 33.8% was 18th among EU countries.

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.
A negative balance, i.e. the difference between the inflow and outflow of components indicates their shortage, while a positive one – an excess of components.

Modern agriculture has a significant effect on environment. Therefore, 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, thus creating the risk of imbalance of ecosystems.

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 2017/2018 was 1.2 million tonnes and was higher in relation to the previous year and to the 1999/2000 economic year by 2.5% and 36.9% respectively. The figure of nitrogen fertilizers per 1 ha of agricultural land in the economic year 2017/2018 was 80.4 kg, while a year before – 78.7 kg, and in the economic year 1999/2000 – 48.4 kg.

In the case of the use of phosphoric fertilizers in the economic year 2017/2018, which amounted to 0.3 million tonnes (in pure ingredient – P_2O_5), there was a decrease in relation to the previous year by 1.4%, but an increase by 14.1% in comparison to the economic year 1999/2000. In the analysed year, the use of phosphoric fertilizers per 1 ha of agricultural land was 23.1 kg, in the previous year – 23.5 kg, and in the economic year 1999/2000 – 16.7 kg.

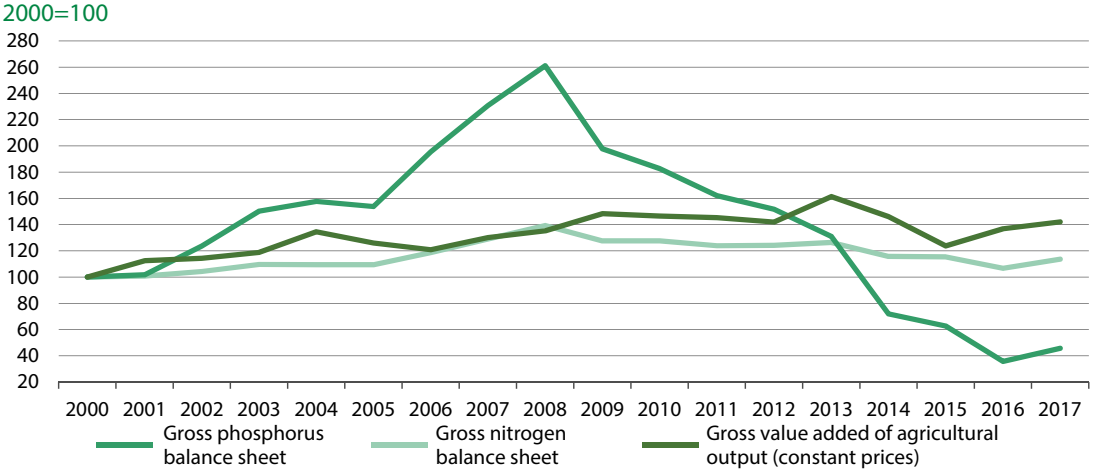
Nitrogen and phosphorus balances, as an example of many agri-environmental indicators, are a very important source of information on agricultural influence on environment conditions. A comprehensive evaluation of gross nitrogen and phosphorous balances is carried out on the basis of at least a 3-year 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 18 years, it can be noted that the average gross nitrogen balance per 1 ha of agricultural land grew from 41.1 kg in the period of 1998–2000 to 46.8 kg in 2015–2017. This value is, however, kept at a safe level – below 70 kg per 1 ha of agricultural land.

In the years 2001–2017 the dynamics of gross nitrogen balance in relation to 2000 was lower (except for the years 2007–2008) than the growth rate of gross value added of agricultural output (chart 11), which is indicative of relative decoupling between agricultural output and gross nitrogen balance.

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



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 prepared by the Institute of Soil Science and Plant Cultivation – National Research Institute (Jerzy Kopiński, Beata Jurga), within the framework of 2.1 PW IUNG-PIB 2016–2020 task according to "Nutrient Budgets" methodology OECD/Eurostat.

As Eurostat database shows, in European Union Member States in 2015 the average gross nitrogen balance sheet per 1 ha of agricultural land was 51 kg, and among UE countries it was between 9 kg in Romania and 194 kg in Cyprus.

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 element, its supplementation in the form of fertilization is necessary. It is assumed that phosphorus balance, with 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 18 years, an average gross phosphorus balance per 1 ha of agricultural land decreased from 3.0 kg in the period of 1998–2000 to 1.4 kg in the years 2015––2017.

Gross phosphorous balance sheet dynamics in 2001–2013 was above a level of the year 2000, and since 2014 the reverse tendency was observed. However, the dynamics of gross value added of agricultural output from 2001 to 2017 was at a lower level than in the base year (2000=100). Although at the beginning there was a relation between gross value added of agricultural output and phosphorous balance sheet, since 2014 there has been an absolute decoupling between these two values.

On the basis of Eurostat data, it can be stated that in 2015 in European Union Member States the average gross phosphorous balance sheet per 1 ha agricultural land was 1 kg, and among Member States was from minus 7 kg in Estonia to 32 kg in Cyprus.

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 tonne of crude petroleum. One tonne of conventional oil equals 41.868 GJ (11.63 MWh).

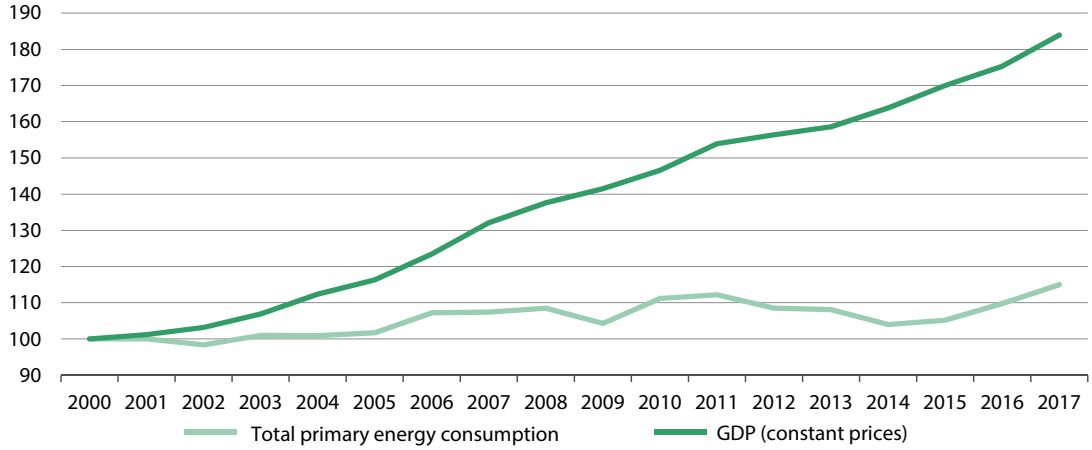
Energy is used in production processes and in households. Its efficient use in economy constitutes an important factor influencing production costs and product competitiveness on international market. Careless use of energy leads to problems with pollution of natural environment (through greenhouse gas emissions) and to energy resources depletion. Energy demand is constantly growing, therefore 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 2017, the total primary energy consumption was 103.9 Mtoe and was higher in relation to the previous year and in comparison to 2000 by 4.7% and 15.1% respectively. Among primary energy carriers in 2017, hard coal and lignite held a dominating position (51.9% of total consumption). Their share in the total consumption in relation to 2000 was reduced by 12.8 pp.

In the years 2001–2017, dynamics of total primary energy consumption in the economy in relation to 2000 assumed values above the level from the base year (except for 2002). However, it was much lower than GDP growth rate. This indicates a relative decoupling between economic growth expressed in GDP and energy consumption (chart 12).

Chart 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 total primary energy consumption, can be used. A higher value of the indicator means a lower energy consumption to produce a GDP unit. In 2017, this measure was 18.80 PLN/kgoe and grew in relation to 2016 and 2000 by 0.6% and 141.1% respectively, which is a positive fact.

Eurostat data show the primary energy productivity indicator in European Union countries in 2017 was 8.9 PPS/kgoe. EU countries with the highest primary energy productivity were Ireland (17.6 PPS/kgoe), Denmark (11.8 PPS/kgoe) and Great Britain (11.1 PPS/kgoe). The lowest indicator was noted in Malta (4.7 PPS/kgoe), Estonia (5.1 PPS/kgoe) and Finland (5.3 PPS/kgoe). Poland, having reached 7.6 PPS/kgoe was in the 17th place among EU Member States.

In the period 2000–2017, 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) took place in Poland. In 2017, the biggest consumer was a transport sector with a 31.5% share, followed by households – 28.5%, industry – 22.8%, services – 11.6% and agriculture – 5.6%. In relation to 2000, the largest decrease in the share of final energy consumption was recorded in industry (by 8.9 pp), which can result, among others, from this sector restructuring and introducing new energy-efficient technology. On the other hand, the greatest increase in the share of final energy consumption structure was noted in transport (by 14.5 pp), i.a. as a result of a dynamic development of road transport and services.

Final energy intensity coefficients, being the relation between final energy consumption in economy and GDP, can also be used to assess an energy policy of a country.

During the years 2000–2015 a gradual decrease of final energy intensity of Polish economy was observed from 76.9 kgoe/thousand PLN to 34.2 kgoe/thousand PLN, which was a favourable condition as the share of energy necessary to produce the same amount of GDP decreased. Since 2016 a slight increase has been noted in this respect. In 2017, it was 35.6 kgoe/thousand PLN, which means it increased by 1.0% in relation to 2016, but decreased by 47.4% in comparison with 2000.

In the case of households, the final energy intensity of this sector, depicting the relation between final energy consumption in households and gross value added (constant prices) produced in this sector, was gradually falling from 2000 (except for 2010 and 2016). In 2017, it amounted to 40.6 kgoe/thousand PLN and was lower in relation to 2016 and 2000 – by 3.7% and 52.4% respectively.

In the period of 2001–2016 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 (constant prices) of this sector. In 2017, this indicator was 35.5 kgoe/thousand

PLN, which means that in comparison with the previous year, its increase was noted by 3.9%, but in relation to 2001 – a decrease by 64.4%.

Final energy intensity of transport is measured as a relation of final energy consumption of transport sector to GDP (constant prices) and in 2017 it was 11.2 kgoe/thousand PLN. It was higher in comparison with 2016 by 10.8%, but in relation to 2000 it was lower by 14.1%.

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, geo-thermal heat, waves, sea currents and tides and energy obtained from solid biofuels, biogas, liquid biofuels) as well as natural environment energy used by heat pumps.

Growing demand for energy, resulting from civilizational growth and care for environment, leads 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 inexhaustible 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 regarded as one of the causes of alarming climate changes, and global resources of traditional carriers are constantly diminishing.

Within the last 14 years there was a constant increase in the amount of renewable energy, from 4.3 Mtoe in 2004 to 9.0 Mtoe in 2017. Solid biofuels occupied the first position in Poland (68.1%) in the structure of energy generation with the use of renewable sources by type of carriers. The share of remaining carriers was as follows: wind energy (14.2%), liquid biofuels (10.1%), biogas (3.1%) as well as hydro energy (2.4%).

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[2]. 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[3].

