Statistical analyses

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Green economy indicators in Poland 2024

Warsaw, Białystok 2024

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Statistics Poland
Statistical Office in Białystok

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ISSN 2956-8447

Publication available on website

stat.gov.pl/en/

bialystok.stat.gov.pl/en/

Preface

We would like to present you the sixth edition of the publication *Green economy indicators in Poland 2024*. It is the fourth edition of the publication after the research *Green economy in Poland* has been included in the Statistical Surveys Program of Official Statistics. At the same time, we would like to inform that in 2023, the *Methodological report Green economy in Poland* was published, after obtaining the approval of the Statistics Poland Methodological Commission. It is available on Statistics Poland website.

Green economy is understood as such that supports economic growth and development while maintaining access to natural capital and ecosystem services, which, in turn, affect human well-being. It is inextricably connected with the concept of sustainable development.

Information regarding green economy is presented in four thematic groups: natural asset base, environmental and resource productivity of the economy, environmental quality of life as well as economic opportunities and policy responses. In order to provide a more complete illustration of the discussed issues, the publication presents context indicators constituting the background and source of basic information on the socio-economic situation of the country.

Current data from the scope of green economy may be used while 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. The set of indicators presented in this report will be updated as new phenomena, instruments emerge or changes in data availability occur.

The suggested set of indicators to monitor the state of green economy includes, apart from public statistics information, extensive data from various national authorities and to compare data between European Union countries – from international organisations. To facilitate the use of data presented in the publication, a set of data has been included in an Excel file.

Presenting *Green economy indicators in Poland 2024*, we would like to sincerely thank all institutions for the information 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 field of green economy.

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Warsaw, Białystok, December 2024

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Symbols

Symbol	Description
Hyphen (–)	magnitude zero
Zero (0,0)	magnitude not zero, but less than 0,05 of a unit
Dot (.)	data not available, classified data (statistical confidentiality) or providing data impossible or purposeless
"Of which"	indicates that not all elements of the sum are given
Comma (,)	used in figures represents the decimal point

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
DMC	domestic material consumption
PPS	Purchasing Power Standard
CAP SP	Common Agricultural Policy Strategic Plan
EEA	European Environment Agency
EMAS	Eco-Management and Audit Scheme
EMEP	European Monitoring and Evaluation Programme
EPO	European Patent Office
ESA	European System of Accounts
EU ETS	European Union Emissions Trading System
IPC	International Patent Classification
IPCC	Intergovernmental Panel on Climate Change
KOBiZE	National Centre for Emissions Management
NECP PL	Poland's National Energy and Climate Plan for the years 2021–2030
NFR	Nomenclature for Reporting
PROW	Rural Development Programme
UNEP	United Nations Environment Programme
WHO	World Health Organization
WISL	National Forest Inventory

Executive summary

Poland, taking up various activities aimed at protecting the environment, is striving to make the economy greener. Progress of these activities may be monitored through indicators grouped in four thematic areas: natural asset base, environmental and resource productivity of the economy, environmental quality of life as well as economic opportunities and policy responses.

Natural asset base indicators describe the state of natural environment, i.e. existing natural resources and their changes. In 2023, surface of the terrestrial protected areas comprised 39.6% of the total area of the country, placing Poland among the top European countries in terms of the percentage of the terrestrial protected areas. In 2023, Forest Bird Index equalled 1.40, reaching its peak in the history of study since the base year 2000, for which the value of 1 has been adopted. However, in the case of Farmland Bird Index, its value of 0.77 was one of the lowest from 2000. In the years 2002–2023, human activity brought about changes in land use. Built-up and urbanised areas increased (by 19.9%), land under waters (by 19.6%), as well as forest land as well as wooded and bushy areas, including wooded and bushy areas on agricultural land (by 7.9%), in lieu of other areas and agricultural land diminishing by 19.4% and 4.6% respectively. In 2023, forests in Poland covered 9283.8 thousand hectares and forest cover was 29.6%. In 2023, annual hard coal exploitation fell by 71.9% compared to 1990, lignite by 37.2%, while natural gas extraction increased by 33.1%.

Indicators of environmental and resource productivity of the economy, presenting 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 values illustrating pressure on environment. This phenomenon should be viewed positively. In the years 2000–2023, water productivity index value increased. In 2023, its growth was observed in comparison with 2022 by 25.5% and in relation to 2000 – almost six times. Resource productivity index also grew successively (except for 2007, 2011, 2017). In 2023 it was higher than in 2022 and 2000 (by 12.7% and 244.9% respectively). Positive changes were noticed in the case of a primary energy productivity indicator. Since 2000 (excluding 2016), it gradually increased. In 2023 in relation to 2022 and 2000 it rose by 18.5% and 308.1% respectively. In 2022, the share of energy from renewable sources in gross final energy consumption was 16.9%, of which in transport – 5.8%. In 2022, greenhouse gas emissions (excluding emissions from international aviation and maritime transport and land use, land use change and forestry) amounted to 380.5 million tonnes of CO_2 equivalent, i.e. 20.0% lower than in 1990.

Environmental quality of life indicators are used to assess population access to basic services in the scope of water and sewage management aimed at environmental protection as well as to assess population exposure to pollutants and health conditions resulting from this exposure. Their values show improvement in the following: reduction of excessive noise (especially industrial one), access to sewage network and water supply network, and supply of water meeting quality requirements to population. On the other hand, although PM_{10} and $PM_{2.5}$ emissions per capita reached in 2022 their lowest values since 2000, they were among the highest in EU countries (after Latvia). According to EEA estimates, in 2021, $PM_{2.5}$ exposure led to 47.3 thousand premature deaths in Poland, which was the highest value among European Union countries.

According to the latest results of a study based on strategic noise maps in Poland, which took place in 2022, the situation in terms of road traffic noise is still far from satisfactory, despite a decrease in the percentage of persons exposed to excessive noise of this type. In 2022, 31.3% of population of cities over 100 thousand inhabitants was exposed to exceeding noise in day-evening-night time and 19.2% in night time (in 2017, 43.5% and 26.3% respectively). In the case of railway noise, the situation has slightly worsened over the last five years. In 2022, population of the cities whose inhabitants were exposed to railway noise constituted 3.7% and 2.7% of total population, while in 2017 it was 2.3% and 1.4% respectively.

Economic opportunities and policy responses indicators relate to instruments affecting economy and society, which are used to create desired development trends aimed at making the economy greener. Organic farming is one of activities supporting the implementation of this idea. In 2023, both the number

and the area of organic farms increased compared to the previous year, by 5.5% and 14.7% respectively. The average size of this type of farm was 28.5 hectares and was the highest since 2000. In 2023, payments received by farmers for farms carrying out organic farming amounted to PLN 822.5 million. It was the highest amount of subsidies dedicated to organic farming in the years 2004–2023. Another instruments of environment protection policy are outlays on fixed assets for environmental protection and environmental taxes. In 2023, the share of outlays on fixed assets for environmental protection in investment outlays of national economy equalled 3.9%, which means an increase in relation to 2022 (by 0.4 pp), but a decrease in comparison with 2000 (by 1.0 pp). In turn, in 2022, revenues from environmental taxes in Poland constituted 7.9% of total revenues from taxes and contributions, and their share in relation to GDP amounted to 2.8%. Among environmentally related taxes, energy taxes were of greatest fiscal importance with 91.2% revenues and transport taxes with their 5.7% revenues. In the period of 2000–2022 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 making the economy greener require, among others, implementing new technologies. In 2023, the Patent Office of the Republic of Poland granted 106 environmental technology patents. Their share in total number of patents amounted to 4.7%. Environmental aspect is taken into consideration by institutions dealing with public procurement. In 2023, 4.1 thousand public procurement contained ecological criteria and their share in the total number of public procurement equalled 2.6%. Total green public procurement value (excluding Value Added Tax) was PLN 11.9 billion, i.e. 4.3% of the total value of awarded public procurement.

Chapter 1

Socio-economic context

The state of environment in Poland is affected by many social and economic factors. Thus, progress in making the economy greener should be made with regard to socio-economic conditions of the country.

Poland occupies the 6th place in Europe in terms of area, which is 313 931 km^2. Land use structure is dominated by agricultural land (as of 1 January 2023 its share was 59.4% of total area of the country).

As of the end of 2023, population equalled 37.6 million, of which the majority lived in urban areas (59.5% of total population). The density showed 120 persons living in 1 km^2.

In 2023, natural increase amounted to minus 136585 persons and it was one of the lowest negative value since 2000. Life expectancy in Poland, which had shortened as a result of the COVID-19 epidemic in the years 2020–2021, began to elongate again and in 2023 amounted to 78.2 years, reaching the highest value since 2000. It was longer for females (82.0 years) rather than for males (74.7 years).

Taking into consideration the division by economic groups of age, it can be noticed that in 2023 in relation to 2000, the share of persons at pre-working age and working age was reduced (by 6.2 pp and 2.4 pp respectively), while the percentage of post-working age population increased (by 8.5 pp). It is reflected in the age dependency ratio, which in 2023 was 71.

In 2023, in Poland there were 15.2 million persons employed, the majority in the group of industry section (21.1% of total employed). A registered unemployment rate in 2023 was one of the lowest ones since 2000 and equalled 5.1%.

In 2023, according to the LFS, 3.7% of young people at the age of 18–24 did not continue their education and the number of adults at the age of 25–64 in life-long learning to total population of the same age group was 8.7%. Public expenditure on education amounted to 4.55% GDP (since 2019 expenditure on education in relation to GDP has been presented together with expenditure on science due to the changes in the budget classification).

In 2022, in comparison to 2000, a gross real disposable income of household sector increased by 73.9%, however, at-risk-of-poverty rate after social transfers fell from 20.5% noted in 2005 to 14.0% in 2023.

In 2023, 93.3% of households and 98.7% of enterprises had access to the Internet.

Investment outlays in the national economy, which in 2023 amounted to PLN 461.9 billion in current prices, increased almost 3.5 times compared to 2000.

Gross domestic product (in current prices) per capita grew from PLN 19.6 thousand in 2000 to PLN 90.4 thousand in 2023 (as preliminary estimate shows). Gross value added, in other words, the value of goods produced by market and non-market national entities less intermediate consumption related with their production in 2023 equalled PLN 3072.3 billion (according to preliminary estimate). Industry, with the dominant share, comprised as much as 26.2% of gross value added.

Table 1. Major data on the country

Specification	2000	2005	2010	2015	2020	2022	2023
Population[a] (as of 31.12.) in millions	38.3	38.2	38.5	38.4	38.1	37.8	37.6
urban areas	23.7	23.4	23.4	23.2	22.8	22.5	22.4
rural areas	14.6	14.7	15.1	15.3	15.3	15.3	15.3
Population[a] per 1 km^2 of total area (as of 31.12.)	122	122	123	123	122	121	120
Natural increase in thousands	10.3	–3.9	34.8	–25.6	–122.0	–143.3	–136.6
Life expectancy in years	73.7	75.0	76.2	77.5	76.5	77.1	78.2
males	69.7	70.8	72.1	73.6	72.6	73.4	74.7
females	78.0	79.4	80.6	81.6	80.7	81.1	82.0
Population of a given age group in % of total population[a] (as of 31.12.):							
pre-working age	24.4	20.6	18.8	18.0	18.4	18.4	18.2
working age	60.8	64.0	64.4	62.4	59.4	58.7	58.4
post-working age	14.8	15.4	16.8	19.6	22.2	22.9	23.3
Demographic dependency ratio[a] (non-working age population per 100 persons of working age; as of 31.12.)	64	56	55	60	68	70	71
Employed persons[b] in thousands (as of 31.12.)	15488.8	12890.7	14106.9	14829.8	14789.1	15209.7	15178.1
of which in %:							
agriculture, forestry and fishing	.	16.6	16.8	16.1	7.7	8.4	8.1
industry	.	22.2	20.6	20.3	21.7	21.3	21.1
of which water supply; sewerage, waste management and remediation activities	.	0.9	1.0	1.0	1.1	1.1	1.1
transportation and storage	.	4.9	5.0	5.2	6.3	6.3	6.3
Registered unemployment rate[c] (as of 31.12.) in %	15.1	17.6	12.4	9.7	6.8	5.2	5.1
Early school leavers[de] in %	.	5.3	5.4	5.3	5.4	4.7	3.7
Lifelong learning[df] in %	.	4.9	5.2	3.5	3.7	7.8	8.7
Public expenditure on education in relation to GDP[g] in %	4.70	5.10	4.70	4.40	4.92	4.35	4.55
Gross real disposable income of households sector (2000=100)	100.0	105.1[h]	130.2[h]	143.9[h]	176.9[h]	173.9	.
At-risk-of-poverty rate after social transfers[i] in %	.	20.5	17.6	17.6	14.8	13.7	14.0

a From 2020, the results of the National Population and Housing Census 2021 have been the basis for the population balance and structure. Therefore, the data and indicators relating to the size and structure of the population (sex and age groups) from 2020 have been recalculated in accordance with the balance prepared on the basis of the results of the Census 2021. b Including employed persons in budgetary entities conducting activity within the scope of national defence and public safety. c Data was compiled taking into account employed on individual farms in agriculture estimated on the basis of census results: in 2000 – the Agricultural Census 1996, in 2005 – the Population and Housing Census 2002 as well as the Agricultural Census 2002, in 2010 and 2015 – the Agricultural Census 2010, and from 2020 – the Agricultural Census 2020. d On the basis of the Labour Force Survey (LFS); the LFS results were generalized using data from the balance of population compiled on the basis of census results: in 2005 – the Population and Housing Census 2002, from 2010 to 2020– the Population and Housing Census 2011, and from 2022 – the Population and Housing Census 2021 which implies that data are not fully comparable to those for previous years. e 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. f Percentage of the population aged 25–64 continuing education or attending vocational trainings to the total population of the same age group. g Due to the changes in the budget classification, since 2019, expenditure on education relative to GDP has been presented together with expenditure on science. h Data have been changed in relation to the data published in the previous edition. i The survey EU-SILC has been conducted in Poland since 2005 – as reference period for incomes is taken the year preceding the one under survey.

Table 1. Major data on the country (cont.)

Specification	2000	2005	2010	2015	2020	2022	2023
Households[j] in % of total households equipped with:							
Internet access	.	30.4	63.4	75.8	90.4	93.3	93.3
broadband Internet	.	15.6	56.8	71.0	89.6	92.6	92.8
Enterprises[k] in % of total enterprises equipped with:							
Internet access	.	86.1	95.8	92.7	98.6	98.5	98.7
broadband Internet	.	42.3	69.0	91.9	98.6	98.5	98.7
Investment outlays (current prices) in million PLN	133160	131055	217287	271839	309458	400081	461945
in %:							
public sector	34.8	34.9	43.5	37.3	36.2	39.3	37.8
private sector	65.2	65.1	56.5	62.7	63.8	60.7	62.2
Gross domestic product[l] (current prices) per capita[m] in PLN	19648	26029	37896	47643	63577	82079	90396[n]
Gross value added[l] (current prices) in million PLN	667508	873226	1267828	1606480	2084829	2766246	3072271[n]
of which in %:							
agriculture, forestry and fishing	3.6	3.4	3.3	2.8	2.9	3.1	3.0
industry	24.0	25.3	25.3	26.1	24.3	26.2	26.2
of which water supply; sewerage, waste management and remediation activities	1.1	1.1	1.2	1.2	1.4	1.2	1.2
transportation and storage	5.1	5.8	6.0	6.6	6.7	6.5	6.7

j Data concern households with at least one person aged 16–74 having the Internet access at home. k Data concern economic entities employing more than 9 persons. l Data for the period 2000–2022 were revised in October 2024. The detailed description of changes regarding revised estimates of annual GDP, is found in news releases of Statistics Poland: https://stat.gov.pl/obszary-tematyczne/rachunki-narodowe/roczne-rachunki-narodowe/informacja-glownego-urzedu-statystycznego-na-temat-rewizji-rachunkow-narodowych-w-latach-1995-2022,17,2.html. m Since 2020 indicator has been calculated on the basis of the number of people compiled on the results of the National Population and Housing Census 2021. n Preliminary estimate.

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 activity. Maintaining biodiversity to protect ecological value is a key factor in ecological and economic terms, both at national and international levels. Ecosystem biodiversity loss is a threat to proper functioning of our planet, and then, in turn, to population and economy.

Establishing areas of special nature value under legal protection is a form of ecosystem protection against uncontrolled human pressure on environment. In 2023, these areas comprised 10.1 million hectares, i.e. 32.2% of the total area of the country. In comparison to the previous year and 2000, the percentage decreased slightly by 0.1 pp and 0.3 pp respectively. There were 2685 m^2 of areas under legal protection per capita. The biggest share in their structure had protected landscape areas (69.4%) and landscape parks (25.9%).

According to OECD database, in 2022, terrestrial protected areas in countries of the European Union amounted to 1081.5 thousand km^2 and constituted 25.6% of the total area of EU. The following countries were in the group of states with the highest share of protected area: Luxembourg (55.3% of total area of the country), Bulgaria (40.9%), Slovenia (40.2%) and Poland (39.6%). Countries with the lowest share, however, were Finland (13.3%) and Ireland (14.3%).

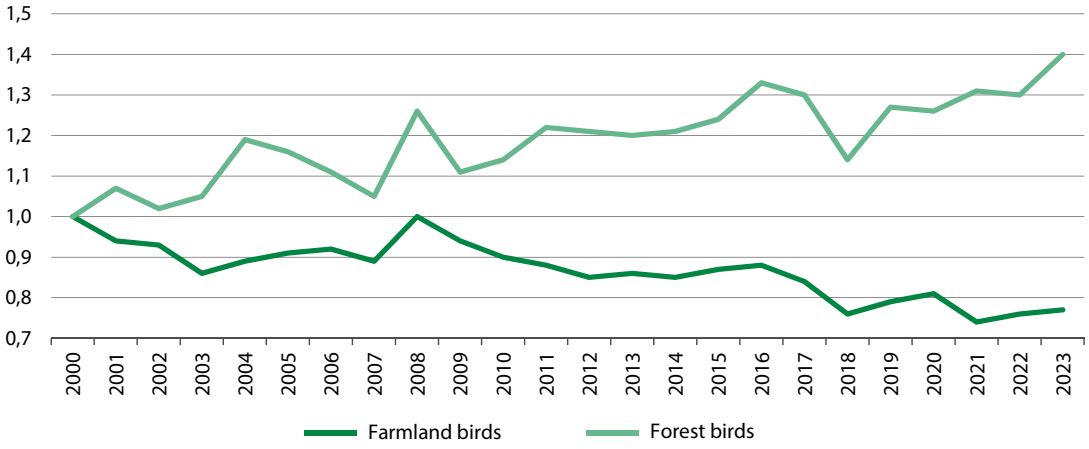
The environment state of ecosystems related to agricultural and forest land may be evaluated on the basis of aggregated Farmland Bird Index (FBI) and Forest Bird Index. Changes in the bird population on a regional or national level are important factors providing information concerning either the improvement, homeostasis or the deterioration of environment quality. The 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 European Starling, the Tree Sparrow, the Seedeater, the Linnet, the Yellowhammer, 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 Common 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 Wood Nuthatch, 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 14% (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 6–26% lower than in the base year, which means that the population number in individual years has been ranged from 74% to 94% of the 2000 year value. The lowest Farmland Bird Index in the history of the study was noted in 2021. It was lower by 26% than in the base year. In the following years, a slight increase in the value of the indicator was observed, which in 2023 amounted to 0.77.

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 2023 at 1.40.

According to Eurostat estimates, on the basis of data compiled in accordance with the European Bird Census Council (EBCC) under the Pan-European Common Bird Monitoring Scheme (PECBMS), in the period 2001–2022, aggregated Farmland Bird Index for the European Union decreased steadily in comparison with the base year (2000=100) and in 2022 amounted to 70.7%. In the case of aggregated Forest Bird Index in the years 2001–2020 the values were lower than the reference value for the year 2000. From 2021, the index was above the base figure for the year 2000. In 2022, it reached its peak, exceeding the base year value by 1.1%.

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, 480 vascular plant species (15% of total vascular plants), 1169 animal species, including 1081 invertebrates (3% of total invertebrates) and 88 vertebrate species: 13 mammal species (11% of total mammals), 47 bird species (10% of total birds), 3 reptile species (25% of total reptiles) as well as 23 fish species (18% 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 (36%). In the case of endangered bird species with habitats in a given country, their highest share was in Estonia (41%) and Denmark (35%), and endangered reptiles – in Slovenia (75%) and Germany (69%). Hungary (43%) and Austria (39%) were among countries with the highest share of endangered fish. The highest percentage of endangered vascular plants was observed in Austria (36%) and Germany (33%).

2.2. Land use

Land use means the land classified into the following categories: arable lands total (agricultural land and wasteland), forest land as well as wooded and bushy land, land under waters, built-up and urbanized area, and miscellaneous land.

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 emissions. It has an impact on water and air quality, soil erosion risk, moreover, it plays an important role in flood protection.

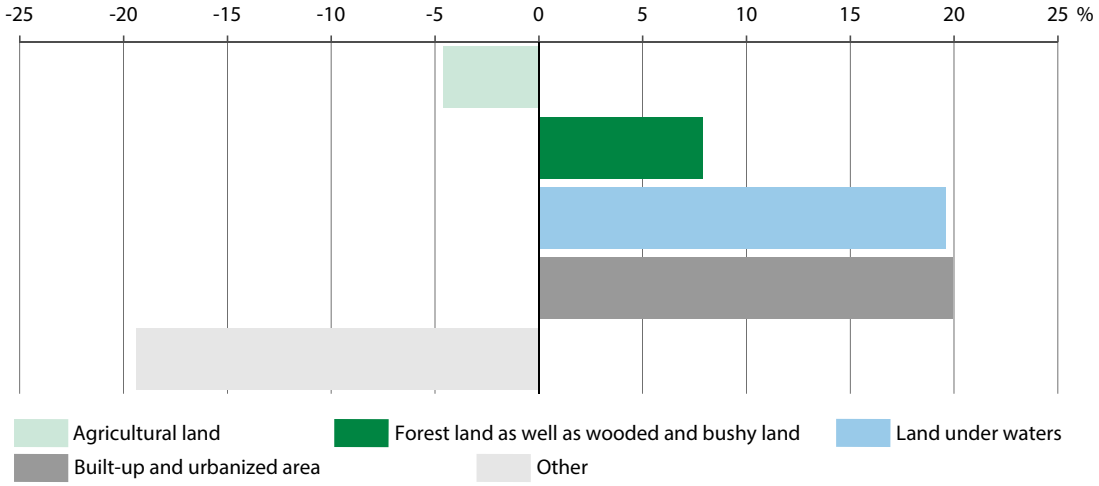
According to a geodesic inventory, in 2023, the largest part, i.e. 59.4% comprised agricultural land (18.6 million hectares), followed by forest land as well as wooded and bushy land – 30.3% (9.5 million hectares), and built-up and urbanized areas – 5.8% (1.8 million hectares) out of the total area of the country, equalling 31.4 million hectares.

Following data from the Food and Agriculture Organization of the United Nations (FAO) database, it can be stated that in 2022, in EU Member States, the total area of agricultural land within agricultural holdings amounted to 162.7 million hectares, which constituted 38.2% 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 Ireland – 61.9%, and with the lowest share in Sweden– 5.7%. Poland, with its share of agricultural land within agricultural holdings equalling 45.3%, ranked 9th among EU countries.

Man influences biodiversity and the ecosystem state by changes in land use. As built-up and urbanized areas are growing, there is a loss of natural functions of soil, fertile agricultural land and semi-natural land. Moreover, new emerging built-up land on areas outside already existing residential areas leads to traffic increase and land fragmentation.

In the years 2002–2023 an increase was noted in built-up and urbanized areas (by 19.9%), land under waters (by 19.6%), forest land as well as wooded and bushy land, including wooded and bushy land on agricultural land (by 7.9%), to the detriment of other areas and agricultural land, for which there was a decrease by 19.4% and 4.6% respectively (chart 2). The increase in the area of land under waters (in particular under internal sea waters) results from the regulation of the boundaries constituting the baseline of the territorial sea in the Gulf of Gdańsk.

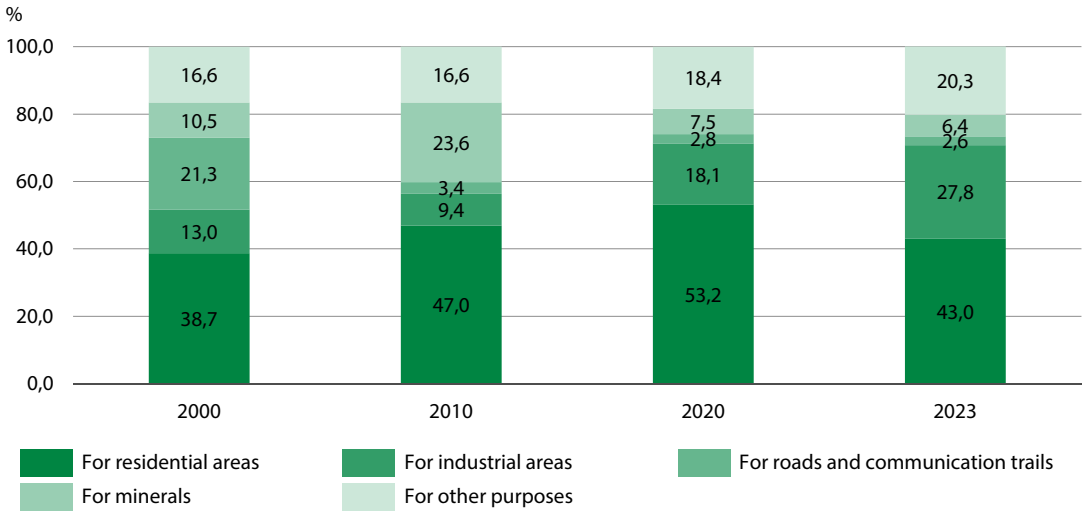
Chart 2. Land use changes in the years 2002–2023[a]



a In order to maintain data comparability, data for 2023 regarding wooded and bushy land on agricultural land were included in forest land as well as wooded and bushy land.
Source: data of the Head Office of Geodesy and Cartography.

In 2023, 5.3 thousand hectares of agricultural and forest land were designated for non-agricultural and non-forest purposes, which is a decrease in relation to the previous year by 6.8% and an increase to the year 2000 by 83.0%. The highest proportion of excluded land was designated for residential areas – 43.0% and industrial areas – 27.8% (chart 3).

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



a According to the existing legal regulations on the protection of agricultural and forest land; excluding agricultural land designed for afforestation.
Source: in regard to: agricultural land – data of the Ministry of Agriculture and Rural Development, forest land – data of the Ministry of Climate and Environment.

Land which has lost its utility value due to human activity or other factors or which utility value was lowered due to the deterioration of natural conditions may be reclaimed and managed. Land reclamation is

the creation or restoration of the utility or the natural value for degraded or devastated land through proper formation of the area topography, improvement of physical and chemical properties, regulation of water conditions, restoration of soil, reinforcement of slopes and reconstruction or construction of necessary roads. Reclaimed land is subject to management i.e. agricultural, forest or other type of utilization. In 2023, devastated and degraded land comprised in total 60.4 thousand hectares. Out of these only 2.3 thousand hectares belonged to reclaimed land, of which land for agricultural purposes comprised 1.1 thousand hectares. Managed land equalled 1.2 thousand hectares, of which the majority was also designated for agricultural purposes – 0.6 thousand hectares. Until now the degree of reclamation and management of devastated and degraded land has been low for many years. In 2023, it accounted for 3.8% and 2.0% of total devastated and degraded land respectively.

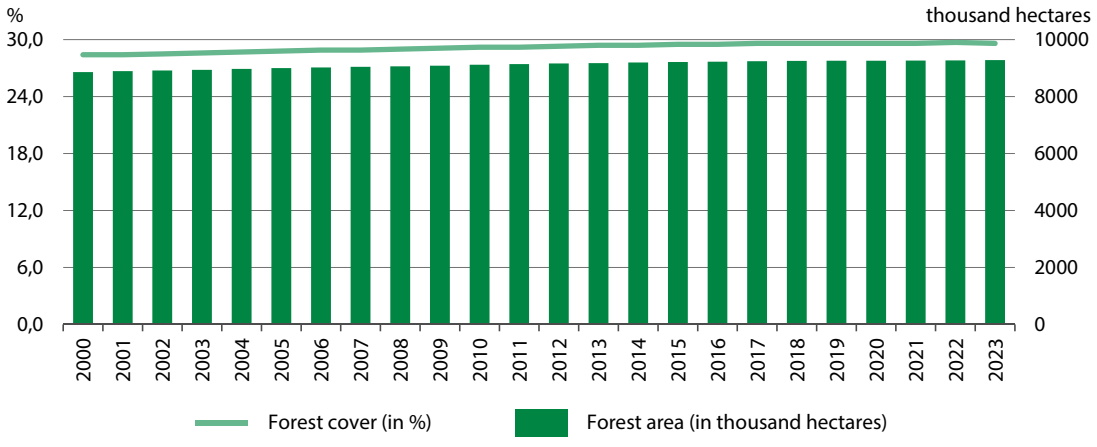
2.3. Forest resources

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 – they provide favourable conditions for health and recreation, and perform productive functions – they supply wood and other forestry products. They constitute an indispensable part of environment sustainability and green economy.

In 2023, forests in Poland covered 9283.8 thousand hectares, which means that their area increased in relation to 2022 and 2000 respectively by 0.1% and 4.7% (chart 4). The increase of forest area in Poland is a result of the state forest policy, which plans to increase the state forest cover to 31%[1] by 2030. Forest cover (percentage ratio of forest area to the total area of the country) in 2023 was 29.6% and decreased in comparison to the previous year by 0.1 pp, but grew in relation to 2000 by 1.2 pp.

Chart 4. Forest cover and forest area



[1] According to the 2030 National Environmental Policy – the Development Strategy in the Area of the Environment and Water Management.