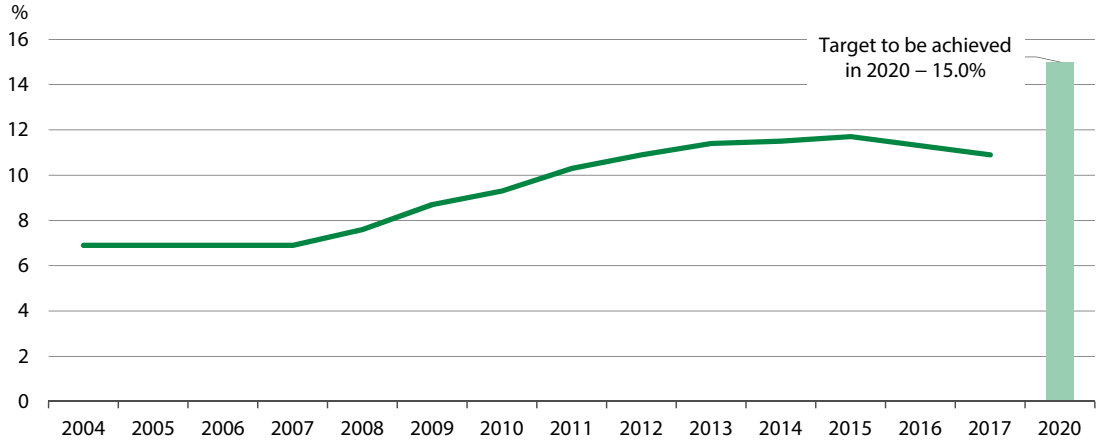
In 2017, the share of renewable energy in gross final energy consumption was 10.9%, which is indicative of a decrease in relation to the previous year by 0.4 pp and growth in comparison with the year 2004 by 4.0 pp (chart 13).

Eurostat database provides such information that the share of renewable energy in gross final energy consumption was 17.5% in European Union countries. The highest value of the indicator was noted in Sweden (54.5%), Finland (41.0%), Latvia (39.0%) and Denmark (35.8%), the lowest, however, in Luxembourg (6.4%), the Netherlands (6.6%) and Malta (7.2%). Among EU countries, Poland ranked 21st.

[2] On the basis of Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources

[3] On the basis of Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources.

Chart 13. Share of renewable energy in gross final energy consumption

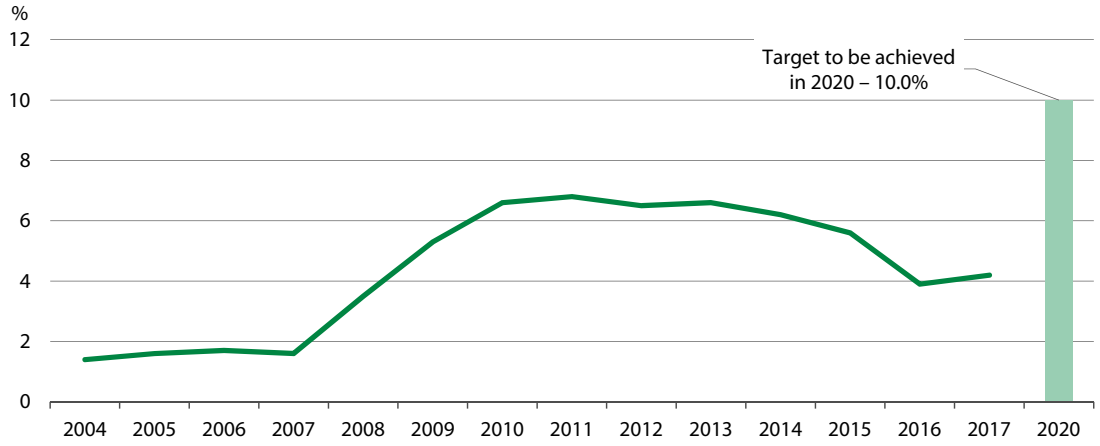


Source: Eurostat database.

The growth of the number of cars and the development of the transport sector lead to the growing demand for energy, including crude oil. It generates problems connected with the increase in natural environment pollution and with petroleum depletion, additionally, it makes it necessary to enhance alternative fuels (i.a. liquid 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 (chart 14). In the years that followed, the share decreased from 6.5% in 2012 to 4.2% in 2017.

Chart 14. Share of renewable energy in transport



Source: Eurostat database.

Liquid biofuel production for transport grew from 13.4 thousand toe in 2004 to 917.7 thousand toe in 2017. In the structure of energy generation from liquid biofuels, from 2004 a dominating position belonged to biodiesel (in 2017 – 86.4% of the total energy production from liquid biofuels), the remaining part – to bioethanol (13.4%) and other biofuels (0.2%).

Inferring from Eurostat data, the share of renewable energy in transport in European Union countries equalled 7.4%, with Sweden (32.1%) and Finland (18.8%) having the biggest share, and Estonia (0.4%) – with the smallest one.

3.7. Greenhouse gas emissions

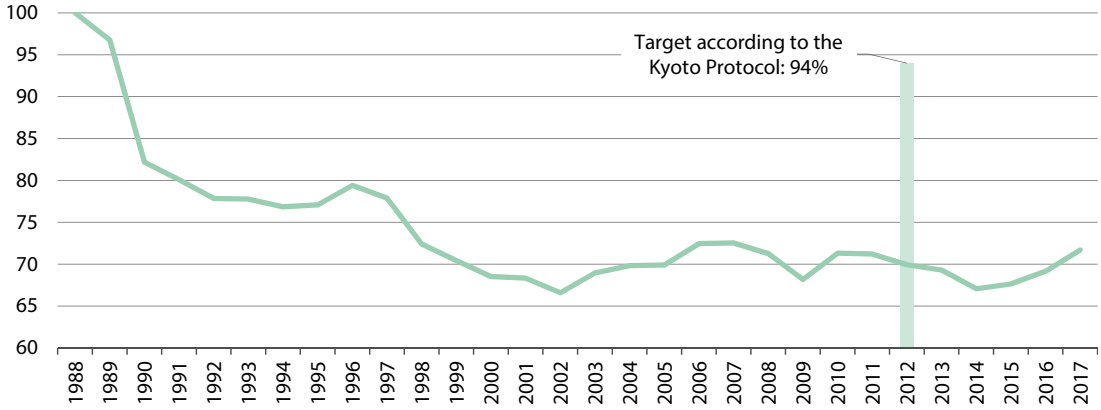
Greenhouse gases are gases preventing the emission of infrared radiation from Earth, causing surface warming. They are emitted to atmosphere as a result of natural processes and human activity. According to the Kyoto Protocol greenhouse gases (the Kyoto basket) refer to carbon dioxide (CO_2), methane (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 was 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 403.6 million tonnes of CO_2 equivalent, which means a significant fall by 30.1% in comparison to 1988 (graph 15). This reduction was substantially larger and 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). In 2017, according to the data of the National Centre for Emissions Management, in Poland greenhouse gas emissions (excluding emissions from international aviation and maritime transport and land use, land use change and forestry) amounted to 413.8 million tonnes of CO_2 equivalent[4]. It means that their emissions were reduced compared to both 1990 and 1988 by 12.8% and 28.3% respectively.

Chart 15. Indices of greenhouse gas emissions

1988=100



Source: data of the National Centre for Emissions Management.

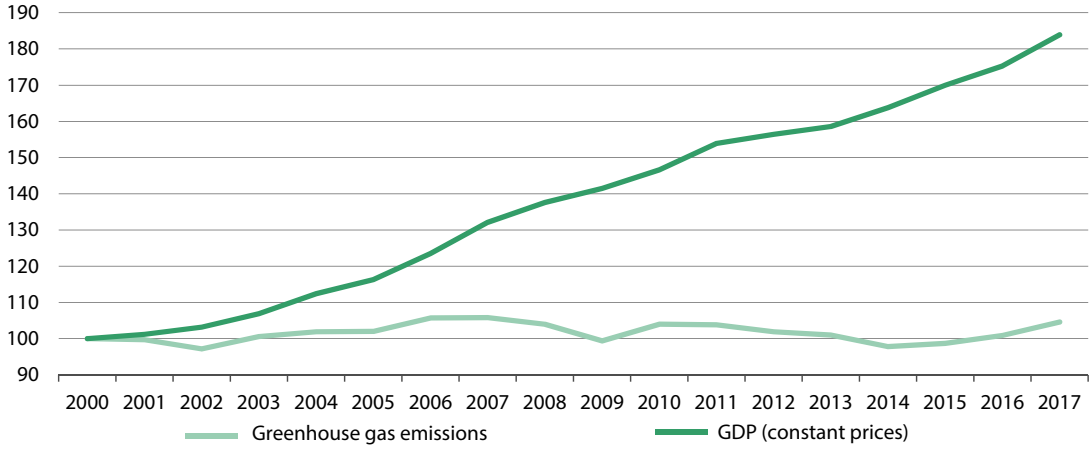
Eurostat database shows that in 2017 greenhouse gas emission (excluding emissions from international aviation and maritime transport and land use, land use change and forestry) in EU countries equalled 4323.2 million tonnes of CO_2 equivalent and was by 23.5% lower than in 1990. The greatest increase in this emission in comparison with 1990 was observed in Cyprus (by 57.8%), Portugal (by 19.4%) and Spain (by 17.9%), and the greatest decrease in Lithuania (by 57.7%), Latvia (by 56.9%) and Romania (by 54.1%).

[4] The equivalent is understood as one megagram (1 Mg) of CO_2 or the amount of any other greenhouse gas being an equivalent of 1 Mg of carbon dioxide, calculated using an appropriate warming potential. Global warming potential for carbon dioxide is – 1, for methane – 25, nitrous oxide – 298.

During the years 2001–2017 the GDP growth rate in comparison to 2000 was decisively faster than the greenhouse gas emission rate. It was a positive phenomenon, because it indicated a limited correlation between economic growth measured by GDP and pressure on the environment caused by greenhouse gas emissions (chart 16).

Chart 16. Indices of greenhouse gas emissions and GDP

2000=100



Source: data regarding greenhouse gas emissions – the National Centre for Emissions Management.

In 2017, the largest share of greenhouse gas emission in Poland had carbon dioxide (81.3% of total emission), followed by methane (11.9%), nitrous oxide (5.0%) and HFCs, PFCs, SF_6 and NF_3 (1.7%). In accordance with the classification prepared by Intergovernmental Panel on Climate Change (IPCC), in 2017 the sector most responsible for greenhouse gas emission was the energy one (82.7% of total emission) and in a smaller scope – agriculture (7.7%), industrial processes and product use (6.5%) followed by waste management (3.1%). Carbon dioxide emission was mainly affected by energy sector (93.9%), industrial processes and product use (5.7%).

In 2007, the European Commission presented the so-called 2020 climate and energy package, which, among others, 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 2017, the total greenhouse gas emissions expressed in CO_2 equivalent in non-ETS sectors in Poland were 204.8 million tonnes, which is a 13.8% increase in comparison to 2005.

Chapter 4

Environmental quality of life

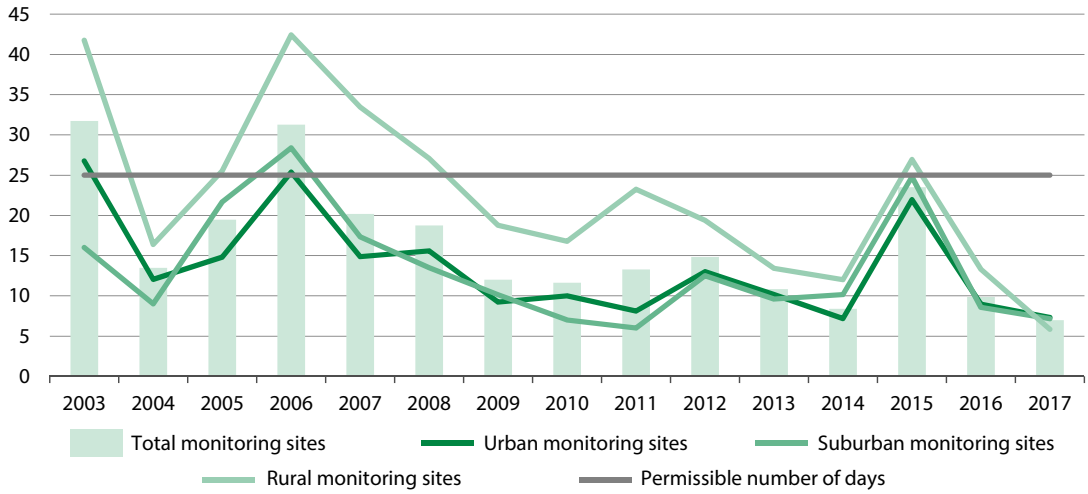
4.1. Gaseous air pollutants

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 one of the main causes 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 are allowed. In 2017, 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 ozone air pollution amounted to 7 and was the lowest one since 2003 (chart 17). The year with the highest number of days exceeding the limit was 2003 – 32 days, 2006 – 31 days and 2015 – 24 days. In the period 2007–2014 this indicator did not exceed 20 days and in the years 2016–2017 – 10 days.

Chart 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 obtained under the State Environmental Monitoring.

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

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 8-hour O_3 concentrations over 70 µg/m^3. The accepted value of this indicator is not stated, however, the higher the level, the higher the threat to human health. In 2017 this indicator equalled 3219 µg/m^3 and it was the lowest one since 2004 (chart 18).

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

Source: data of the Chief Inspectorate of Environmental Protection / JPOAT2.0 database statistics (series with completeness over 85%).

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 1.1 thousand premature deaths in Poland in 2016. Among the European Union countries, the worst situation in this respect occurred in Italy (3.0 thousand) and Germany (2.4 thousand), while the best in Luxembourg and Malta (0.0 thousand each).

4.2. Particulate air pollutants

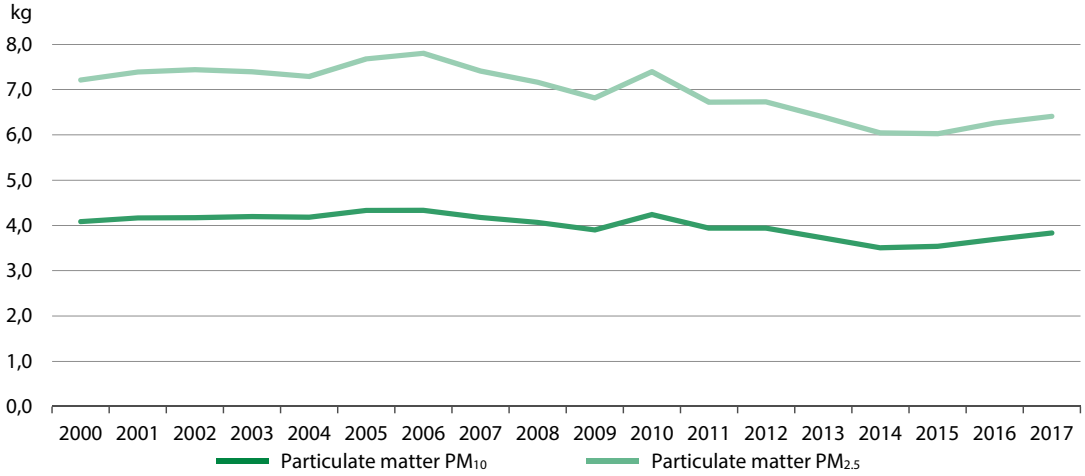
Particulate matter is air pollution that is a mixture of fine solid and liquid particles, consisting of both organic and inorganic compounds. The surface of particulate matter is a carrier of chemical compounds toxic to human health, such as heavy metals (arsenic, nickel, cadmium, lead) and polycyclic 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 2017, PM_{10} emission amounted to 246.3 thousand tonnes and was by 2.4% higher than in the previous year but by 10.0% lower than in 2000. In the case of $PM_{2.5}$, its emission equalled 147.3 thousand tonnes and increased by 3.8% compared to 2016, but was lower than in 2000 by 7.6%. Per capita, the emission of PM_{10} was 6.4 kg, of which $PM_{2.5}$ – 3.8 kg and the figures for these decreased in relation to the ones noted in 2000 (chart 19).

In the European Union countries, on the basis of the European Monitoring and Evaluation Programme (EMEP) data, the indicator in 2017 was 3.9 kg for PM_{10} and 2.6 kg for $PM_{2.5}$, respectively. The highest PM_{10} emissions, including $PM_{2.5}$ per capita, were recorded in Latvia (12.8 kg and 9.2 kg, respectively) and Estonia (10.6 kg and 7.0 kg), while the lowest ones in Malta (0.8 kg and 0.5 kg) and the Netherlands (1.6 kg and 0.8 kg).

Chart 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 2017, their share in the national PM_{10} emissions, as in the case of $PM_{2.5}$, was 46.5%. Emissions of particulate matter came mainly from the municipal and residential sector (especially from building heating with hard coal and wood).

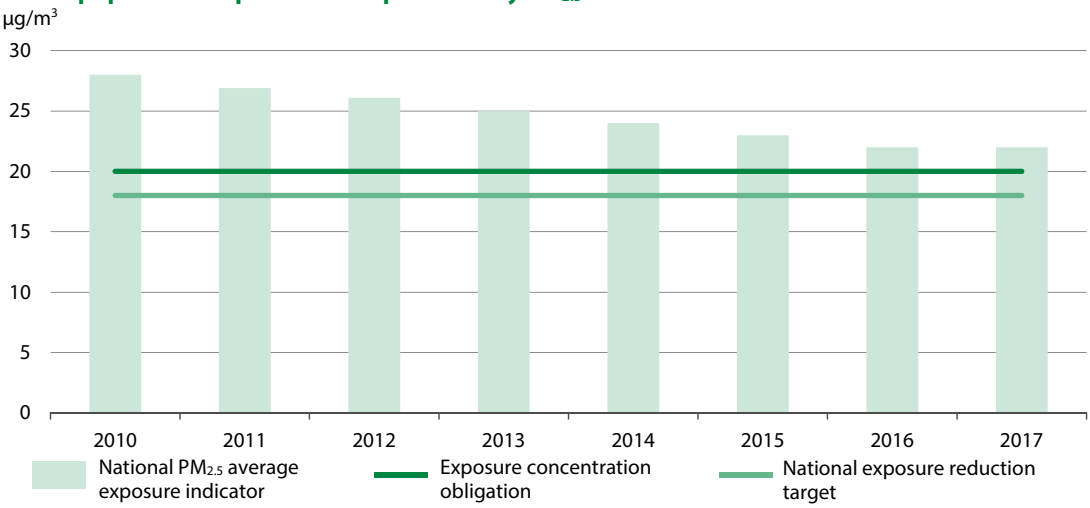
In 2017, combustion processes in industry were also a significant source of the emissions (especially such branches as energy, chemistry, mining, and metallurgy), which generated 13.5% of total PM_{10} emissions and 21.1% of $PM_{2.5}$ emissions. However, due to the height of the devices emitting particulate 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.

Road transport, as the third largest source of particulate matter emissions, in 2017 was responsible for 7.8% of domestic PM_{10} emissions and 10.2% of total $PM_{2.5}$ emissions, which in city centres with high vehicle traffic could have been the reason for exceeding criteria values set forth for particulate matter.

The indicator of population exposure to PM_{10} reflects the population exposure to air pollution by PM_{10}, and its permissible level for the mean annual concentration is 40 $\mu g/m^3$. According to Eurostat, in 2017, the indicator measured at urban background monitoring sites in Poland was 32.2 $\mu g/m^3$ and was one of the lowest from 2000. However, it significantly exceeded the European average of 21.6 $\mu g/m^3$. Among the European Union countries, the highest value was noted in Bulgaria (37.3 $\mu g/m^3$) and Croatia (35.1 $\mu g/m^3$), while the lowest in Finland (10.0 $\mu g/m^3$) and Estonia (10.5 $\mu g/m^3$).

The national $PM_{2.5}$ average exposure indicator is determined on the basis of measurements obtained under the State Environmental Monitoring in urban background areas for cities over 100 thousand inhabitants and agglomerations. It reflects the population exposure to air pollution by $PM_{2.5}$ and is calculated as the arithmetic mean of the average annual $PM_{2.5}$ concentrations from three years. In 2017, the indicator amounted to 22 $\mu g/m^3$ (chart 20), which means that it exceeds the exposure concentration obligation of 20 $\mu g/m^3$ in force since 2015 and the national exposure reduction target (18 $\mu g/m^3$) planned to be achieved until 2020.

Chart 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.

According to Eurostat, in 2017 Poland together with Bulgaria (with $PM_{2.5}$ average exposure indicator at the level of 23.8 µg/m^3) were among the EU leaders in terms of urban population exposure to $PM_{2.5}$ concentration. In these countries, the indicator significantly exceeded the average for the European Union (14.1 µg/m^3). The least exposed to air pollution by $PM_{2.5}$ was the urban population of Finland (4.9 µg/m^3), Estonia (5.3 µg/m^3) and Sweden (5.4 µg/m^3).

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 2016 $PM_{2.5}$ exposure led to 43.1 thousand premature deaths in Poland. Among the European Union countries, higher values were recorded only in Germany (59.6 thousand) and Italy (58.6 thousand). The least premature deaths due to this reason occurred in Luxembourg and Malta (0.2 thousand each).

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.

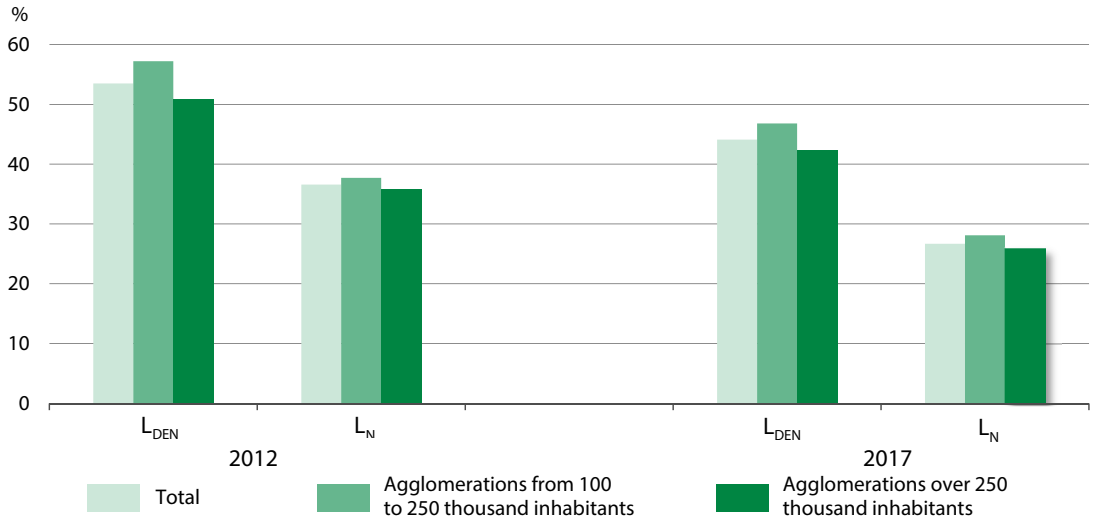
Noise is one of the main environmental factors affecting the quality of life and comfort of living. The problem of excessive noise in environment, especially the urban one, is increasing and leading to human fatigue, stress, cardiovascular diseases, the weakening of both the immune system and the autonomic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

Road traffic noise

Road traffic noise is a nuisance for residents, especially in urban 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 2017, 44.1% of population of cities[1] over 100 thousand inhabitants was exposed to exceeding noise over 55 dB in the day-evening-night time (L_{DEN} indicator) (chart 21). In the night-time (L_N indicator) the situation was a bit better, although still unsatisfactory as 26.7% of city population was exposed to the noise exceeding 50 dB. In comparison to 2012, the situation improved, as both in the day-evening-night time and in the night time, the percentage of people exposed to excessive noise decreased by 9.4 pp and 9.9 pp, respectively.