According to FAO database, in European Union countries in 2022, the share of forest land in land area amounted to 39.9%. Countries with its highest value were Finland (73.7%), Sweden (68.7%) and Slovenia (61.3%), and the country with the lowest one was Malta (1.4%). Poland, with the value of 31.1%, held 18th position among EU Member States.

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 2019–2023, growing stock reached the volume of 2696.3 million m^3 of gross timber (a 17.0% increase in comparison to the first 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 2020, the estimation of wood resources[2] of the European Union amounted to 27228.8 million m^3 of timber. Among EU countries, Poland was placed in the group of countries with the highest share of wood resources, following Germany (3663.0 million m^3 of timber), Sweden (3653.9 million m^3) and France (3055.8 million m^3).

As a result of constantly growing both forest area and growing stock, it is possible to gradually increase removals (timber and slash). In 2023 in Poland, removals amounted to 41.7 million m^3, which is by 6.7% less than in the previous year, but by 50.6% more than in 2000. The biggest share (95.6%) of removals was timber, which amounted to 39.8 million m^3. It was harvested 6.7% less than a year before, but 53.1% more than in 2000. It is important to keep the balance between the volume of timber increment and removals to preserve forest heritage for future generations.

As Eurostat estimates show, in 2022, European Union countries harvested 509.3 million m^3 of wood. Among the countries, for which data is available the largest amount of wood was harvested in Germany (78.9 million m^3), followed by Sweden (77.2 million m^3) and Finland (65.6 million m^3). Poland came 4th[3] (45.7 million m^3) in this respect.

While analysing forest resources, their health state cannot be overlooked. The area of damaged tree stands (in damages classes above 20%) in Poland in 2023 equalled 2904.9 thousand hectares, which constituted 31.4% of total forest area. The dominant reasons of damage included, apart from "other agents" category (comprising 24.8% of total forest area), the categories as follows: damage caused by game (3.2%), fungi and wind (1.3% each) as well as insects (0.8%).

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 a given period.

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

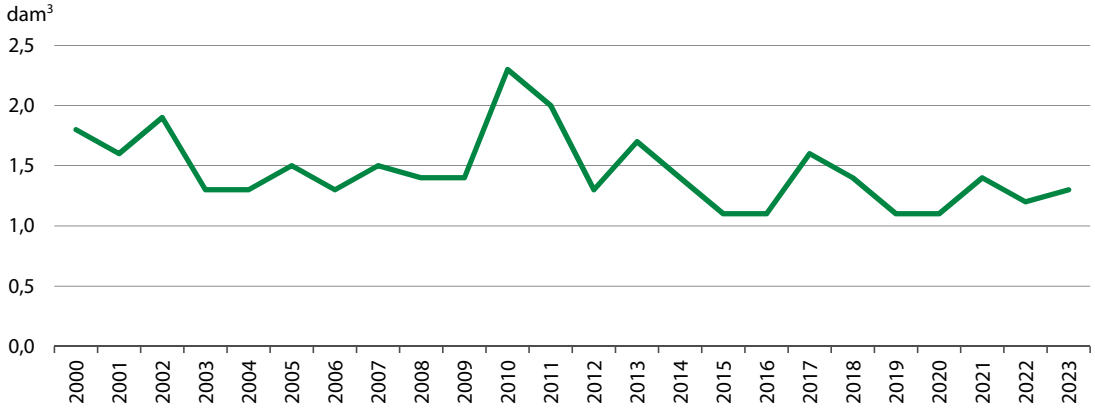
Agriculture, industrial infrastructure, urbanization and individual needs of population lead to the increase in freshwater demand, therefore it is important both to use it in an effective way as well as to monitor its quantity and quality.

[2] 5 yearly data collection.
[3] It should be noted that according to Eurostat database, in 2021, France had a large wood harvest (53.1 million m^3), which in this respect ranked 4th among EU countries. Data for 2022 is not available.

Poland is a country of limited freshwater resources. Most of them are surface water resources. As Eurostat data show, freshwater resources in Poland equal 57.8 billion m^3 (as a long-period average). It is less than 1.6 dam^3 water per capita, which places Poland together with Malta (0.2 dam^3), Cyprus (0.4 dam^3) and Czechia (1.4 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 France (206 billion m^3), Sweden (195 billion m^3) and Germany (173 billion m^3). Freshwater resources per capita are the highest in Croatia (30.7 dam^3), Finland (19.8 dam^3), Latvia (19.5 dam^3) and Sweden (18.6 dam^3).

The most commonly used measurement for establishing the amount of water resources is the indicator of surface water availability. It states the average annual outflow of surface water (from Polish territory, including inflows from abroad) per capita. In 2023, the indicator was 1.3 dam^3, compared to 1.2 dam^3 noted the year before, and 1.8 dam^3 in 2000. The indicator of waters availability in the years 2000–2023 peaked in 2010 and reached 2.3 dam^3 (chart 5).

Chart 5. Indicator of surface water availability per capita



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

Surface waters are the main source of providing national economy with water. Surface water withdrawal in 2023 (excluding irrigation in agriculture and forestry) was 6516.5 hm^3, accounting for 78.2% of total withdrawal. Surface water abstraction from rivers and lakes is used mainly for production purposes – in 2023 it represented 78.6%.

Underground waters as waters of much better quality are mainly treated as drinking water supplies. Exploitable resources of underground waters at the end of 2023, amounted to 18873.8 hm^3, which is more than in the previous year and 2000 by 0.7% and 17.6% respectively. Their withdrawal was 1776.6 hm^3 (21.3% of total withdrawal), so it increased both in comparison to 2022 and 2000 by 0.9% and 1.7% respectively.

To illustrate the entire water country demand in relation to available water resources, indicator of level of water stress is used. It presents the intensity of use of freshwater resources and refers to gross abstraction of freshwater in total renewable freshwater resources[4]. According to OECD database, in 2022 the indicator in Poland amounted to 17.0%. Since 2000, its highest value was recorded in 2006 (21.5%).

[4] More information in methodological notes on page 58.

2.5. Mineral resources

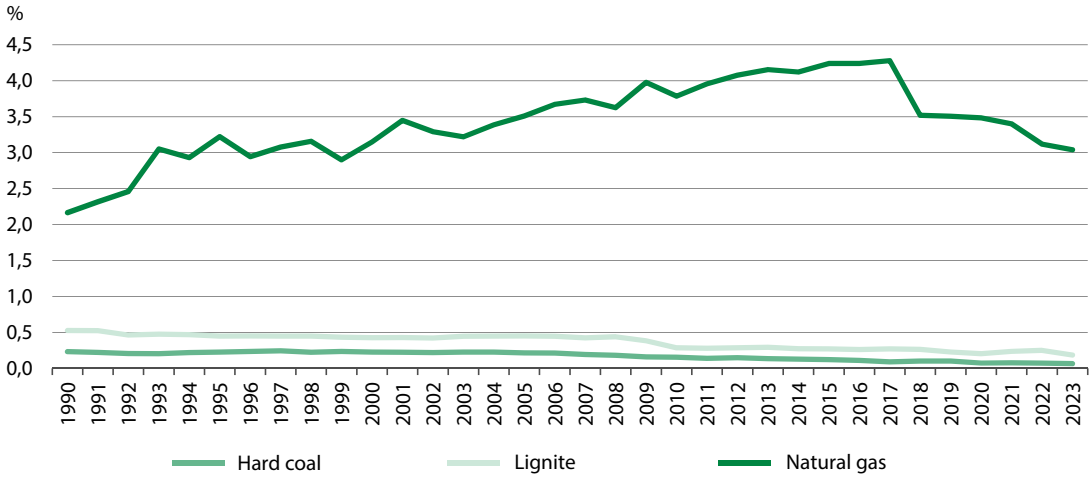
Mineral resources, belonging to the group of non-renewable natural resources, are minerals constituting elements of the natural environment: earth's crust, hydrosphere, biosphere and atmosphere, separated from them and adapted for use by a certain field of technique or a specific technology.

A key role to ensure a high standard of living in developed countries and to maintain constant economic growth is taken by energy and rock raw materials. They safe-guard access to energy, warmth, building material resources and, moreover, they constitute a basis for industry and technological development.

In the face of limited and diminishing resources, including hard coal, lignite, natural gas, the implementation of green economy assumptions is to ensure meeting the needs of not only present, but also 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 1990–2023 geological resources of hard coal (balance-sheet and off-balance-sheet) diminished from 86.0 billion tonnes to 77.8 billion tonnes (by 9.5%), which was mainly caused by exploitation of deposits and changes in balance criteria. Its annual exploitation fell from 151.3 million tonnes in 1990 to 42.5 million tonnes in 2023 (by 71.9%). In 2023, the share of extraction in balance-sheet resources of hard coal was 0.1% and fell 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 data, in 2023, the total of 49.7 million tonnes of hard coal were mined in Member States of the European Union, i.e. by 82.1% less than in 1990. Since the last decade of the 20th century, the number of Member States with active mining also decreased from 13 in 1990 to 2 in 2023 (Poland and Czechia). The share of Polish hard coal mining in total EU coal mining extraction increased from 53.2% in 1990 to 97.2% in 2023.

Lignite, in comparison to hard coal, is a lower ranking type of coal, with a much lower calorific value. In 2023, its geological resources (balance-sheet and off-balance-sheet) were 26.6 billion tonnes, which means that they increased by 55.4% in relation to 1990. The increase was mainly connected with the documentation of new deposits. Due to the fact that the presence of coal matter, which is located on the Polish territory, is identified to a great degree, it can be assumed that the chances for finding new large

lignite resources are limited, however, it is still possible to discover small and medium deposits of economic significance in the area of carbon deposits. The volume of annual lignite extraction fell in the years 1990–2023 from 67.7 million tonnes to 42.5 million tonnes (by 37.2%). In 2023, the share of lignite extraction in its balance-sheet resources was 0.2% (in 1990 – 0.5%).

As Eurostat data show, in 2023, lignite was extracted in 9 from 27 countries of the European Union with the amount equalling 224.5 million tonnes. Countries with the greatest extraction were Germany (102.3 million tonnes) and Poland (40.1 million tonnes). Their share in the total extraction of EU countries was 63.4%.

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 153.5 billion m^3 in 2023, i.e. by 6.4%. Ecological properties of gas, as well as the wide scope of its use resulted in the increase in the annual gas extraction by 33.1% from 3.5 billion m^3 recorded in 1990 to 4.6 billion m^3 noted in 2023. The share of extraction in balance-sheet resources of natural gas was 3.0% in 2023 (in 1990 – 2.2%).

Eurostat data show that in 2022 natural gas was produced by 17 among 27 EU countries. The production amounted to 46.8 billion m^3. The highest production was reported in the Netherlands (18.0 billion m^3) and Romania (9.1 billion m^3). Poland ranked 3rd among EU countries producing natural gas at 5.5 billion m^3, and its share in total production of EU countries increased from 2.5% in 1990 to 11.7% in 2022.

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.

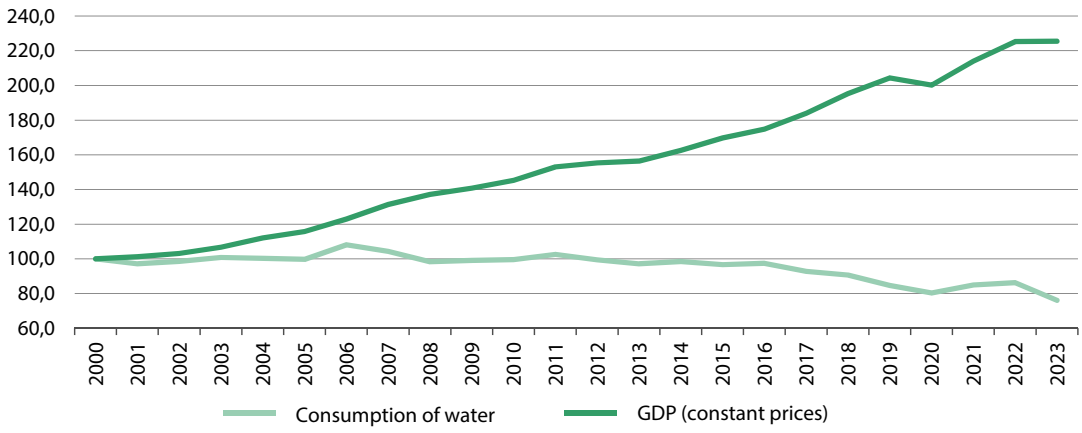
Water plays an important role in processes taking place in ecosystems, constituting an abiotic component of environment. It is a very valuable, distinctive and renewable material, whose resources vary in time. It fulfils different functions in economic activity, therefore it is necessary both to protect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

In 2023, consumption of water for needs of the national economy and population (excluding irrigation in agriculture and forestry) was 7921.3 hm^3, of which for industrial purposes – 5414.1 hm^3 (68.4% of total water consumption), exploitation of water supply network – 1673.4 hm^3 (21.1%), as well as fishing (i.e. filling and completing fish ponds) – 833.8 hm^3 (10.5%). In relation to 2000, positive changes took place in industry, with the decrease in water consumption by 28.7% and with the fall in the case of exploitation of water supply network – by 4.6%. The decrease was also noted in water consumption for the needs of national economy and population per capita (from 272.1 m^3 in 2000 to 210.1 m^3 in 2023).

Main factors affecting the quantity of used water are production intensity together with the volume and patterns of individual consumption. The analysis of the dynamics of consumption of water and GDP in the years 2001–2023 in relation to 2000 may lead to the observation of a positive trend – almost a steady water consumption level (excluding 2006 and 2007, when a relatively high increase of water consumption was noted in comparison with 2000), followed even by its decrease noted in recent years, accompanied by a constant gradual GDP increase (chart 7).

Chart 7. Dynamics of consumption of water for needs of the national economy and population as well as GDP[a]

2000=100



a Consumption of water for needs of the national economy and population – since 2019 excluding irrigation in agriculture and forestry; GDP for 2023 – preliminary estimate.

Efficient water consumption constitutes a base for proper water management. In the years 2000–2023 water productivity index[1] was becoming more and more favorable. In 2023, the ratio of GDP to cubic meter of water consumed was 392.00 PLN/m^3, which is an increase both to the year 2022 and 2000 by 25.5% and 475.7% respectively.

To assess the effectiveness of water management, apart from water productivity index, it is possible to use water intensity indicators, such as water use intensity of industry or water use intensity of households.

Since 2000 there have been positive tendencies in Poland in terms of both indicators. The water use intensity of industry was gradually decreasing (excluding the years 2002, 2006 and 2011, when a slight increase was observed in relation to the preceding year). In 2023, it reached 7.5 m^3/thousand PLN, i.e. was lower in comparison to 2022 and 2000 by 25.7% and 85.1% respectively. Household sector was also characterized by a much lower water use intensity index. In 2023, it was 1.9 m^3/thousand PLN and it decreased in relation to 2022 and 2001 by 5.0% and 65.5% respectively.

3.2. Domestic material consumption

Domestic material consumption (DMC) includes the total amount of materials directly used in economic processes for the needs of the economy. It is the sum of raw materials extracted from the domestic territory of the total economy, plus all physical imports minus all physical exports.