Chart 21. Percentage of population exposed to road traffic noise in agglomerations over 100 thousand inhabitants

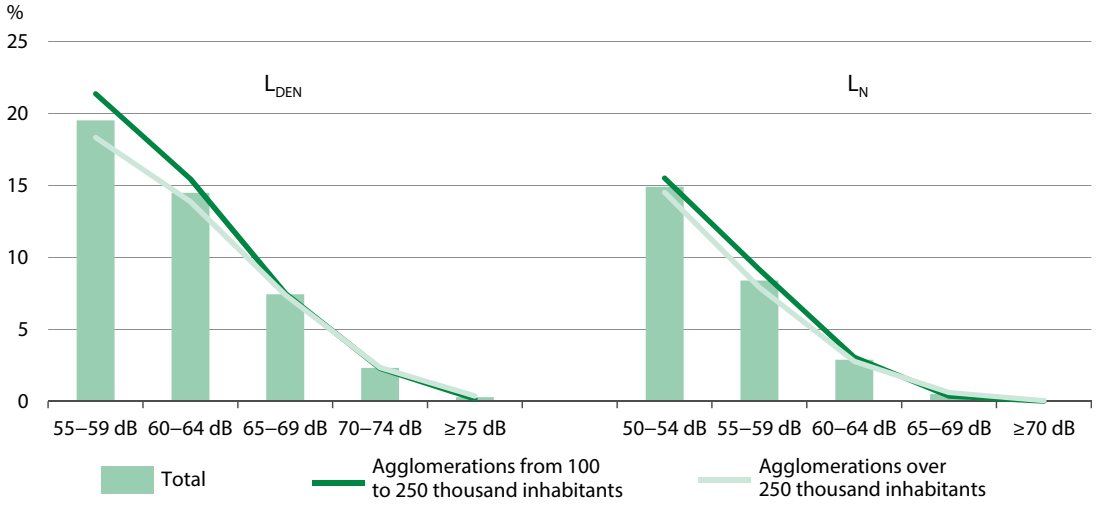


Source: data of the Chief Inspectorate of Environmental Protection obtained under the State Environmental Monitoring based on acoustic maps.

Monitoring of road traffic noise in agglomerations carried out in 2017 proves that the highest percentage of population was exposed to excessive noise up to 5 dB in day-evening-night time – 19.5% and in night time – 14.9% (chart 22). In relation to 2012, this percentage decreased by 0.9 pp in the day-evening-night time and by 2.6 pp in night time.

[1] The study based on acoustic maps in 2012 and 2017 covered 35 agglomerations over 100 thousand inhabitants.

Chart 22. Percentage of population exposed to road traffic noise in agglomerations in particular classes of noise levels in 2017



Source: data of the Chief Inspectorate of Environmental Protection obtained under the State Environmental Monitoring based on acoustic maps.

Railway noise

Railway noise, one of the most common type of traffic noise after road traffic noise, is the most troublesome for city inhabitants.

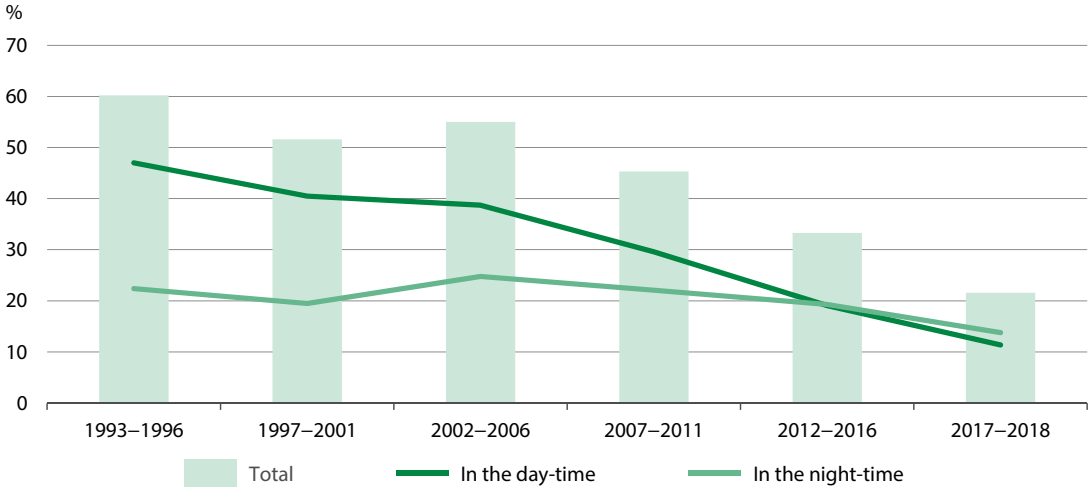
Based on data from acoustic maps obtained in 2017, 227.6 thousand population in the area of 35 agglomerations over 100 thousand inhabitants was exposed to excessive noise above 55 dB in day-night-night time and in night time – 141.3 thousand. They constituted 2.3% and 1.4% of total population of the analyzed cities, respectively. In relation to 2012 (this percentage was at the level of 4.0% and 3.1%) the situation improved, which may be the result of railway lines and rolling stock modernization.

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, in the years 1993–2018, positive trends were noted in terms of the percentage of plants exceeding industrial noise limits (chart 23). 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% within the years 1993–1996 to 21.6% in the period from 2017 to 2018), in the day-time in particular (similarly – from 47.0% to 11.4%). In the night-time, the percentage of units exceeding the permissible sound levels decreased from 22.4% to 13.8%, of which significantly in the case of sound levels causing local serious disturbances of night silence, i.e. above 15 dB (from 5.7% in 1993–1996 to 1.2% in the years 2017–2018).

Chart 23. Percentage of plants exceeding industrial noise limits



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

Data from the European Union Statistics on Income and Living Conditions (EU-SILC) may 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, industrial plants or 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 13.8% in 2018), 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 – 12.8% in relation to the latter – 15.0% in 2018.

According to Eurostat estimates, in 2018, in the European Union countries 18.1% of households affected excessive noise. The lowest, most favorable value of the indicator was recorded in Croatia (8.0%), Hungary (8.5%) and Estonia (8.6%). In contrast, the highest percentage of analyzed households occurred in Malta (28.2%), Germany (27.8%) and the Netherlands (27.1%). In relation to the EU average, the indicator for Poland was by 4.3 pp lower.

4.4. Access to drinking water

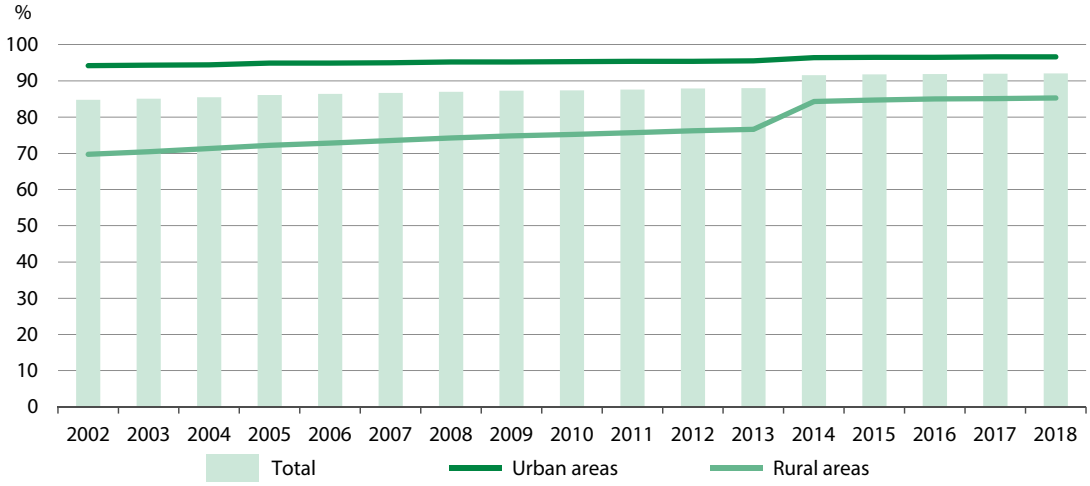
Population using water supply network concerns the estimated number of population inhabiting residential buildings and collective accommodation facilities connected to water supply network as well as population using water supply systems via street and yard outlets (devices installed to street water 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 2018, 92.1% of population used water supply network, which is an increase in relation to 2017 and 2002 by 0.1 pp and 7.3 pp respectively (chart 24).

Chart 24. Percentage of population using water supply network



In the period of 2002–2018 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 2018, the indicator in mind equalled 96.6% and 85.3% 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 2002–2018 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 99.7% in 2018.

In 2017, among the European Union countries, according to the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene data, the lowest percentage of the population using safely managed drinking water services was recorded in Romania (81.9%), Hungary (89.6%) and Croatia (90.0%). The best situation in this regard occurred in Greece, the Netherlands, Great Britain and Malta, where the discussed indicator was at the level of 100%. Based on WHO/UNICEF estimates, 99.2% of the population in Poland used safely managed drinking water services.

4.5. Municipal sewage treatment

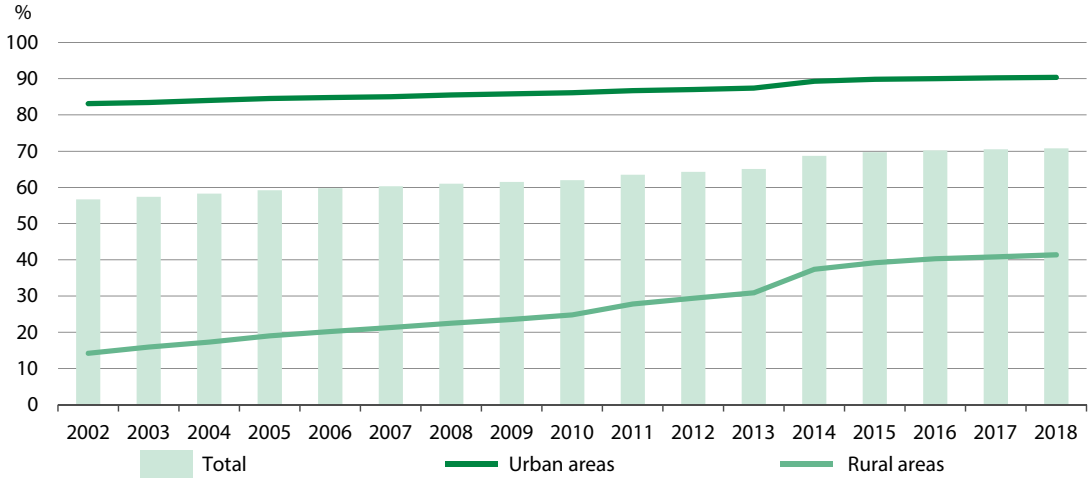
Population using sewage network concerns the estimated number of population inhabiting residential buildings and collective accommodation facilities connected to sewage network as well as population using sewage system via sewage inlets.