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 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.

According to estimates of Eurostat, domestic material consumption in 2023 in Poland was 661.4 million tonnes. It was lower by 1.9% in relation to the previous year, but higher by 26.7% in comparison with 2000. Yearly domestic material consumption per capita amounted to 18.0 tonnes.

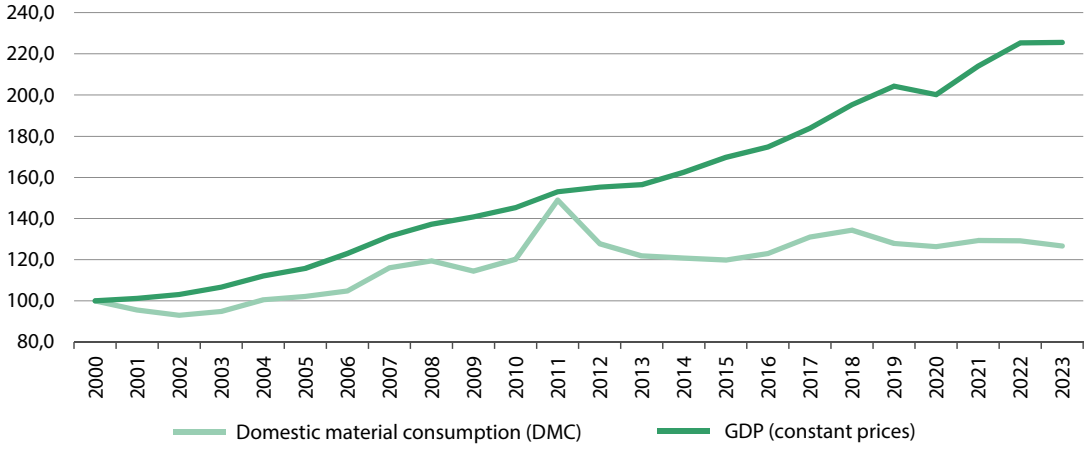
Domestic material consumption in Member States of the European Union in 2023 reached 6220.4 million tonnes, and per capita in the EU – 13.9 tonnes. The highest material consumption per capita was in Finland (42.3 tonnes) and Romania (32.2 tonnes), and the lowest in Spain (8.1 tonnes) and Italy (8.4 tonnes). Among EU countries with the highest indicator value, Poland ranked 11th.

In DMC structure, the biggest share in Poland had non-metallic minerals (51.5%), whose consumption in the analysed year was 340.5 million tonnes. The share of remaining materials, i.e. biomass, fossil energy materials/carriers and metal ores in the total consumption was: 23.2%, 20.6% and 5.5% respectively. In relation to 2000, the consumption of non-metallic minerals increased the most, by 98.9%. It is largely connected with the realisation of infrastructure projects, among others financed from European Union funds.

In the period 2001–2023, the dynamics of DMC 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). However, the growth rate of domestic material consumption was lower than the growth rate of GDP. It proves a relative decoupling between GDP and material consumption.

[1] When calculating the indicator, since 2019 consumption of water for needs of the national economy and population does not include irrigation in agriculture and forestry.

Chart 8. Dynamics of domestic material consumption (DMC) and GDP[a]
2000=100



a GDP for 2023 – preliminary estimate.
Source: data regarding domestic material consumption – Eurostat database (access date 31 October 2024).

To measure the efficiency of material consumption in economy, 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 fewer resources are used to produce a unit of GDP. In the years 2000–2023, the efficiency of resource use gradually increased from 1.36 PLN/kg to 4.69 PLN/kg (except for the years 2007, 2011 and 2017, when the analysed indicator assumed lower values compared to the preceding year).

According to estimates of Eurostat, in 2023, the resource productivity index in countries of the European Union was 2.7 PPS/kg. The Member States with the highest index were the Netherlands (6.0 PPS/kg), Italy and Luxembourg (4.3 PPS/kg each), and the country with the lowest one – Romania (0.9 PPS/kg). Poland with the index value of 1.7 PPS/kg ranked 21st among countries of European Union.

3.3. Waste management

Waste is any substance or object which the holder discards or intends or is required to discard. It comprises waste generated in production processes (excluding municipal waste) and municipal waste.
Municipal waste is waste generated in households and waste from other waste producers, which due to its nature and composition is similar to waste from households, in particular unsegregated (mixed) municipal waste and waste collected separately from:
a) households, including paper and cardboard, glass, metals, plastics, bio-waste, wood, textiles, packaging, waste electrical and electronic equipment, used batteries and accumulators and bulky waste, including mattresses and furniture, and
b) sources other than households, if this waste is similar in nature and composition 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 inefficient resource management, leading, additionally, to pollutant emissions to air, land and water, to wasting areas on landfilling sites and damaging the natural beauty of landscape. Only the

reuse 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 more efficient resource management.

In 2023, 122.8 million tonnes of waste were produced, of which 89.0% was waste other than the municipal one.

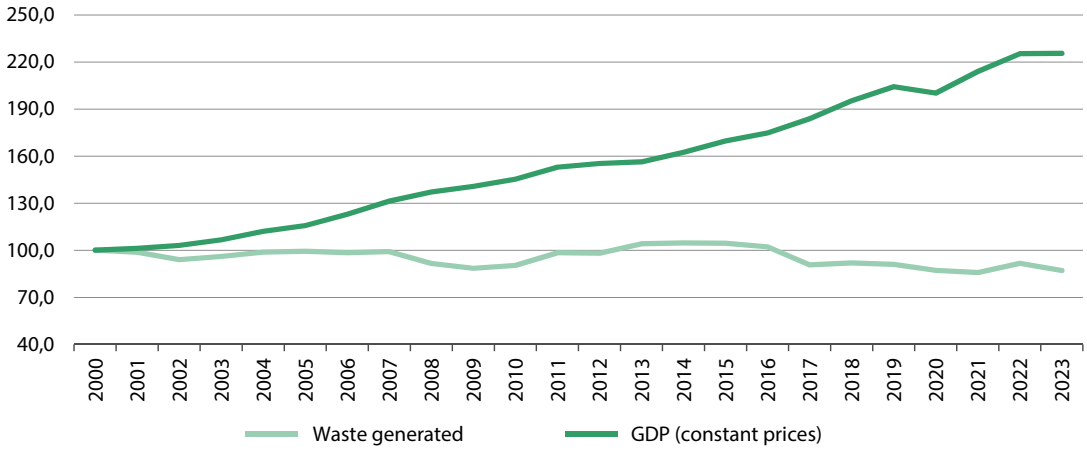
Waste (excluding municipal waste)

In the period 2000–2023 the largest amount of generated waste (excluding municipal waste) was noted in the year 2014 (131.3 million tonnes), while the lowest amount – in 2021 (107.7 million tonnes). In 2023, the figure was 109.3 million tonnes. In comparison with the previous year and 2000, the amount of waste decreased by 5.0% and 12.9% respectively. The main source of waste generation were entities belonging to the following sections: mining and quarrying (56.7% of total amount of generated waste excluding municipal one), manufacturing (18.6%), as well as electricity, gas, steam and air conditioning supply (8.5%).

Recovery processes play a meaningful role in waste management. In 2023, recovered waste by waste producer on his own as well as transferred to other recipients for recovery processes was 53.3 million tonnes, which accounted for 48.8% of total generated waste (in 2022 – 48.4%).

Analysing the dynamics of the amount of generated waste and GDP in the period of 2001–2023 in relation to 2000, one can observe a positive trend (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. Dynamics of waste generated (excluding municipal waste) and GDP[a]
2000=100



a GDP for 2023 – preliminary estimate.

Municipal waste[2]

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.

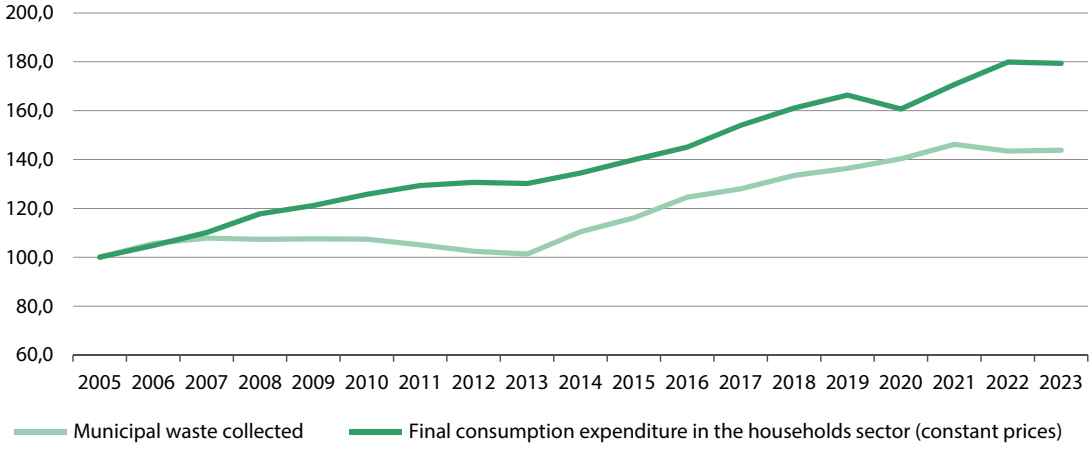
In 2023, 13.4 million tonnes of municipal waste were collected, which is an increase both in relation to 2022 and 2005 by 0.2% and 43.8% respectively. In 2023 in Poland, waste per capita amounted to 356.7 kg, which is more in comparison with the previous year and 2005 by 0.5% (by 1.9 kg) and 45.5% (by 111.6 kg).

Eurostat data show that in 2022 the amount of municipal waste per capita in Poland (364 kg) was decisively lower that the European Union average (513 kg) and was one of the lowest (preceded only by Romania – 303 kg) in EU countries. The highest analysed value was recorded in Austria (803 kg), Denmark (802 kg), and Luxembourg (721 kg).

In Poland in the years 2006–2021 the dynamics of the amount of municipal waste collected and final consumption expenditure in the households sector (chart 10) was above the base year level (2005=100). Since 2007, the growth rate of generating municipal waste has been lower than the growth rate of consumption in the households sector. In 2023, they were at 43.8% and 79.4% respectively, which shows a relative decoupling between the amount of generated municipal waste and consumption in the households sector.

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

2005=100



a Final consumption expenditure in the households sector for 2023 – preliminary estimate.

One of the main methods of reducing the amount of waste is recycling, the aim of which is to reuse the same materials. Selective waste collection is necessary to facilitate recycling processes. In 2023, 5.5 million tonnes of municipal waste were collected separately. The proportion of waste collected separately in the total mass of collected municipal waste from 2003 gradually grew, reaching 40.7% in 2023. This positive trend may result from, among others, a steady rise of ecological awareness of population, the implementation of programmes of managing municipal waste as well as from the pricing policy of gminas in the

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

field of waste collection. Yet, although the amount of waste collected non-selectively is falling, it still has a high share (in 2023 – 59.3%).

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 2022 was 48.7%. Germany (69.2%), Austria and Slovenia (62.6% each) and the Netherlands (57.5%) had the highest value of the indicator and Romania (12.3%) – the lowest. Poland with the recycling rate of municipal waste at 40.9% was 14th among EU countries.

3.4. Nitrogen and phosphorus balances

Gross nitrogen and phosphorus balance is 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 ecosystem imbalance.

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 compounds – 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 improper application of fertilizers lead to the accumulation of harmful components in soil and their transmission to animal and human food chain.

Consumption of nitric fertilizers in the economic year[3] 2022/23 was 1.0 million tonnes (in pure ingredient – N) and was higher in relation to the previous period, for which data were collected, i.e. to the year 2019/20[4] and to the economic year 1999/2000 by 0.7% and 20.7% respectively. The figure of nitrogen fertilizers per 1 ha of agricultural land in the economic year 2022/23 was 70.7 kg, while in the year 2019/20 – 69.1 kg, and in the economic year 1999/2000 – 48.4 kg.

In the case of phosphoric fertilizers in the year 2022/23, their use amounted to 0.3 million tonnes (in pure ingredient – P_2O_5). It means that there was a decrease both in relation to the year 2019/20 and to the economic year 1999/2000 by 20.7% and 4.2% respectively. In the analysed year, the use of phosphoric fertilizers per 1 ha of agricultural land was 19.3 kg, three years before – 24.0 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.

[3] Economic year covers the period from 1 July of the current year to 30 June of the following year.
[4] Data for 2019/20 come from the Agricultural Census 2020 and cover the period from 2 June 2019 to 1 June 2020 inclusive.

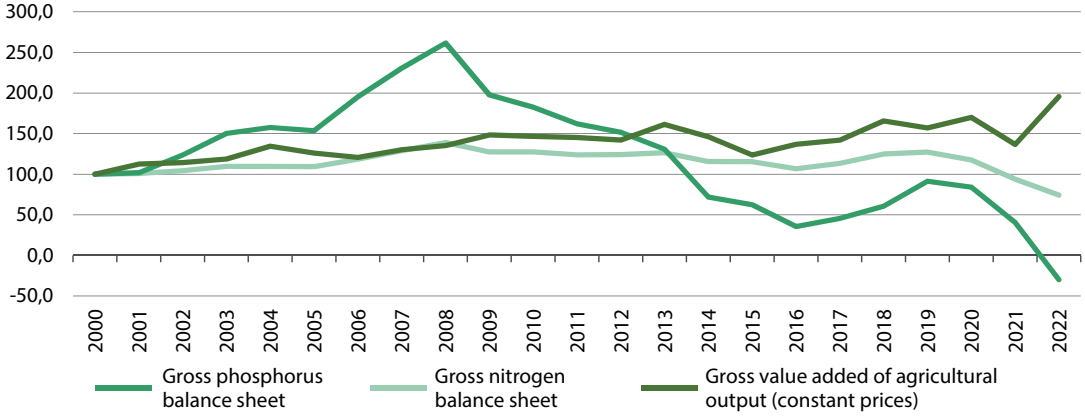
In nitrogen plant fertilization, nitrogen balance is in general disturbed, due to inevitable losses to air or leaching nitrates to lower levels of soil and groundwater. It is assumed that because of the yield and the quality of groundwater, the gross nitrogen balance sheet should amount to 30–70 kg per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

While analysing data concerning last 22 years, it can be noted that the average gross nitrogen balance per 1 ha of agricultural land fell from 41.1 kg in the period of 1998–2000 to 30.5 kg in 2020–2022. This value is kept at a safe level – below 70 kg per 1 ha of agricultural land.

In the years 2001–2019 the dynamics of gross nitrogen balance sheet in relation to 2000 was lower (except for 2008) than the growth rate of gross value added of agricultural output (chart 11), which is indicative of a relative decoupling between agricultural output and gross nitrogen balance sheet. Since 2020, there has been an absolute decoupling between the gross value added of agricultural output and the gross nitrogen balance sheet – compared to 2000, the dynamics of the first value is above the level of 2000, while the second one has been constantly decreasing.

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

2000=100



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

Source: data regarding gross nitrogen and phosphorus balance sheet prepared by the Institute of Soil Science and Plant Cultivation – National Research Institute (Jerzy Kopiński, Beata Jurga), within the framework of 1.8, 2.1, 2.2 PW IUNG-PIB 2016–2020 task according to "Nutrient Budgets" methodology OECD/Eurostat.