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 2002–2018 the percentage of population using sewage network (chart 25) grew constantly. In 2018, 70.8% of population used this form of waste disposal and in comparison to 2002, the share increased by 14.1 pp. Greater changes were noted in rural rather than urban areas. In 2018, this indicator in the cities amounted to 90.3% and was by 7.2 pp higher than in 2002. In rural areas the percentage of population using sewage network almost threefold over the years, from 14.2% in 2002 to 41.3% in 2018.

Chart 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. collect wastewater in leak-proof septic tanks) or wastewater treatment facilities (so as to treat waste on their own). Using the second of these solutions 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 the number of wastewater treatment facilities increased from 51.9 thousand pieces in 2008 to 256.4 thousand pieces in 2018. This number calculated per 1000 population not using sewage network grew 6.5 times (from 3.49 in 2008 to 22.83 in 2018).

Based on the data from the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene, in 2017 among the EU countries the lowest percentage of the population using safely managed sanitation services occurred in Croatia (58.5%) and Bulgaria (64.4%), while the highest in Finland (99.2%) and Great Britain (97.8%). According to WHO / UNICEF estimates, Poland was 15th among 28 EU countries with a ratio of 93.3%.

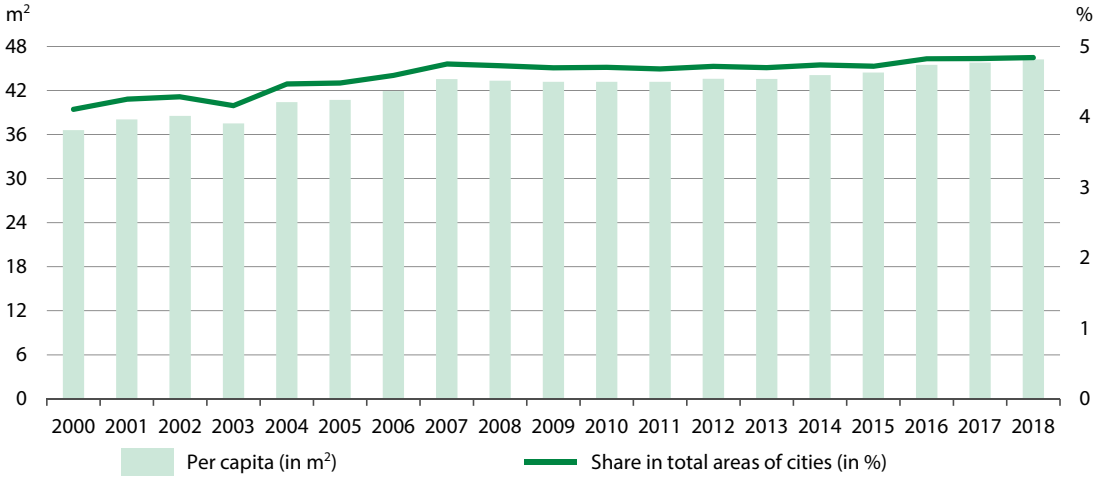
4.6. Green areas

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 contribute to the creation of job places.

Chart 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 2018, green areas in cities amounted to 106.6 thousand hectares. It means there were 46.2 m^2 of green areas per capita (chart 26), i.e. by 9.6 m^2 more than in 2000. The increase resulted mainly from enhancing street greenery areas and from the inclusion of cemeteries into green areas since 2005. In 2018, the share of urban green area in the total city area equalled 4.8% and was by 0.7 pp higher than in 2000.

Chapter 5

Economic opportunities and policy responses

5.1. Organic farms

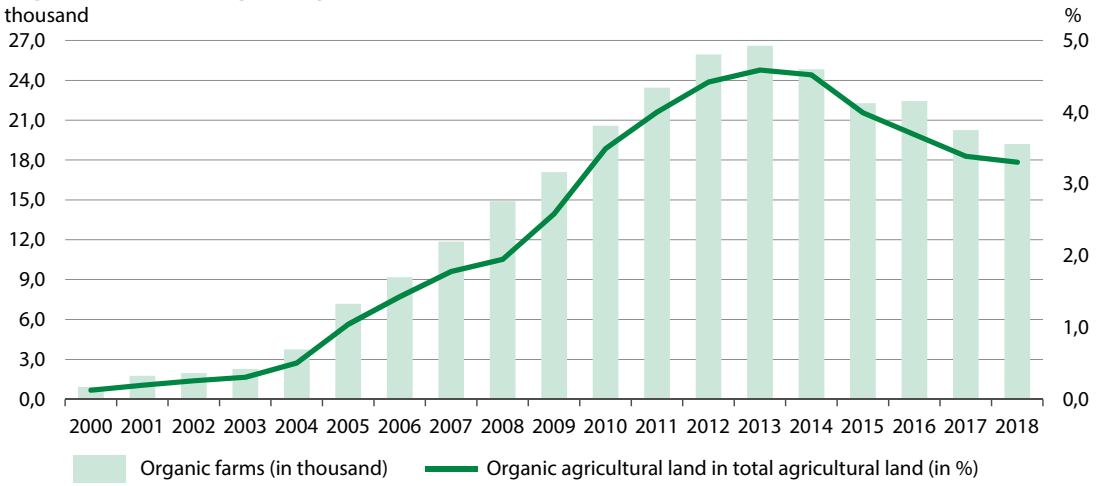
Organic farm is an agricultural holding, which has a certificate granted to it by a certification body or which is under conversion to organic methods of agricultural production under control of a certification body.

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.

In 2018, there were 19.2 thousand ecological farms in Poland, which covered 484.7 thousand hectares of agricultural land, i.e. 3.3% of total agricultural land. It means that their number and area decreased in relation to the previous year by 5.2% and 2.1%, respectively (chart 27). The average size of organic farm was 25.2 hectares.

From the year 2000 the biggest number of organic farms (26.6 thousand) operated in 2013 on 670.0 thousand hectares of agricultural land. Since 2014, a systematic decline has been noted, both in number of farms (except for 2016) and organic agricultural land.

Chart 27. Organic farms and organic agricultural land



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

According to Eurostat database, in 2017, in the European Union countries there were over 300 thousand organic farms – the most located in Italy (66.8 thousand) and the least – in Malta (0.0 thousand). Agricultural land on which organic production was conducted constituted 7.0% of total agricultural land in the European Union. Among EU countries, the highest percentage of organic agricultural land was recorded in Austria (23.4%) and the lowest in Malta (0.4%).

The 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.

According to the data of the Agency for Restructuring and Modernisation of Agriculture, in 2018, the amount of payment for farms carrying out organic farming was 287.8 million PLN (as of 30th September 2019). It decreased in relation to the previous year by 0.8%, but increased over 8 times in comparison with 2004, when RDP 2004–2006 came into operation. Its share in the total amount of subsidies for farms realising an agri-environmental programme equalled 38.8% and was by 1.5 pp higher in relation to 2017. In the years 2004–2018, the largest amounts for organic farming were implemented in 2012 – 418.6 million PLN. From 2013, payments paid for the farms have been systematically decreasing.

5.2. Outlays on environmental protection

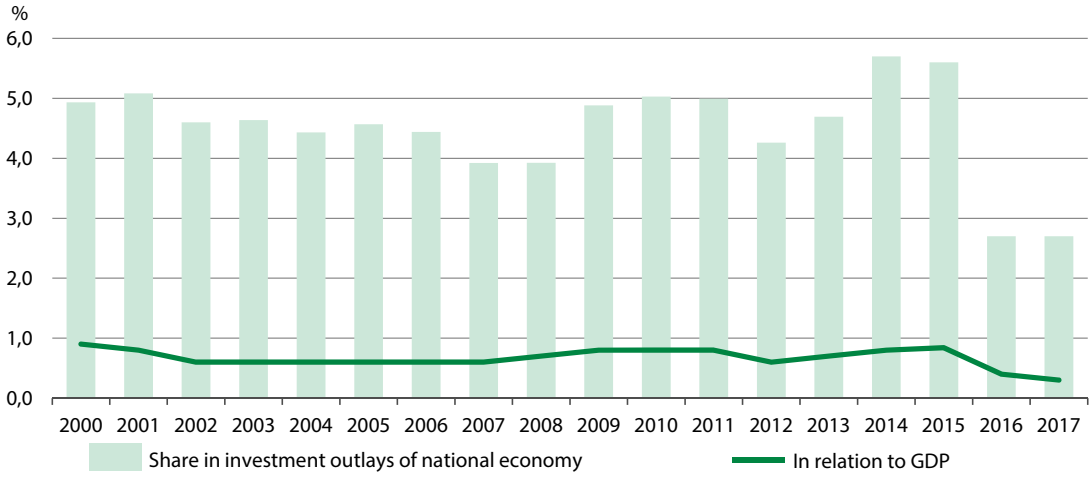
Outlays on environmental protection is the sum of outlays on fixed assets for environmental protection and current costs borne by public and economic sectors as well as by households.

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 2017, outlays on fixed assets for environmental protection amounted to 6.8 billion PLN, which is an increase in relation to 2016 and 2000 by 4.7% and 3.9%, respectively. In 2017, their share in relation to GDP equalled 0.3% (chart 28).

In 2017, the share of outlays on fixed assets for environmental protection in investment outlays of national economy reached 2.7% and it did not change compared to the previous year, however it decreased by 2.2 pp in relation to 2000.

Chart 28. Outlays on fixed assets for environmental protection



In 2017, economic entity own funds were prevailing in the financing structure and amounted to 63.9% of the total outlays on fixed assets for environmental protection, the next financing sources were, among others, funds from abroad – 12.1%, ecological funds – 9.7%, domestic credits and loans – 7.0%. The majority of financial means were allocated to wastewater management and protection of water (39.8%), protection of air and climate (33.9%) as well as waste management (12.7%).

Households also incur expenditures on environmental protection. They are not subsidised and as a whole constitute a burden on a household budget. In 2017, the expenditures amounted to 19.2 billion PLN. Calculated per capita they equalled 500.1 PLN and were higher than in 2016 and 2000 (by 2.6% and 23.4%, respectively).

According to Eurostat data, in 2016, national expenditures on environmental protection in the European Union countries amounted to 278.3 billion euro. In relation to GDP they accounted for 1.9%. Among the EU countries, the highest share of this type of expenditure in GDP occurred in Belgium and Austria (3.2% each), and the lowest one – in Ireland (0.5%) and Luxembourg (0.9%). In Poland, this share equalled 2.0%.