As Eurostat database shows, in 2021 among 12 European Union Member States, for which data are available, the average gross nitrogen balance sheet per 1 ha of agricultural land was between minus 16.2 kg in Romania and 62.9 kg in Czechia.

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 sheet, with an average phosphorus soil content should be nearing zero, however, with a low phosphorus soil content – to 5 kg per 1 ha of agricultural land.

Within the last 22 years, an average gross phosphorus balance sheet per 1 ha of agricultural land decreased from 3.0 kg in the period of 1998–2000 to minus 0.9 kg in the years 2020–2022.

Dynamics of gross phosphorous balance sheet in 2001–2013 was above the level of the year 2000, and since 2014 below the level of the base year (2000=100). However, the dynamics of gross value added of agricultural output from 2001 to 2022 was above the level of the year 2000. 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, in 2021 among 12 European Union Member States, for which data are available, the average gross phosphorous balance sheet per 1 ha of agricultural land was from minus 6.4 kg in Germany to 4.3 kg in Spain.

3.5. Energy productivity

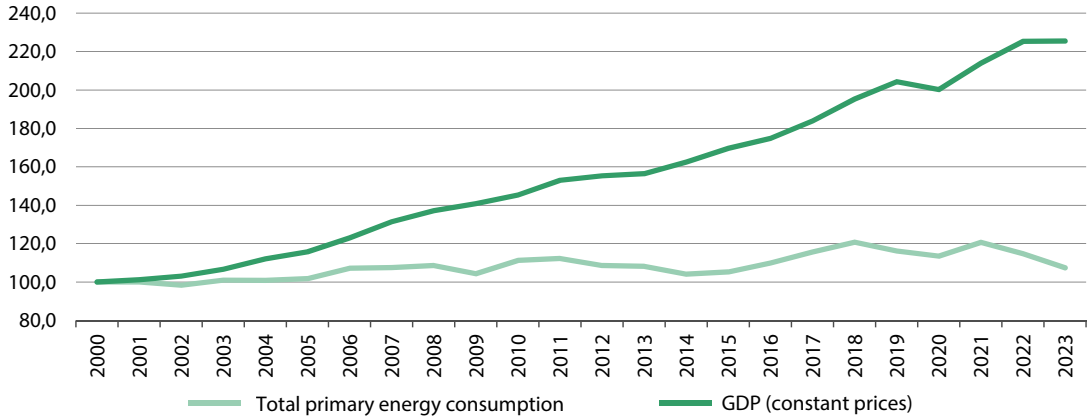
Primary energy is energy embodied in the primary energy carriers that are acquired directly from renewable and non-renewable natural resources, necessary to cover the demand for final energy, having regard to the efficiency of the entire chain of processes related to production, conversion and transport 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 households. Its efficient use in economy constitutes an important factor influencing production costs and product competitiveness on an international market. Careless use of energy leads to problems with the 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 2023, total primary energy consumption was 97.0 Mtoe and was lower in relation to the previous year by 6.5%, but higher in comparison to 2000 by 7.4%. Among primary energy carriers in 2023, hard coal and lignite held a dominating position (39.9% of total consumption). Their share in the total consumption in relation to 2022 and 2000 was reduced by 5.2 pp and 24.8 pp respectively.

In the years 2001–2023, dynamics of total primary energy consumption in the economy in relation to 2000 assumed values above the level of 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. Dynamics of total primary energy consumption and GDP[a]
2000=100



a GDP for 2023 – preliminary estimate.

To assess the energy policy of the country a primary energy productivity indicator, which is a relation between gross domestic product (in 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 2023, this measure was 32.02 PLN/kgoe and grew in relation to 2022 and 2000 by 18.5% and 308.1% respectively, which is a positive fact.

Eurostat data show that the primary energy productivity indicator in European Union countries in 2022 was 11.4 PPS/kgoe. EU countries with the highest primary energy productivity were Ireland (28.8 PPS/kgoe), Denmark (16.6 PPS/kgoe) and Romania (16.0 PPS/kgoe). The lowest indicator was noted in Malta (6.4 PPS/kgoe), Finland (6.6 PPS/kgoe) and Bulgaria (7.3 PPS/kgoe). Poland, having reached 10.2 PPS/kgoe was in the 18th place among EU Member States.

In the period 2000–2023, changes in the structure of final energy consumption, i.e. the one used by final customers (exclusively for energy purposes without processing into other energy carriers) took place in Poland. In 2023, the biggest consumer was a transport sector with a 34.0% share, followed by households sector – 28.8%, industry – 20.3%, services – 11.7% and agriculture – 5.2%. In relation to 2000, the largest decrease in the share of final energy consumption was recorded in industry (by 11.4 pp), which may 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 17.0 pp), i.a. as a result of dynamic development of road transport and services.

Final energy intensity indices, 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 2000–2023 a gradual decrease of final energy intensity of Polish economy was observed from 76.4 kgoe/thousand PLN to 22.3 kgoe/thousand PLN (except for the years 2010, 2016 and 2017, when the analysed indicator assumed higher values compared to the preceding year). It was a positive development as the share of energy necessary to produce the same amount of GDP decreased. In 2023 the indicator of final energy intensity in relation to 2022 and 2000 was lower by 12.4% and 70.8% respectively.

Final energy intensity of households sector was gradually falling from 2001, except for 2010, 2016, 2018 and 2021 when slight increases were recorded in relation to the previous year. In 2023, the analysed indicator amounted to 28.5 kgoe/thousand PLN and decreased in relation to 2022 and 2001 by 13.6% and 64.9% respectively.

In the period of 2000–2016 (except for 2011 and 2013) also in industry there were positive trends such as the fall in the final energy intensity indicator of this sector. After an increase of the indicator in 2017, in subsequent years it fell again to 19.5 kgoe/thousand PLN in 2023. It means that in comparison with the previous year and 2000, it decreased by 17.1% and 82.8% respectively.

In 2023, final energy intensity of transport was 7.6 kgoe/thousand PLN. It was lower in relation to 2022 and 2000 by 11.1% and 41.5% respectively.

3.6. Renewable energy

Renewable energy is the energy derived from natural, repetitive environmental processes, obtained from renewable non-fossil energy sources: energy of water, wind, solar heat, geothermal 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.

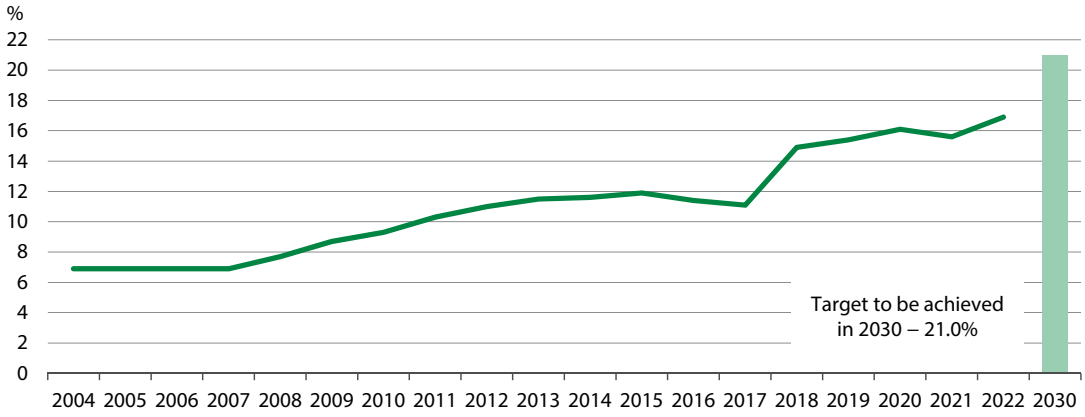
In recent years, renewable energy sources (RES) have been increasingly used as an alternative to traditional energy resources (fossil fuels). The main reason for their growing popularity is the fact that they can be treated as inexhaustible and, at the same time, decisively less dangerous to environment 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 18 years in Poland there was a constant increase in the amount of renewable energy, from 4.3 Mtoe in 2004 to 13.4 Mtoe in 2022. The structure of energy obtained from renewable sources by type of carrier was dominated by solid biofuels (64.5%) and wind energy (12.6%).

The increase in the share of energy from renewable sources in gross final energy consumption is a part of energy policy of the European Union, Poland included. 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 established new targets for the European Union for 2030, and also modified the rules for calculating the shares of energy from renewable sources in gross final energy consumption from 2021. The Directive does not specify individual targets for Member States. Poland defined them in the "National Energy and Climate Plan for the years 2021-2030" (NECP PL), submitted to the European Commission in December 2019. In the aforementioned document, Poland declared that it would achieve, among others, the following issues by 2030: 21% share of energy from renewable sources in gross final energy consumption from all sources (i.e. total consumption in electricity, heating and cooling as well as for transport purposes) and 14% share of energy from renewable sources in final energy consumption in transport.

In 2022, the share of energy from renewable sources in gross final energy consumption was 16.9%, which is indicative of an increase in relation to the previous year and 2004 by 1.3 pp and 10.0 pp respectively (chart 13).

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



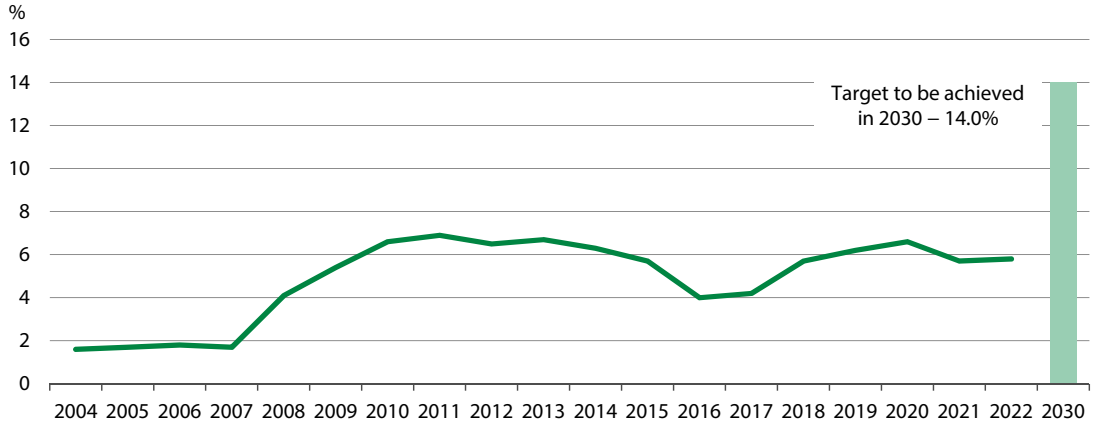
a Due to changes in methodology, data from 2021 are not fully comparable with data for the previous years.
Source: Eurostat database (access date 12 November 2024).

Eurostat database provides such information that in 2022 the share of energy from renewable sources in gross final energy consumption was 23.0% in European Union countries. The highest value of the indicator was noted in Sweden (66.0%), Finland (47.9%), Latvia (43.3%) and Denmark (41.6%), the lowest, however, in Ireland (13.1%), Malta (13.4%) and Belgium (13.8%). Among EU countries, Poland ranked 21st.

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, makes it necessary to enhance alternative fuels (i.a. liquid biofuels) use in transport.

In the period 2004–2011, in Poland a constant increase of the share of energy from renewable sources in final energy consumption in transport was noted and its highest level (6.9%) was reached in 2011 (chart 14). In the years 2013–2016, the share gradually decreased from 6.7% to 4.0%, and then started to increase year on year to 6.6% in 2020. In 2022 the share of energy from renewable sources in final energy consumption in transport was 5.8%, i.e. higher than in 2021 and 2004 by 0.1 pp and 4.2 pp respectively.

Chart 14. Share of energy from renewable sources in final energy consumption in transport



a Due to changes in methodology, data from 2021 are not fully comparable with data for the previous years.
Source: Eurostat database (access date 12 November 2024).

Liquid biofuel production for transport grew from 13.4 thousand toe in 2004 to 1081.4 thousand toe in 2022. In the structure of energy generation from liquid biofuels, from 2004 a dominating position belonged to biodiesel (in 2022 – 81.4% of the total energy production from liquid biofuels), the remaining part – to bioethanol (18.4%) and other biofuels (0.2%).

Inferring from Eurostat data, in 2022 the share of energy from renewable sources in final energy consumption in transport in European Union countries equalled 9.6%. The biggest share was achieved by Sweden (29.2%) and Finland (18.8%), and the smallest one – by Croatia (2.4%). Among EU countries Poland ranked 23rd.

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 fluorinated gases: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).

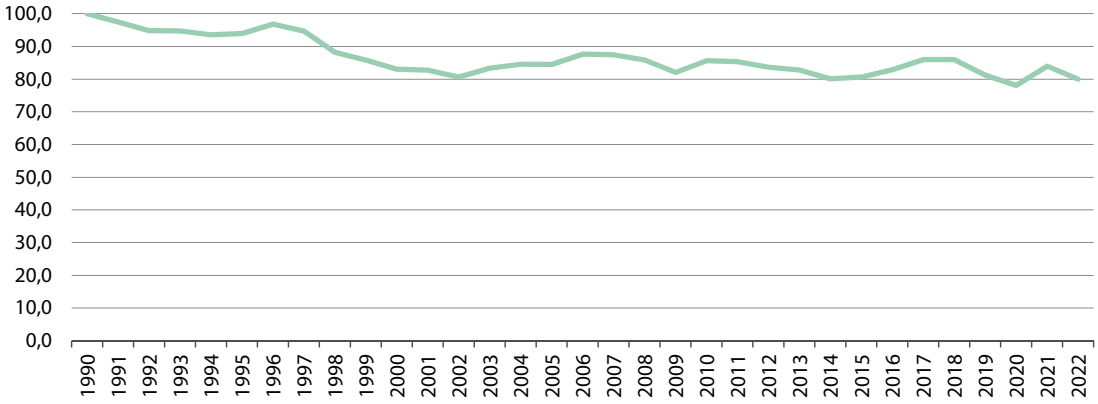
The Republic of Poland has entered international activities aiming at preventing climate change by ratifying in 1994 the United Nations Framework Convention on Climate Change (1992) as well as in 2002 the Kyoto Protocol (1997). One of the main obligations arising from signing the Kyoto Protocol by Poland was the greenhouse gas emission reduction in the years 2008–2012 by 6% in relation to the base year, which was the year 1988 for Poland. In 2012, greenhouse gas emission in Poland was 398.0 million tonnes of CO_2

equivalent[5], which means a fall by 31.3% in comparison to 1988. This reduction was substantially larger than Poland's obligation.

In the next commitment period, in line with the Doha Amendment and Europe 2020 Strategy in the years of 2013–2020 it was planned that the European Union would reduce greenhouse gas emission by at least 20% in relation to the base year (for the majority of countries it was 1990). In 2020, according to the data of KOBiZE (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 371.4 million tonnes of CO_2 equivalent. It means that their emissions were reduced compared to 1990 by 35.9% (chart 15).