5.3. Environmental taxes

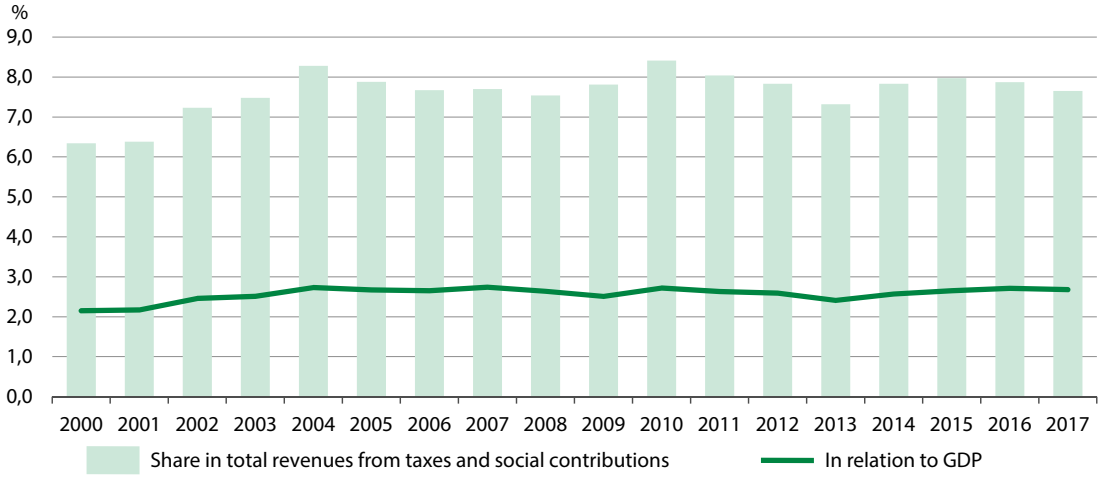
Environmental tax is a tax whose tax base is a physical unit (or a proxy of it) of something that has a proven, specific negative impact on the environment, and which is identified in ESA 2010 as a tax.

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 2017, revenues from environmental taxes amounted to 53.4 billion PLN and constituted 7.7% of total revenue from taxes and social contributions (chart 29). They were lower in relation to the previous year (by 0.2 pp), but higher than in the year 2000 (by 1.3 pp). In 2017, the ratio of environmental taxes to GDP was 2.7% and did not change compared to the previous year, but increased in relation to 2000 (by 0.5 pp).

Among environmental taxes, the major fiscal impact exerted energy taxes, which contributed 86.9% of revenue from environmental taxes, and transport taxes – 8.5% of the revenue.

Chart 29. Environmental taxes



Source: Eurostat database.

According to Eurostat data, in 2017, in the European Union countries total amount of environmental taxes amounted to 368.8 billion euro. Their share in total revenues from taxes and social contributions amounted to 6.0%, and in relation to GDP – 2.4%. In the structure of taxes by type, energy taxes dominated, representing 76.9% of total environmental taxes, followed by transport taxes (19.8%).

The leading countries of the EU with the highest share of environmental taxes in total revenues from taxes and social contribution were Latvia (11.1%) and Slovenia (10.1%). The lowest share was noted in Luxembourg (4.3%) and Germany (4.5%). In relation to GDP the highest share of these taxes was recorded in Greece (4.0%) as well as in Slovenia and Denmark (3.7% each), while the lowest in Luxembourg (1.7%). Poland was 13th among EU countries in this respect. In all Member States, energy taxes prevailed among environmental taxes – the highest their percentage was in the Czech Republic (93.1%) and Romania (92.5%), and the lowest in Malta (50.8%) and Denmark (53.8%).

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&D) 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 2018, gross domestic expenditures on R&D activity amounted to 25.6 billion PLN and increased by 24.6% in relation to 2017 and more than five times compared to 2000.

Entities in R&D are grouped in four sectors of performance, i.e. business enterprise, government, higher education and private non-profit. In 2018, business enterprise sector allocated the majority of funds on R&D – 66.1% of total expenditure in this category, whereas the share of higher education sector was 31.7%.

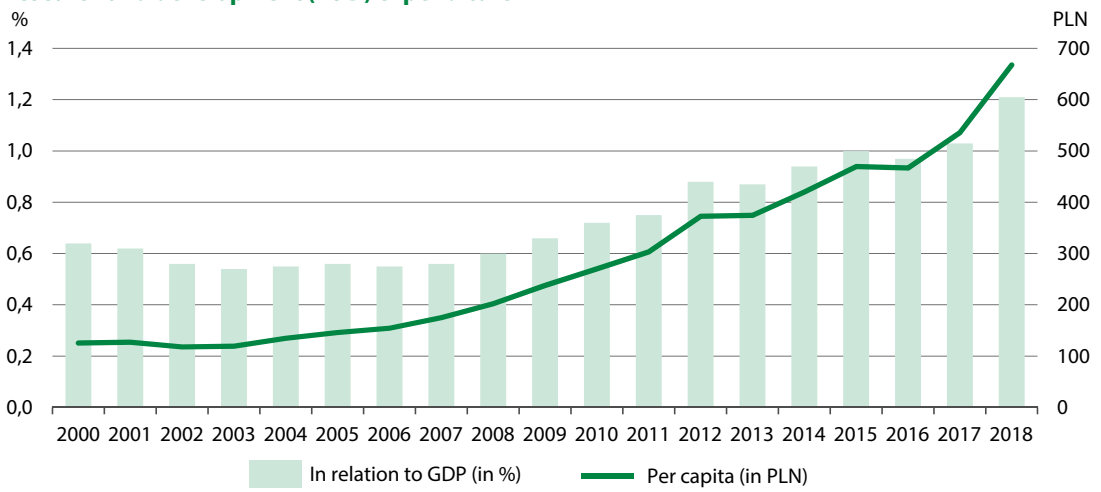
In the structure of gross domestic expenditures on R&D activity by funding sectors, the funds of business enterprise sector (53.3%) and government sector (35.4%) predominated.

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 (chart 30). In the years 2000––2018, the minimum value of the indicator was recorded in 2003 (0.54%), while the maximum in 2018 (1.21%).

According to preliminary Eurostat data, in 2018, research and development intensity in total EU countries amounted to 2.11%, and among individual Member States ranged from 0.51% in Romania to 3.31% in Sweden. Poland, together with Luxembourg took 16 position among the EU countries.

While analysing R&B expenditure per capita, since 2003 a growing tendency has been noted in Poland (except for 2016). In 2018, it amounted to 667.7 PLN, i.e. by 24.7% more than in the previous year and more than five times in comparison to 2000.

Chart 30. Research and development (R&D) expenditure[a]



a Intramural, excluding depreciation of fixed assets.

According to Eurostat data, in 2018, gross domestic expenditure in research and development activity (GERD) per capita in the European Union was 655.1 euro. The highest expenditure of this type per capita was recorded in Denmark (1580.9 euro) and Sweden (1540.7 euro), while the lowest in Latvia (96.3 euro) and Croatia (122.2 euro). Poland, with an index value of 158.5 euro, took 20th place among the 28 member countries.

Activity to protect components of environment so as to restore or maintain environmental sustainability require financial means. In 2018, within expenditures on fixed assets for environmental protection it was spent as much as 7.9 million PLN on research and development activity in Poland. They were by 56.1% lower than in the previous year and constituted 0,1% of total expenditures 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 indus-trially 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).

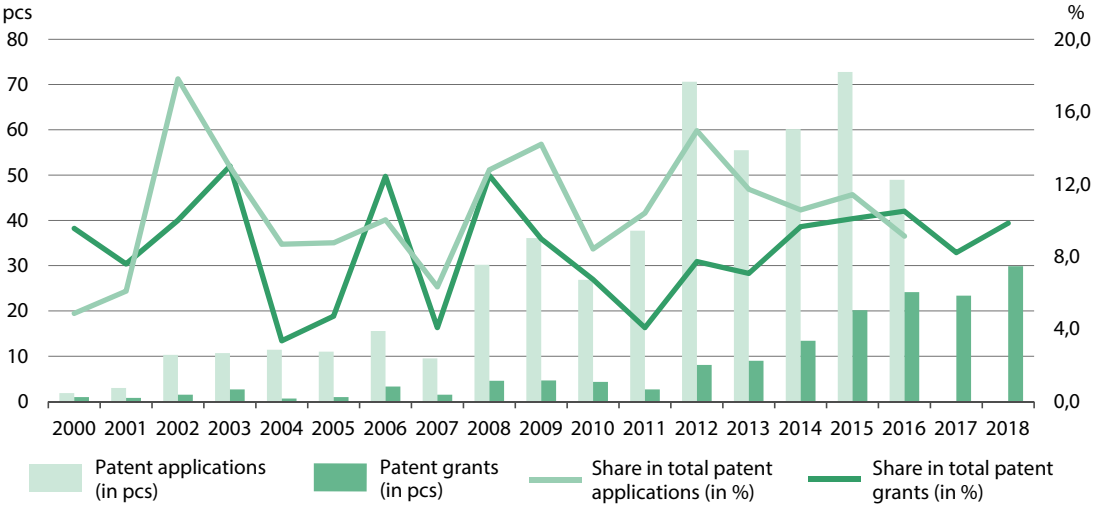
Patent applications and grants are classified according to the International Patent Classification. They are presented also by fields of technology based on WIPO IPC-Technology Concordance Table, on the basis of which environment-related technologies comprise such fields that are within the scope of, 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 contribute to the use of natural resources in an efficient way, reduction of 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.

In 2016, according to OECD database, Polish residents filed 49 patent applications within the field of environment-related technologies to the European Patent Office (EPO) (chart 31). Since 2000, the best result achieved by Poland was in 2015 and it amounted to 73 patent files. The percentage of patent applications in environment-related technologies in comparison to the total patent applications filed by Polish residents in 2016 comprised 9.1% and was lower by 2.3 pp than in the previous year, but by 4.2 pp higher than in the year 2000.

In 2016, residents of EU countries filed 5.7 thousand patent applications within the field of environment-related technologies to the European Patent Office, which accounted for 9.8% of the total number of inventions. The most active countries in this respect were Germany, with 2114 inventions of this type, i.e. 37.1% of total patent applications reported within the field of environment-related technologies in the European Union, France – 908 (16.0%) and Great Britain – 628 (11.0%). Poland, with a share of 0.9% of total number of patent applications within the field of environment-related technologies in the EU, came 12th among the EU countries.

Chart 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). Data on inventions are presented according to the application date of the invention to the EPO, and in the case of patents – according to the date of grant of the patent at the EPO.

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

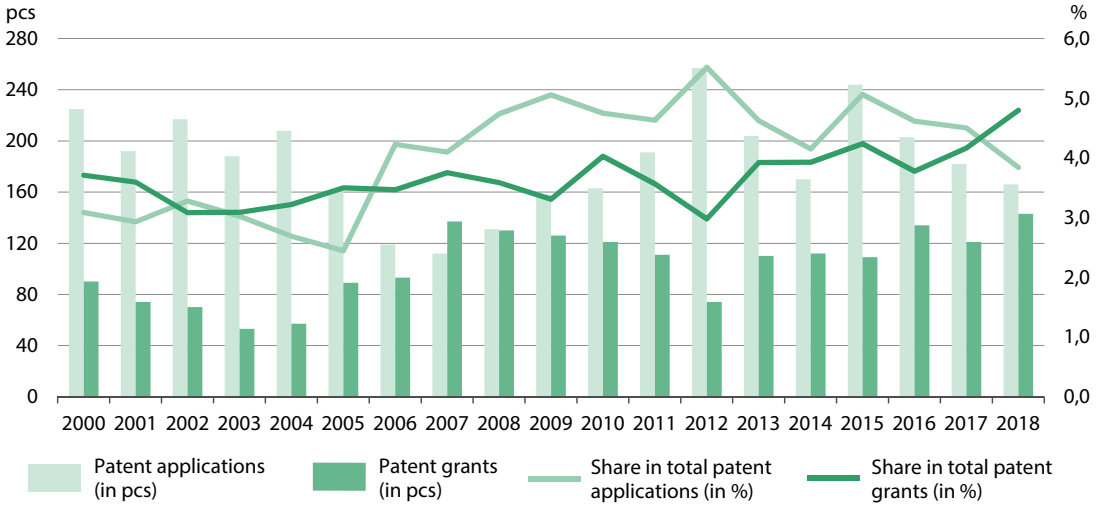
In 2018, the European Patent Office granted 30 patents in environment-related technologies to Polish residents, i.e. it was the highest score from 2000. These patents constituted 9.8% of total number of patents granted to Polish residents. In relation to the previous year and 2000, their share increased by 1.7 pp and 0.2 pp, respectively.