In 2018, the European Union adopted another package of energy and climate regulations[6] to achieve, among other things, the greenhouse gas emission reduction target by 2030 resulting from the ratification of the Paris Agreement. Initially, this package assumed a total reduction of greenhouse gas emissions by the European Union by 40% compared to 1990. It was then updated[7] in 2021. It was assumed that by 2030 the European Union would reduce greenhouse gas emissions by 55% compared to 1990 levels. According to KOBiZE data, in 2022, greenhouse gas emissions in Poland (excluding emissions from international aviation and maritime transport and land use, land use change and forestry) amounted to 380.5 million tonnes of CO_2 equivalent, i.e. were 20.0% lower than in 1990.

Chart 15. Dynamics of greenhouse gas emissions
1990=100



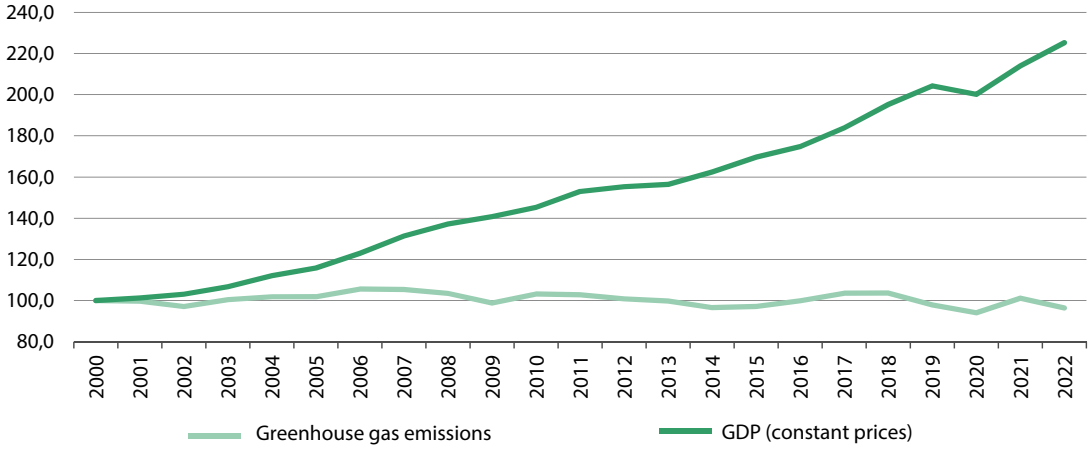
Source: own elaboration on the basis of data of the National Centre for Emissions Management (access date 14 November 2022).

Eurostat database shows that in 2022 greenhouse gas emission (excluding emissions from international aviation and maritime transport and land use, land use change and forestry) in EU countries equalled 3374.7 million tonnes of CO_2 equivalent and was by 30.7% lower than in 1990. The greatest decrease in this emission in comparison with 1990 was observed in Estonia (by 65.4%), Latvia (by 61.1%) and Lithuania (by 60.6%). Three EU countries experienced an increase in their emissions, i.e. Cyprus (by 57.4%) and Ireland (by 9.7%) and Spain (by 2.4%).

[5] 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.
[6] Including Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action.
[7] Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999.

During the years 2001–2022 in Poland the GDP growth rate in comparison to 2000 was decisively higher than the rate of greenhouse gas emission growth. 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. Dynamics of greenhouse gas emissions and GDP
2000=100



Source: data regarding greenhouse gas emissions – the National Centre for Emissions Management (access date 7 November 2024).

In 2022, the largest share of greenhouse gas emission in Poland had carbon dioxide (82.9% of total emission), followed by methane (10.7%), nitrous oxide (5.2%) and fluorinated gases, the so-called F-gases (1.2%). No emissions of nitrogen trifluoride were recorded in Poland.

In accordance with the classification prepared by Intergovernmental Panel on Climate Change (IPCC), in 2022 the sector most responsible for greenhouse gas emission was the energy one (83.9% of total emission) and in a smaller scope – agriculture (8.8%), industrial processes and product use (6.2%) as well as waste management (1.0%). Carbon dioxide emission, as the dominant greenhouse gas, was mainly affected by energy sector (93.5%) as well as industrial processes and product use (5.8%).

In 2007, the European Commission presented the so-called climate and energy package, which, among others, differentiated greenhouse gas emission reduction targets for sectors covered and not covered by the EU Emissions Trading System (EU ETS). For sectors not covered by the ETS, the so-called non-ETS sectors[8], 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 EEA data, in 2020, the total greenhouse gas emissions expressed in CO_2 equivalent in non-ETS sectors in Poland were 205.1 million tonnes, which was a 14.0% increase in comparison with 2005.

In the years 2021–2030, EU Member States, in accordance with the so-called ESR Regulation[9], will jointly fulfil the obligation to reduce greenhouse gas emissions resulting from the Paris Agreement. In the case of emissions covered by the EU ETS, Poland, like other EU countries, does not have a national reduction target for the years 2021–2030 imposed on these emissions, because the limit for these emissions is imposed at the level of the entire EU system, and emissions within this limit are settled directly by operators of installations. Poland, on the other hand, like other Member States, will settle the part of greenhouse

[8] Non-ETS emissions include the following sectors: transport, agriculture, waste, industrial emissions outside the EU ETS and the municipal and housing sector with buildings, small sources, households, services, etc.
[9] Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013.

gas emissions related to non-ETS sectors (i.e. not covered by the EU ETS system), including indirect CO_2 emissions[10] (included in non-ETS emissions).

Based on the provisions of the ESR Regulation, Annual Emission Allocations[11] (AEA) were determined in non-ETS sectors for EU Member States for the years 2021–2030. Poland was allocated 204.4 million tonnes of CO_2 equivalent for 2022, while the estimated emission amounted to 196.2 million tonnes of CO_2 equivalent. This means that it was below the limit by over 8 million tonnes of CO_2 equivalent. However, it should be borne in mind that the settlement of non-ETS emissions will take place in 2027 for the entire period 2021–2025 after the EU review, which may result in a correction of greenhouse gas emissions and a possible revision of emissions in non-ETS sectors.

[10] Derived from the oxidation of NMVOCs (non-methane volatile organic compounds) emitted into the atmosphere from sector 2. Industrial processes.

[11] Defined in Commission Implementing Decision (EU) 2020/2126 of 16 December 2020 on setting out the annual emission allocations of the Member States for the period from 2021 to 2030 pursuant to Regulation (EU) 2018/842 of the European Parliament and of the Council.

Chapter 4

Environmental quality of life

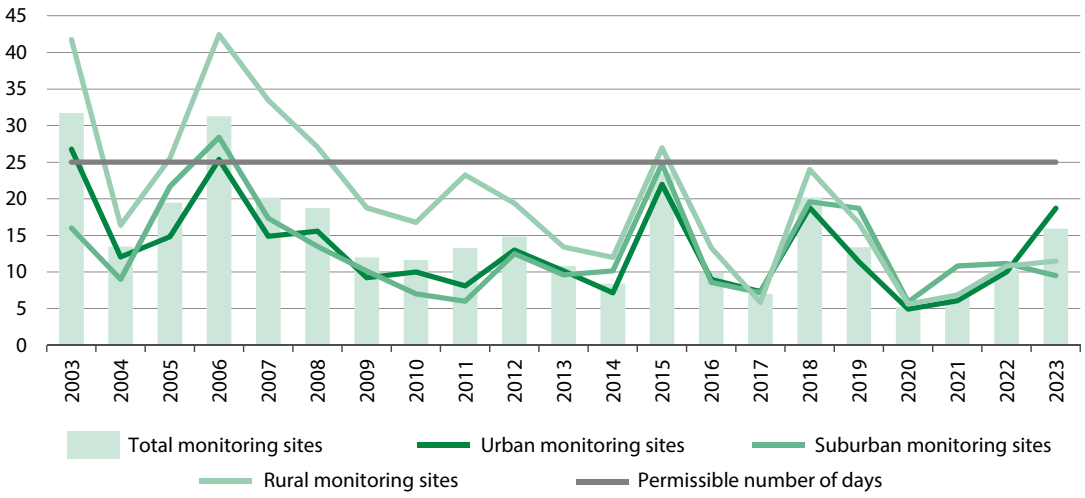
4.1. Gaseous air pollutants

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 pollution is one of the main causes of threat to environment. It affects all these: the environment, health condition and quality of life of population. It cannot be restricted by area, so that it 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 2023, 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 16 and was higher than one noted in 2022 – 10 days (chart 17). The years with the highest number of days exceeding the limit were 2003 – 32 days, 2006 – 31 days and 2015 – 24 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 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 2023 this indicator in Poland in agglomerations over 250 thousand inhabitants equalled 4093.5 µg/m^3 and it was higher than in 2022 and 2004 (chart 18).

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

a In agglomerations over 250 thousand inhabitants.

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

Exposure of humans (especially children, the elderly, and people spending much time outdoors) to high concentrations of tropospheric ozone causes numerous negative health conditions. It can lead to eye irritation, 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 ozone exposure attributed to 1.9 thousand premature deaths in Poland in 2021. Among European Union countries, the worst situation in this respect occurred in Italy (5.1 thousand) and Germany (3.3 thousand), while the best in Luxembourg (0.01 thousand), Estonia and Malta (0.03 thousand each).

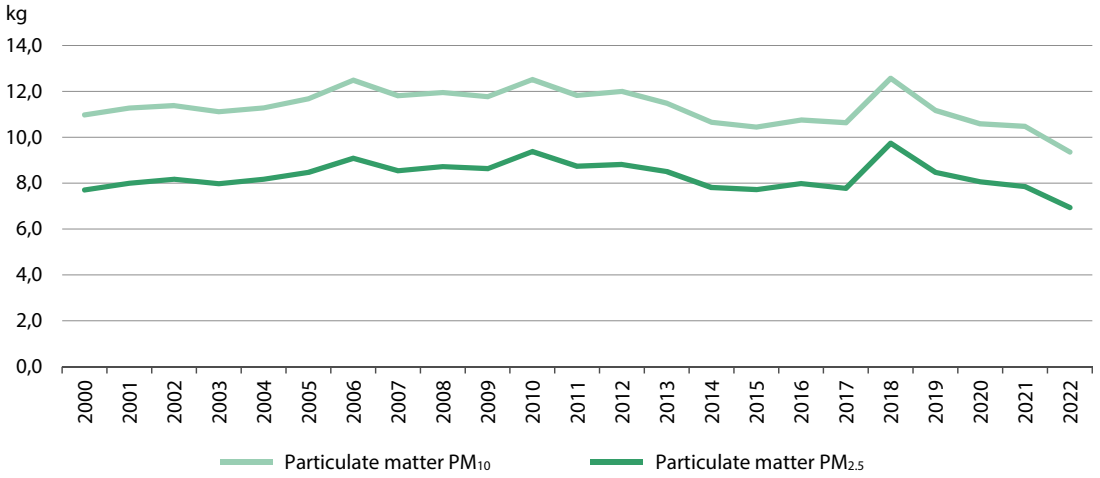
4.2. Particulate air pollutants

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 a 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 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 the 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 2022, PM_{10} emission amounted to 353.7 thousand tonnes and was lower in relation to the previous year and 2000 by 11.0% and 15.7% respectively. In the case of $PM_{2.5}$, its emission equalled 262.3 thousand tonnes and decreased by 12.0% in relation to 2021 and by 11.0% compared to 2000. Per capita in 2022, the emission of PM_{10} was 9.4 kg, of which $PM_{2.5}$ – 6.9 kg and the figures for these were the lowest in relation to the ones noted since 2000 (chart 19).

Chart 19. Emissions of PM_{10} and $PM_{2.5}$ per capita



Source: data concerning particulate matter emission – the National Centre for Emissions Management – the Institute of Environmental Protection – National Research Institute.

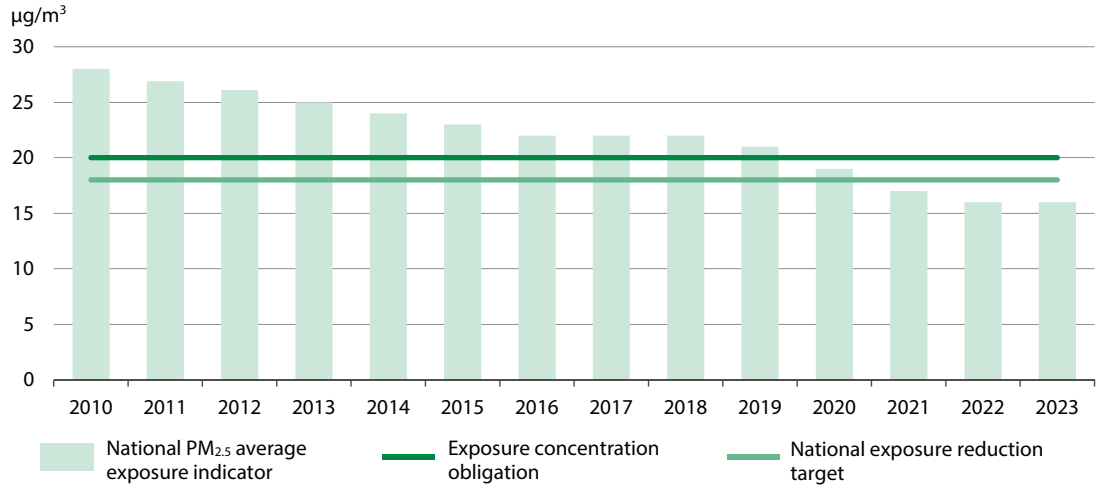
In the European Union countries, on the basis of the European Monitoring and Evaluation Programme (EMEP) data, the indicator in 2022 was 4.4 kg for PM_{10} and 2.9 kg for $PM_{2.5}$ respectively. The highest PM_{10} emissions, including $PM_{2.5}$ per capita, were recorded in Latvia (14.0 kg and 9.1 kg respectively) and Poland (9.6 kg and 7.1 kg), while the lowest ones in the Netherlands (1.5 kg and 0.8 kg), Germany (2.2 kg and 1.0 kg) and Cyprus (2.2 kg and 1.1 kg).

In 2022, in Poland the highest direct emission of PM_{10} was caused (according to the Nomenclature for Reporting) by fuel combustion processes, which were responsible for 76.2% of the national PM_{10} emissions. Among these processes, the emissions from "other sectors" category (i.e. from institutions, trade, services, households, fuel combustion in agriculture, forestry and fishing) were dominant – their share in the national PM_{10} emissions amounted to 67.6%. Emissions of this particulate matter came mainly from heating of buildings with hard coal and wood by households. In 2022, other significant sources of PM_{10} emissions were agriculture sector (which generated 10.7% of total emissions of particulate matter of this kind) as well as industrial processes (9.0%).

$PM_{2.5}$ particulates (just like PM_{10}) were mostly emitted during fuel combustion processes, which accounted for 92.9% of their total emission in 2022. Within combustion processes the biggest share was in "other sectors" category (84.6% of the total $PM_{2.5}$ emission), followed by transport (with its 4.0% share).