In 2018, in the European Union EPO granted 5.9 thousand patents in environment-related technologies, which accounted for 11.0% of total number of patents. Most of them were granted to Germany – 2314, i.e. 39.1% of all patents granted in environment-related technologies in the European Union as well as to France – 1056 (17.8%). Poland, with a share of 0.5% of total number of patents in environment-related technologies in the EU, achieved 12th position among the EU Member States.

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 (chart 32).

In 2018, the total number of patent applications in environmental technologies submitted to the Patent Office of the Republic of Poland equalled 166, which constituted 3.8% of total patent applications. It is a decrease in relation to the previous year and to the year 2000 by 8.8% and 26.2%, respectively. From 2000 to 2018 the highest number of this type of inventions was noted in 2012 – 257 (5.5% of total patent applications). The greatest number was submitted by domestic entities – 247.

Chart 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 2018, granted 143 environmental technology patents, of which 140 ones to domestic entities. Their share in total patent number constituted 4.8%, and it was the highest score since 2000.

5.6. Eco-innovation

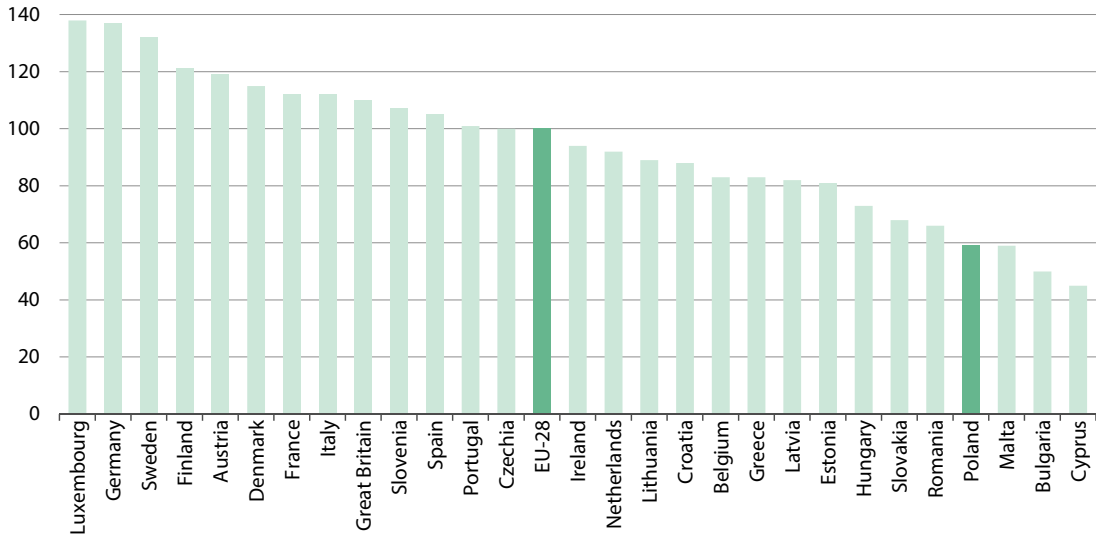
Eco-innovation is a new or significantly improved product (goods or service), process, organizational or marketing method, which brings benefits to the environment.

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 eco-innovation index, the so-called the Eco-Innovation Scoreboard, was established, on the basis of 16 indicators grouped according to 5 thematic fields. It comprehensively compares eco-innovation results achieved by individual EU-28 countries with the EU average (EU-28=100).

According to the ranking presented in the chart, Poland is one of the countries with the lowest eco-innovation index among the EU Member States (chart 33). In 2018, it (along with Malta) came in 25th position (with a score of 59) in the eco-innovation ranking. Together with Cyprus, Bulgaria, Malta, Romania, Slovakia, Hungary, Estonia, Latvia, Greece and Belgium, it was classified to the group of "countries catching up in eco-innovation", achieving results below 85% of the EU average.

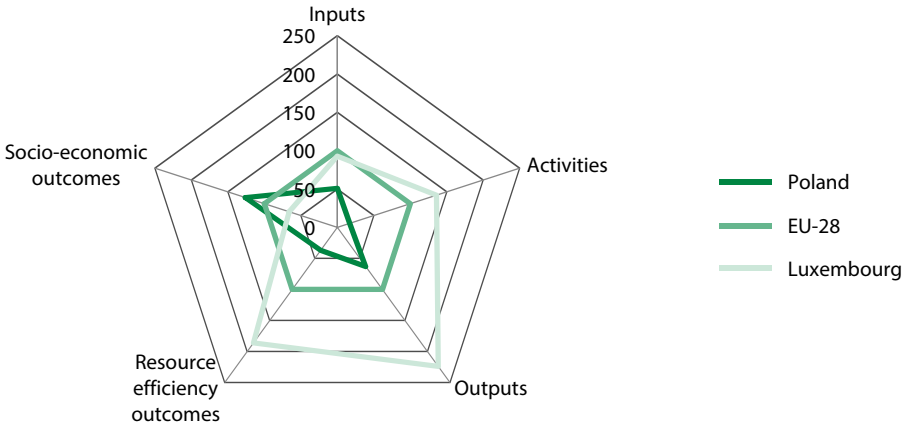
Chart 33. Eco-innovation index for the EU-28 Member States in 2018



Source: data of the European Commission.

While analysing the results in the individual indicator groups that are generated for Poland (chart 34), it can be stated that, in 2018, the relatively strongest point of Polish eco-innovation on the background of EU countries was socio-economic outcomes, being the result of introducing eco-innovations (7th position with a score of 126). In the case of four remaining areas, i.e. within achieved eco-innovation outputs – Poland was ranked 20th (with a score of 63), within eco-innovation inputs – 21st (with a score of 51), within resource efficiency outcomes – 26th (with a score of 37), whereas within eco-innovation activities – 26th (with a score of 17).

Chart 34. Poland on the background of the EU-28 Member States and country with the highest eco-innovation index in 5 thematic areas in 2018



Source: data of the European Commission.

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, insufficient government inputs on R&D, including the environmental one.

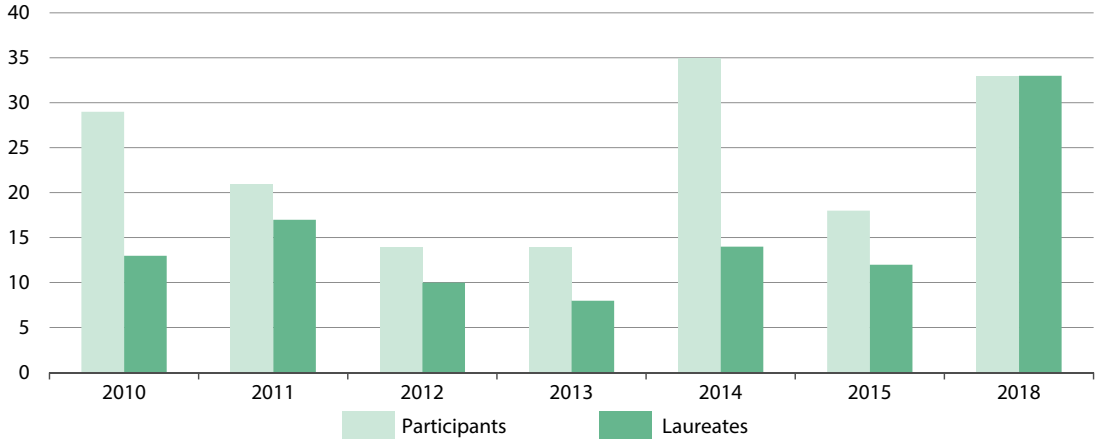
5.7. Green technology

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. 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.

Until 2015, entities could apply for funds to cover the costs of these activities within the available instruments supporting export, offered by the former Ministry of Economy and the Polish Agency for the Enterprise Development. In 2018, the GreenEvo program was financed by the National Fund for Environmental Protection and Water Management.

Chart 35. Participants and laureates of Green Technology Accelerator



Source: data of the Ministry of Environment.

In 2018, the Ministry of Environment, after a 2-year break, resumed the implementation of the GreenEvo program– Green Technology Accelerator. In accordance with the regulations, the subject of the 7th edition of the program was to select active winners of the previous six editions of the GreenEvo competition, in order to use the potential of proven innovative Polish environmental technologies and provide them with substantive and educational support. 33 participants took part in the competition and 33 laureates were selected (chart 35) from eight areas of green technologies covered by the program, such as: renewable energy sources, environmentally friendly solutions for the mining industry, solutions supporting energy saving, systems supporting monitoring and gathering information on the natural environment, technologies conducive to climate protection, technologies supporting waste management, water and sewage technologies as well as low-emission transport 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.

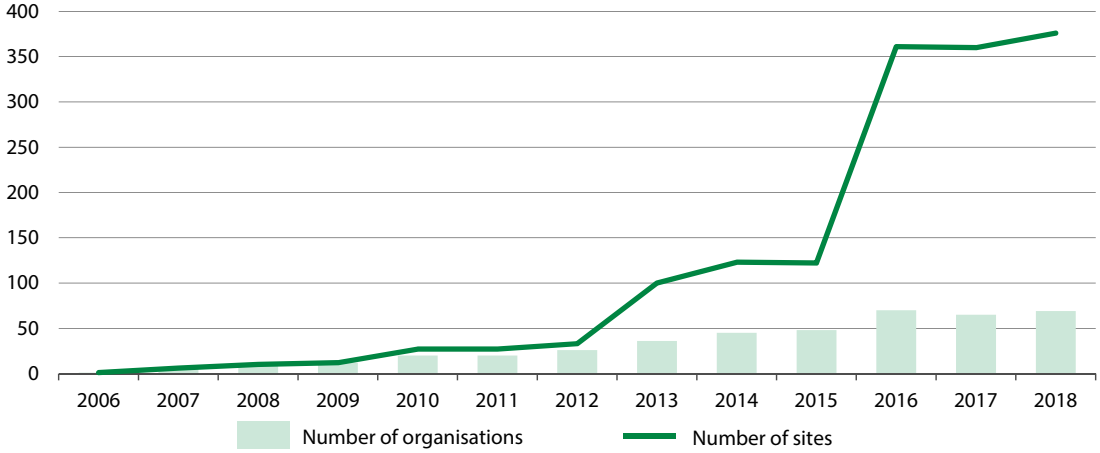
EMAS is an important tool for environmental protection aiming at the constant improvement of environmental activity of an organisation in compliance with the European Union and national laws on environmental protection. It assumes active participation of employers in the process of improving relations 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", confirmed with a trustworthy certificate, in Poland issued by the General Director for Environmental Protection.

On the basis of Eurostat data, it was in 2006 that the first national organisation was recorded in the EMAS in Poland (chart 36). In the years 2007–2016 their number was constantly growing. In 2017, in relation to 2016, a decrease by 7.1% was noted. In 2018, according to the data of the General Directorate for Environmental Protection 69 organisations were registered in the EMAS register, which means an increase by 6.2% in comparison to 2017.