The national $PM_{2.5}$ average exposure indicator is determined on the basis of measurements obtained under the State Environmental Monitoring in 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 2023, the indicator amounted to 16 $\mu g/m^3$ and remained at the same level as in the previous year (chart 20). The year 2023 was the third one in a row when the indicator did not exceed the national exposure reduction target (18 $\mu g/m^3$) which was planned to be achieved until 2020. In addition, the value of the national average exposure indicator in 2023 was 20.0% below the exposure concentration obligation (20 $\mu g/m^3$), which is the air quality standard to be provided since 2015.

Chart 20. National $PM_{2.5}$ average exposure indicator



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

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 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 2021 $PM_{2.5}$ exposure led to 47.3 thousand premature deaths in Poland and it was the highest value among European Union countries. High value was also recorded in Italy (46.8 thousand). The least premature deaths due to this reason was estimated in Estonia and Luxembourg (0.1 thousand each) as well as Finland and Malta (0.2 thousand each).

4.3. Noise[1]

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.

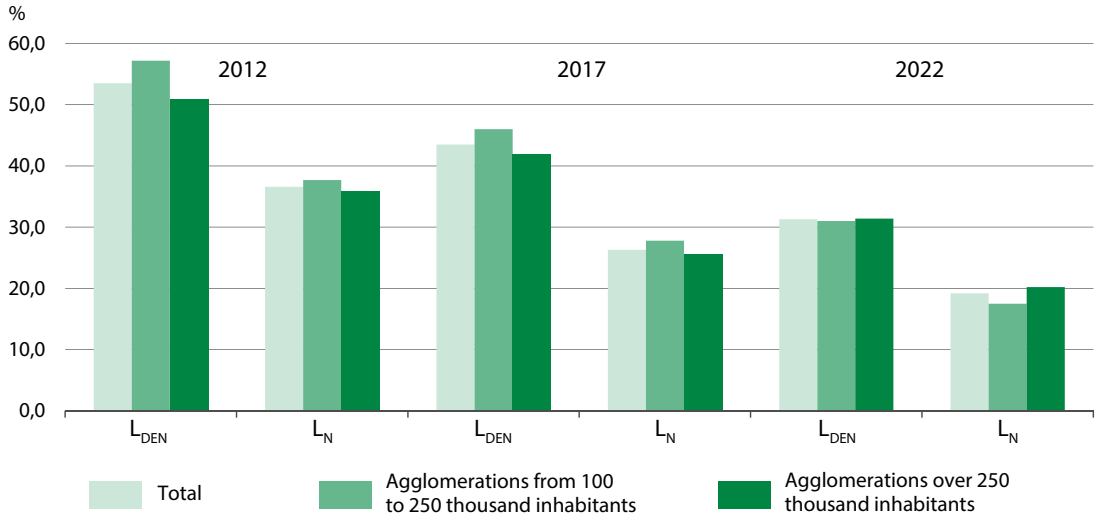
Reducing noise in environment is a long-term process. Limitation of noise to the permissible levels is one of the greatest challenges that Poland is facing.

[1] The assessment of the acoustic state of the environment and the observation of changes is carried out obligatorily every 5 years as part of the State Environmental Monitoring (PMŚ) by the Chief Inspectorate of Environmental Protection. The last assessment took place in 2022.

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 2022, 31.3% of population of cities[2] over 100 thousand inhabitants was exposed to exceeding noise over 55 dB in day-evening-night time (L_{DEN} indicator) (chart 21). In night time (L_N indicator) the situation was a bit better, as 19.2% of city population was exposed to the noise exceeding 50 dB. In comparison to 2017 and 2012, the situation improved, as in day-evening-night time, the percentage of people exposed to excessive noise decreased by 12.2 pp and 22.2 pp respectively, and in night time by 7.1 pp and 17.4 pp respectively.

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

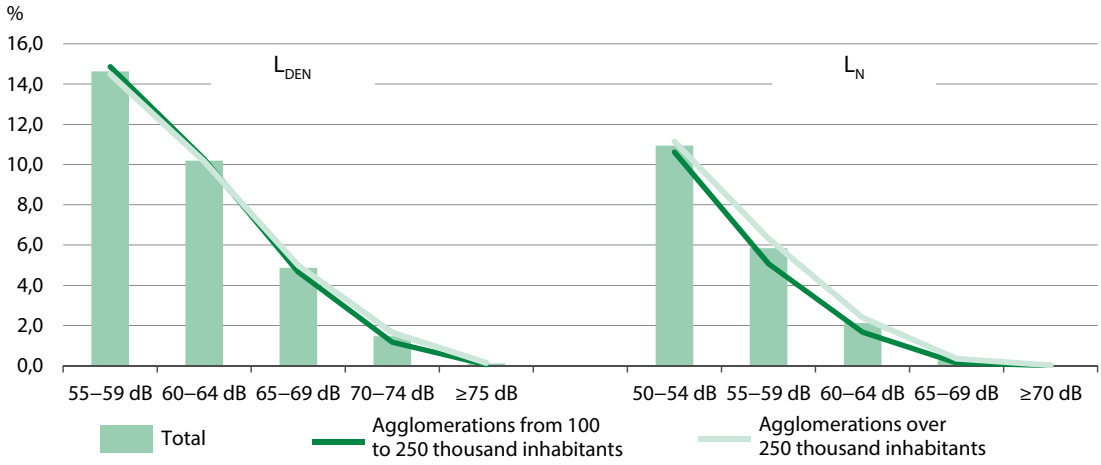


Source: data of the Chief Inspectorate of Environmental Protection obtained under the State Environmental Monitoring based on acoustic maps.

Monitoring of road traffic noise in agglomerations carried out in 2022 proves that the highest percentage of population was exposed to noise exceeding the norm by up to 5 dB in day-evening-night time – 14.6% and in night time – 10.9% (chart 22). In relation to 2017 and 2012, this percentage decreased in day-evening-night time by 4.6 pp and 5.8 pp respectively and in night time by 3.8 pp and 6.6 pp respectively.

[2] The study based on acoustic maps in 2012, 2017 and 2022 covered respectively 35, 37 and 36 agglomerations with over 100 thousand inhabitants.

Chart 22. Percentage of population exposed to road traffic noise in agglomerations in particular classes of noise levels in 2022



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

Railway noise

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

Based on data from acoustic maps obtained in 2022, 366.3 thousand population in the area of 35 out of 36 agglomerations (covered by the study) over 100 thousand inhabitants was exposed to excessive noise above 55 dB in day-evening-night time and in night time – 267.8 thousand population was exposed to noise above 50 dB. They constituted 3.7% and 2.7% respectively of total population of the cities, whose inhabitants were exposed to railway noise. In relation to 2017 (when this percentage was at the level of 2.3% and 1.4%) the situation worsened, but was more favourable than in 2012 (4.2% and 3.2%).

Aviation noise

Aviation noise concerns a relatively small number of population of Poland, residing in the zones located near airports, yet, it seems to be causing most disturbance.

Aviation noise study based on acoustic maps in 2022 concerned 12 agglomerations with an airport located within their boundaries (in 2017 – there were 6 agglomerations and in 2012 – 5). The number of population exposed to this type of noise was significantly dependant on the part of the day. In day-evening-night time 43.9 thousand residents of 8 out of 12 agglomerations suffered noise exceeding 55dB (i.e. 1.1% of total population of the agglomerations, whose inhabitants were exposed to aviation noise), whereas in night time 8.7 thousand population (i.e. 0.2%) suffered noise over 50 dB. A comparison of these data and data from 2017 and 2012 shows an improvement in day-evening-night time because the number of population exposed to aviation noise decreased (by 15.7% and 28.2% respectively). The situation reversed in the case of noise pollution in night time as the number of population exposed to this kind of noise increased by 46.8% in relation to 2017 and more than twice compared to 2012.

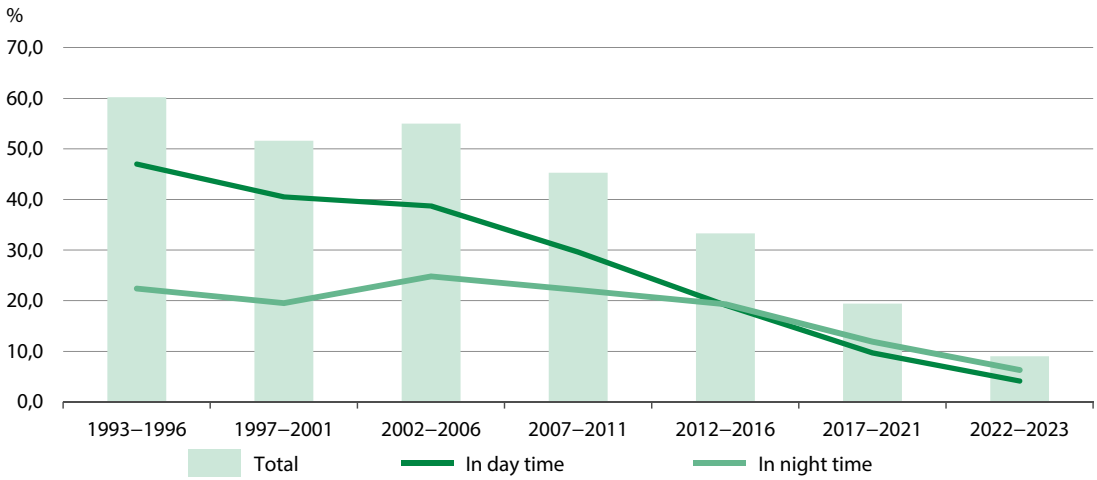
Industrial noise

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.

According to the data of the Chief Inspectorate of Environmental Protection obtained under the State Environmental Monitoring based on acoustic maps in 2022, 11.4 thousand of population noted industrial noise exceeding 55dB in day-evening-night time in 26 out of 36 agglomerations (covered by the study) in Poland. In night time the noise above 50 dB caused disturbance to 7.7 thousand of population, which is a relatively small percentage of total population of the analysed agglomerations (0.2% and 0.1% respectively).

In the case of entities exceeding industrial noise limits, in the years 1993–2023, positive trends were noted in terms of the share of these entities in total number of inspected companies (chart 23). In each period of noise monitoring leading to the assessment of acoustic climate changes, a significant fall in this percentage was noted (from 60.2% within the years 1993–1996 to 9.0% in the period from 2022 to 2023), in day time in particular (similarly – from 47.0% to 4.1%). In night time, the percentage of units exceeding the permissible sound levels decreased from 22.4% to 6.3%. It is worth noting, however, that years 2022–2023 comprise only two years of a new 5-year monitoring period (2022–2026) and only an analysis of a set of data for the entire period will make it possible to assess the trends clearly.

Chart 23. Share of entities exceeding industrial noise limits in total number of inspected companies[a]



a Included in the central register of acoustic climate control of the Institute of Environmental Protection.
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 in Poland the percentage of households affected by excessive noise is diminishing year by year (from 21.4% in 2005 to 9.3% in 2023), which can be indicative of the fact that population is getting used to surrounding noise or the noise is effectively eliminated. 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 – 8.2% in relation to the latter – 10.6% in 2023.

According to Eurostat estimates, in 2023, in European Union countries 18.2% of households suffered from excessive noise. The lowest, most favorable value of the indicator was recorded in Croatia (6.7%), Slovakia (8.6%), Bulgaria (8.7%) and Poland (9.3%). In contrast, the highest percentage of such households occurred in Malta (31.3%), Luxembourg (30.2%) and Portugal (28.7%).

4.4. Access to drinking water

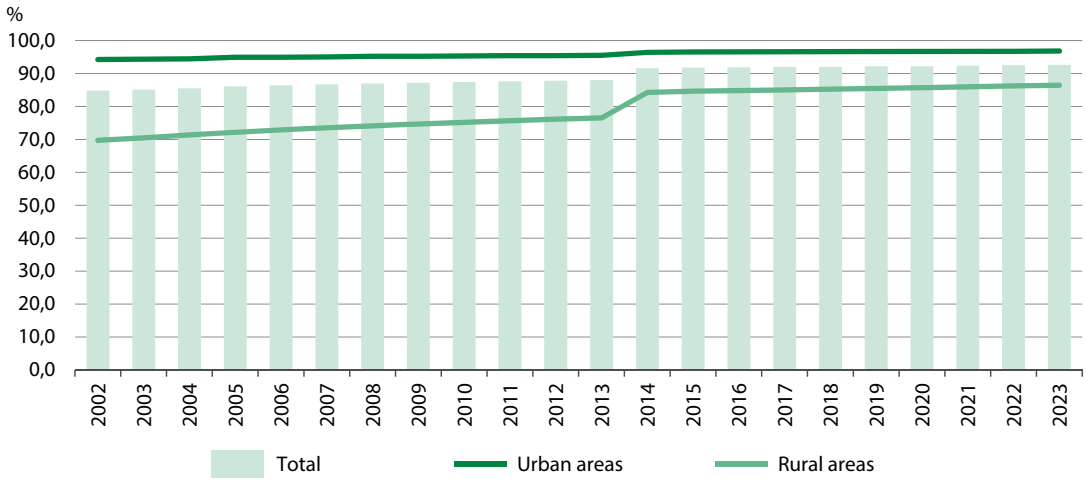
Population using water supply network is the estimated number of population inhabiting residential buildings and collective accommodation facilities connected to water supply network as well as population using water supply systems via street and yard outlets (devices installed to street water supply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

Basic measurement of assessing changes towards making the economy greener in terms of water management is the indicator concerning population using water supply network.

In 2023, 92.6% of population used water supply network, which is an increase in relation to 2022 and 2002 by 0.1 pp and 7.8 pp respectively (chart 24).

Chart 24. Percentage of population using water supply network



In the period of 2002–2023 a positive trend in using 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 2023, the indicator in mind equalled 96.8% and 86.4% 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 2002–2023 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 99.8% in 2023.

In 2022, among European Union countries (with the exception of Croatia, for which data is not available), according to the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene estimated data, the lowest percentage of the population using safely managed drinking water services was recorded in Romania (82.1%), Poland (88.9%) and Italy (92.7%). The best situation in this regard was recorded in the Netherlands and Hungary, where the discussed indicator was at the level of 100%.

4.5. Municipal sewage treatment

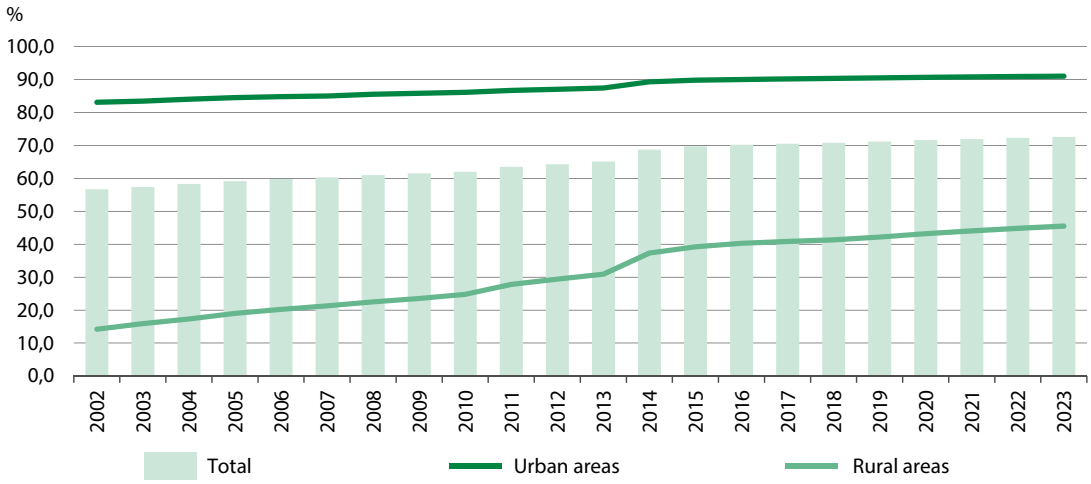
Population using sewage network is the estimated number of population inhabiting residential buildings and collective accommodation facilities connected to sewage network as well as population using sewage system via sewage inlets.