Chart 36. Organisations and their sites with Eco-Management and Audit Scheme (EMAS) registration[a]

As of 31st December



a In 2017, data on number of sites as of April based on data from the EMAS register.

Source: data for the years 2006–2015 – Eurostat database; from 2016 – data of the General Directorate for Environmental Protection.

As of September 2018, as the EMAS register data show, in the European Union countries 3.8 thousand organisations were operating in the Eco-Management and Audit System and 13.2 thousand sites of these organizations. Most organisations of this type were registered in Germany – 1.2 thousand (2.2 thousand sites of these organizations) and Italy – 1.0 thousand (5.8 thousand sites), while in Croatia and Latvia such units were not recorded at all. Organisations in the EMAS system in Poland constituted 1.8% of their total number in the EU Member States, and their sites – 2.8% of total number of the sites in the EU.

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.

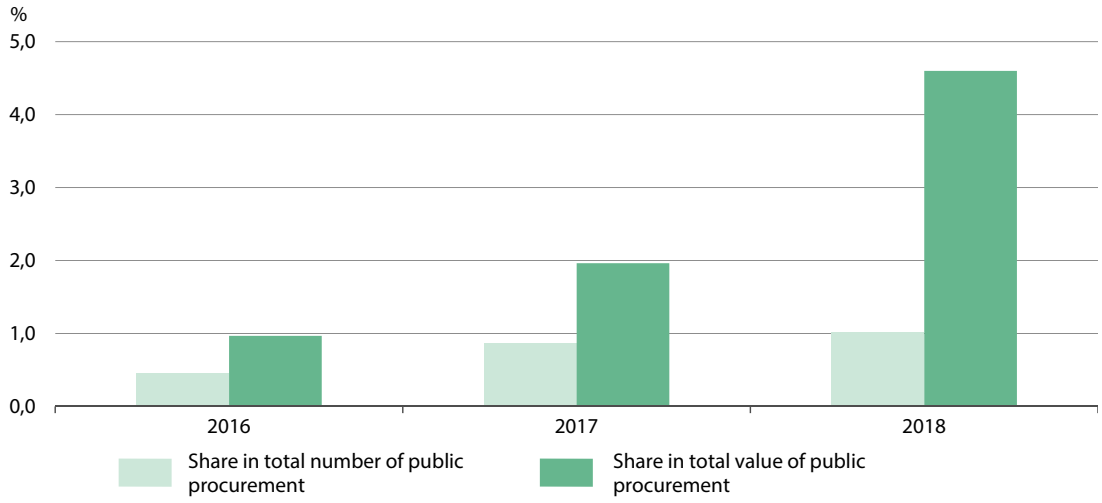
Green public procurement is an important instrument to encourage entrepreneurs to produce new, greener products and to deliver services that take into account environmental aspects. It should lead to the purchase of products or services that are environmentally friendly, namely such that exert a smaller negative effect on natural environment than other similar conventional products / services that fulfil the same functions. On the other hand, they can contribute to the financial savings of public entities contracting them, especially when taking into account the costs of products or services throughout the life cycle.

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.

Since 2016, data on green public procurement are obtained by the Public Procurement Office from information contained in annual reports on awarded public procurement[1]. Until 2015, they were set 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. Therefore, the data from 2016 are incomparable to the data for previous years and the scope of data presentation was limited to 2016–2018.

According to the data provided by contracting authorities to the Public Procurement Office, in 2018, 1.4 thousand green public procurement, i.e. taking into account environmental aspects, were awarded. Their share in the total number of public procurement was 1.0% (chart 37). The total value of green public procurement (excluding value added tax) amounted to 9.3 billion PLN , i.e. 4.6% of total value of public procurement awarded.

Chart 37. Green public procurement



Source: data of the Public Procurement Office.

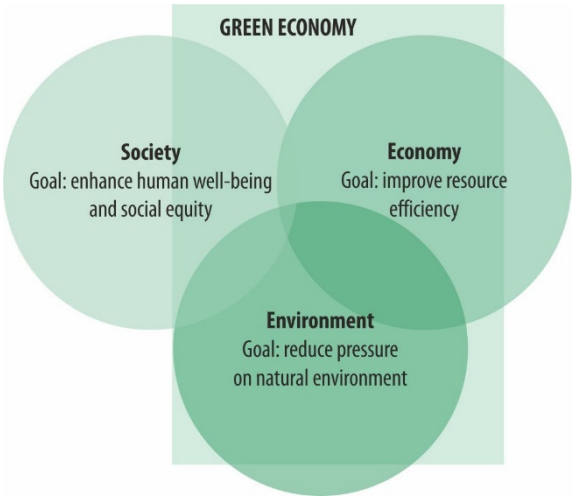
[1] National Action Plan on sustainable public procurement for 2017–2020, Public Procurement Office, Warsaw 2017.

Methodological notes

Polish public statistics on the basis of achievements of Organisation for Economic Co-operation and Development (OECD) and other environmental organisations, such as United Nations Environment Programme (UNEP) and European Environment Agency (EEA) has tried to adjust the term of green economy to Polish circumstances. The term **green economy** means such economy that supports economic growth and development while maintaining access to natural capital and ecosystem services, which, in turn, affect human well-being. 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



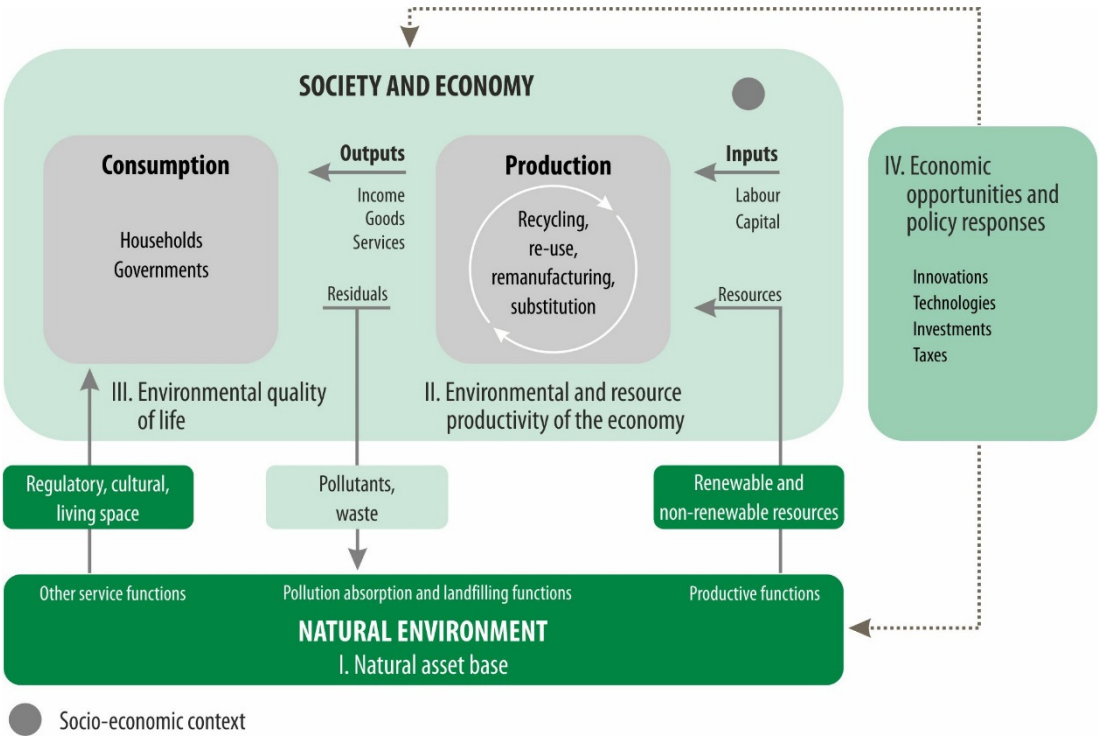
Source: own elaboration on the basis of Environmental Indicator Report 2012. Ecosystem Resilience and Resource Efficiency in a Green Economy in Europe, EEA, 2012, page 20.

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 (figure 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 ones. A set of indices proposed to monitor natural capital is shown in table 1.

Table 1. Indicators of natural asset base

Topic	Indicator group / name
Biodiversity and ecosystems	**Biodiversity** Share of legally protected area in total country area Farmland Bird Index Forest Bird Index Share of endangered species in total number of species **Land use** Agricultural land designated for non-agricultural purposes and forest land designated for non-forest purposes Degree of reclamation and management of devastated and degraded land
Renewable stocks	**Forest resources** Forest cover Forest growing stock Timber removals Share of damaged forest stands area in total forest area **Freshwater resources** Indicator of surface waters availability per capita Exploitable underground water resources Water exploitation index (WEI)
Non-renewable stocks	**Mineral resources** Share of extraction in hard coal resources Share of extraction in lignite resources 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 – environmental and resource productivity of the economy. 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, 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.

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 2.

Table 2. Indicators of environmental and resource productivity of the economy

Topic	Indicator group / name
Resources	**Water productivity** Consumption of water for needs of the national economy and population per capita Water productivity Water intensity of industry Water intensity of households **Domestic material consumption** Resource productivity (GDP/DMC) Domestic material consumption per capita **Waste management** Share of waste recovered in waste generated Municipal waste generated per capita Municipal waste collected separately in relation to total waste Recycling rate of municipal waste **Nitrogen and phosphorus balances** Gross nitrogen balance Gross phosphorus balance
Energy	**Energy productivity** Primary energy productivity Final energy intensity of the economy **Renewable energy** Share of renewable energy in gross final energy consumption
Greenhouse gas	**Greenhouse gas emissions** Greenhouse gas emissions Greenhouse gas emissions by emission source 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 the 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 in the scope of water and sewage management that simultaneously 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 3.

Table 3. Indicators of environmental quality of life

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

Table 4. Indicators of economic opportunities and policy responses

Topic	Indicator group / name
Agriculture	**Organic farms** Organic agricultural area in % of total agricultural area Payments for organic farming in % of total payments for agriculture under agri-environmental programme
Environmental protection	**Outlays on environmental protection** Outlays on fixed assets for environmental protection in relation to GDP Share of outlays on fixed assets for environmental protection in investment outlays of national economy Household expenditures on environmental protection per capita
Taxes	**Environmental taxes** Share of environmental tax revenues in GDP Share of environmental tax revenues in total revenues from taxes and social contributions
Technology and innovation	**Research and development (R&D) activity** Research and development (R&D) intensity Research and development (R&D) expenditure per capita Outlays on fixed assets for environmental protection in research and development activity in % of total outlays on fixed assets for environmental protection **Inventions and patents** Patent applications in environment-related technologies in % of total patent applications filed in the European Patent Office Patents in environment-related technologies granted in % of total patents granted by the European Patent Office Patent applications in environmental technologies in % of total patent applications filed in the Patent Office of the Republic of Poland Patents in environmental technologies granted in % of total patents granted by the Patent Office of the Republic of Poland **Eco-innovation** Eco-innovation index **Green technology** Participants and laureates of GreenEvo Technology Accelerator
Management	**Eco-Management and Audit Scheme (EMAS)** Organisations with Eco-Management and Audit Scheme (EMAS) registration Sites of organisations with Eco-Management and Audit Scheme (EMAS) registration
Public procurement	**Green public procurement** Share of green public procurement in total public procurement Share of green public procurement value in total public procurement value

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.

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