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.

The assessment of changes towards making the economy greener in terms of sewage management can be made, among others, on the basis of data concerning the percentage of population using sewage network.

In the period 2002–2023 the percentage of population using sewage network (chart 25) grew constantly. In 2023, 72.6% of population used this form of sewage disposal and in comparison to 2002, the share increased by 15.9 pp. Greater changes were noted in rural rather than urban areas. In 2023, this indicator in the cities amounted to 91.0% and was by 7.9 pp higher than in 2002. In rural areas the percentage of population using sewage network increased more than threefold over the last 21 years, from 14.2% in 2002 to 45.5% in 2023.

Chart 25. Percentage of population using sewage network



In 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 other 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 409.9 thousand pieces in 2023. This number calculated per 1000 population not using sewage network grew over 11 times (from 3.49 in 2008 to 39.71 in 2023).

Based on the estimated data from the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene, in 2022, EU countries (with the exception of Croatia and Latvia, for which data are not available) with the lowest percentage of population using safely managed sanitation services were Bulgaria (73.5%) and Cyprus (76.8%), while the highest: Austria (99.7%) and Denmark (98.8%). According to WHO/UNICEF estimates, Poland was 3rd among EU countries with a ratio of 97.9%.

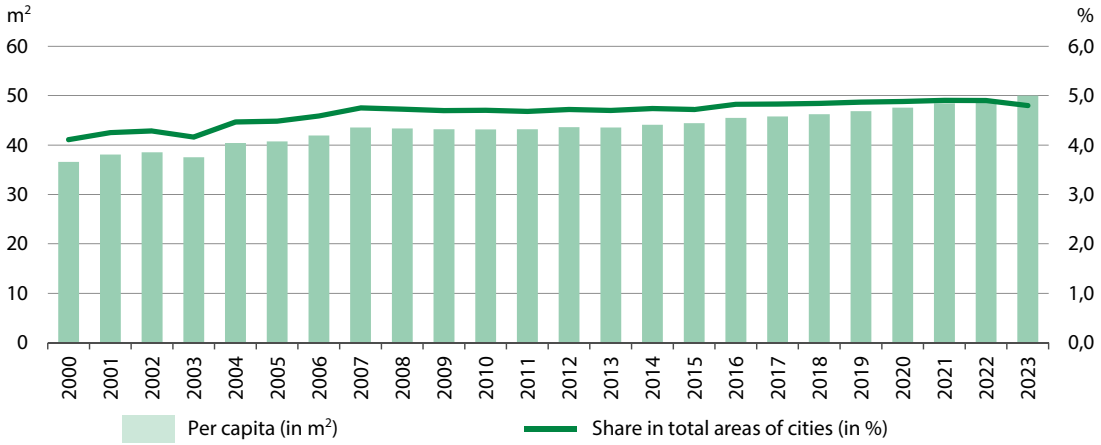
4.6. Green areas

Green areas in cities are 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 protective functions and in particular: strolling-recreational parks, lawns, street greenery, 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, they 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 areas, which include, i.a. greenery along railway tractions, airport and industrial facility greenery, and since 2005 – cemeteries.

In 2023, green areas in cities amounted to 111.8 thousand hectares. It means there were 50.0 m^2 of green areas per capita (chart 26), i.e. by 13.4 m^2 more than in 2000. The increase was mainly a result of enhancing street greenery and lawns as well as of the inclusion of cemeteries into green areas since 2005. In 2023, 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

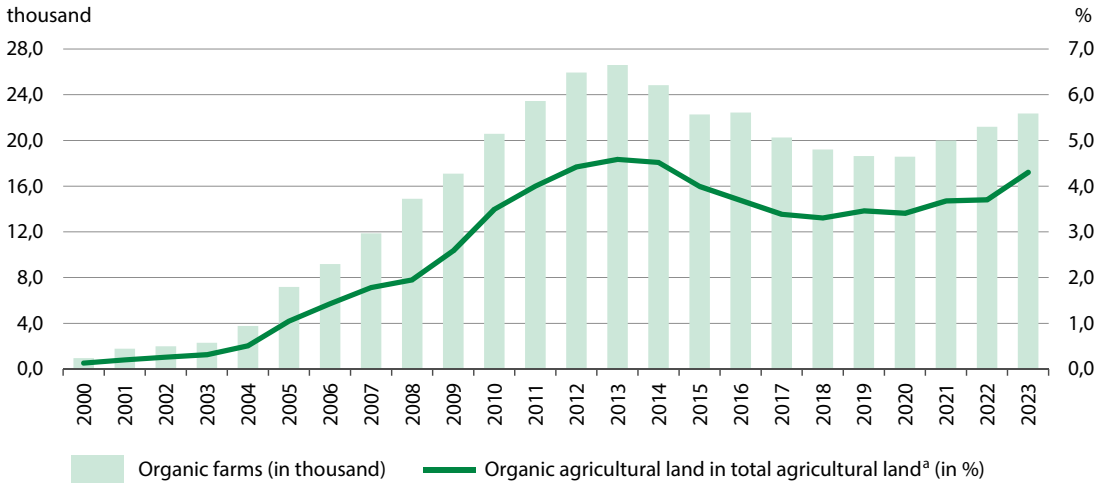
5.1. Organic farms

Organic farm is an agricultural holding, which has a certificate granted to it by a certification body after the conversion period and during the conversion period to organic methods of agricultural production under the control of the 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 2023, in Poland there were 22.4 thousand organic farms. They operated on 636.0 thousand hectares of agricultural land, i.e. 4.3% of total agricultural land. In relation to the previous year, their number and area increased by 5.5% and 14.7% respectively (chart 27). The average size of an organic farm was 28.5 hectares and was the highest since 2000. In the period from 2000, the largest number, as much as 26.6 thousand organic farms operated in 2013 on an area of 670.0 thousand hectares of agricultural land.

Chart 27. Organic farms and organic agricultural land



a To calculate the indicator for 2021–2022, data on total agricultural land in 2020 were used; for 2023 – preliminary data on total agricultural land in 2023.

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

Among EU countries, the highest share of organic agricultural land in the total agricultural area of a given country was recorded in Estonia (23.4%)[1], and the lowest – in Malta (0.6%). In this respect, Poland ranked 23rd among EU countries. In 2022, the largest number of organic farms operated in Italy (82.6 thousand), and the fewest in Malta (0.03 thousand).

[1] It should be noted that according to Eurostat database, in 2020, the country with the highest percentage of organic agricultural land was Austria (25.7%), for which data for 2021–2022 is not available.

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), and since 2023 from the Common Agricultural Policy Strategic Plan (CAP SP 2023–2027).

According to the data of the Agency for Restructuring and Modernisation of Agriculture, in 2023, the amount of payment for farms carrying out organic farming was PLN 822.5 million (as of 4 October 2024) and it was the highest amount of subsidies dedicated to organic farming in the years 2004–2023 . It increased in relation to the previous year by 57.0% and more than 23 times in comparison with 2004, when RDP 2004–2006 came into operation. Its share in the total amount of subsidies for farms (including agri-environment-climate actions and organic farming under the RDP 2014–2020 and agri-environment-climate interventions and organic farming under the CAP SP 2023–2027) equalled 42.0%.

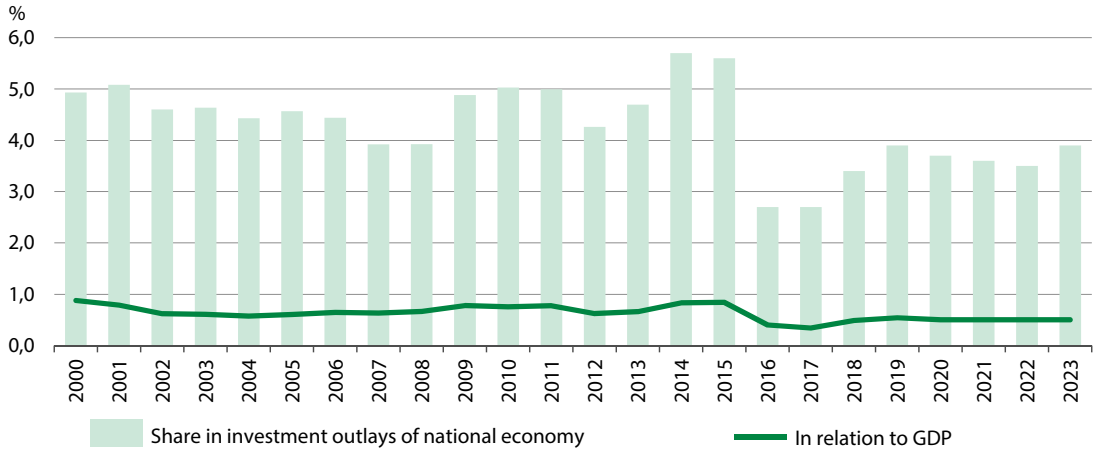
5.2. Outlays on environmental protection

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 2023, outlays on fixed assets for environmental protection (in current prices) amounted to PLN 18.2 billion, and were higher in relation to 2022 (by 30.8%) and 2000 (more than 2.5 times). In 2023, their share in relation to GDP (in current prices) equalled 0.5% (chart 28).

Chart 28. Outlays on fixed assets for environmental protection[a] (in current prices)



a GDP for 2023 – preliminary estimate.

In 2023, the share of outlays on fixed assets for environmental protection in investment outlays of national economy equalled 3.9%, which means an increase compared to 2022 (by 0.4 pp), but a decrease to 2000 (by 1.0 pp).

In 2023, economic entity own funds were prevailing in the financing structure and amounted to 55.2% of total outlays on fixed assets for environmental protection. The next financing sources were, among others, funds from the central budget – 13.1%, ecological funds – 12.5% and funds from abroad – 9.4%. The

majority of financial means were allocated to wastewater management and protection of water (46.1%), protection of air and climate (26.6%) as well as waste management (10.6%).

Households also incur expenditures on environmental protection. They are not subsidised and as a whole constitute a burden on a household budget. In 2023, the expenditures (in current prices) amounted to PLN 59.9 billion. Per capita they equalled PLN 1589 and were by 12.8% higher than in 2022 and almost 4 times higher than in 2000.

According to Eurostat, in 2021, national expenditures on environmental protection in European Union countries amounted to EUR 321.4 billion. In relation to GDP they accounted for 2.2%. Poland was among the top EU countries with the highest share of this type of expenditure in GDP at the level of 2.4%, following Austria (3.6%), Belgium (3.3%) and Italy (2.6%). Ireland and Luxembourg had the lowest share (0.9% each).

5.3. Environmental taxes

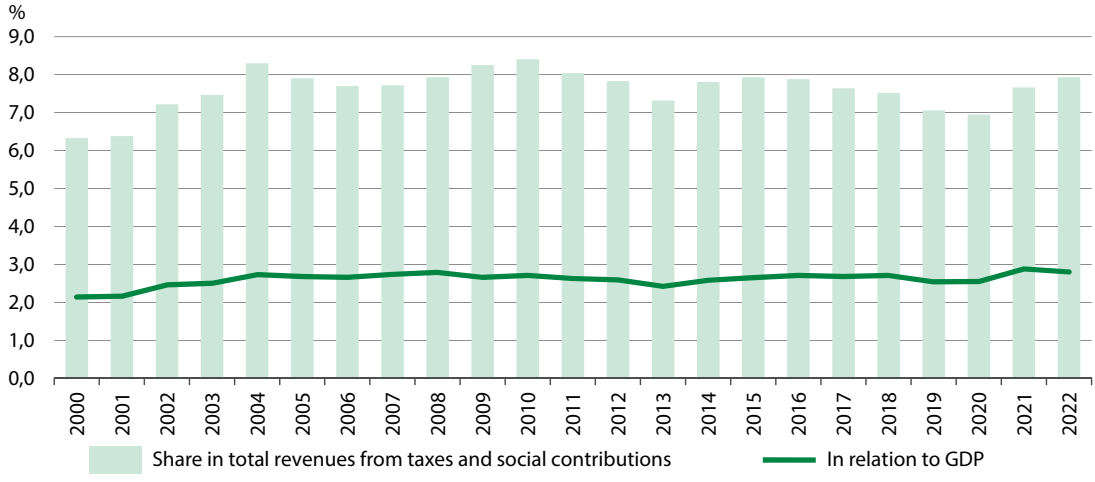
Environmental tax is a tax whose tax base is a physical unit (or a proxy of it) of something that has a proven, specific negative impact on the environment, and which is identified in ESA 2010 as a tax.

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 a Eurostat methodology, environmental taxes distinguish four different categories of taxes in division by type, i.e. energy, transport, pollution and resources.

In 2022, revenues from environmental taxes amounted to PLN 85.9 billion and constituted 7.9% of the total revenue from taxes and social contributions (chart 29). They were higher both in relation to the previous year (by 0.2 pp) and 2000 (by 1.6 pp). In the analyzed year, the ratio of environmental taxes to GDP was 2.8% and decreased compared to the previous year (by 0.1 pp), but increased in relation to 2000 (by 0.7 pp).

Among environmental taxes, the major fiscal impact exerted energy taxes, which contributed 91.2% of revenue from environmental taxes, and transport taxes – 5.7% of the revenue.

Chart 29. Environmental taxes



Source: Eurostat database (access date 4 November 2024).

According to Eurostat data, in 2022, in European Union countries the total amount of environmental taxes was EUR 320.8 billion. Their share in total revenues from taxes and social contributions amounted to 4.9%, and in relation to GDP – 2.0%. In the structure of taxes by type, energy taxes dominated, representing 77.4% of total environmental taxes, followed by transport taxes (18.7%).

The leading countries of EU with the highest share of environmental taxes in total revenues from taxes and social contribution were Bulgaria (15.3%) and Romania (10.1%). The lowest share was noted in Norway (3.0%) and Luxembourg (3.2%). In relation to GDP the highest share of these taxes was recorded in Greece (5.6%) and Bulgaria (4.8%), while the lowest in Luxembourg (0.9%). Poland was 5th among EU countries in this respect. In all Member States, energy taxes prevailed among environmental taxes – their highest percentage was recorded in Czechia (97.9%) and Luxembourg (91.7%), and the lowest – in the Netherlands (49.4%) and Malta (50.3%).

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 making the economy greener, 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 2023, intramural expenditures on R&D activity amounted to PLN 53.1 billion and increased by 18.8% in relation to 2022 and more than 11 times compared to 2000.

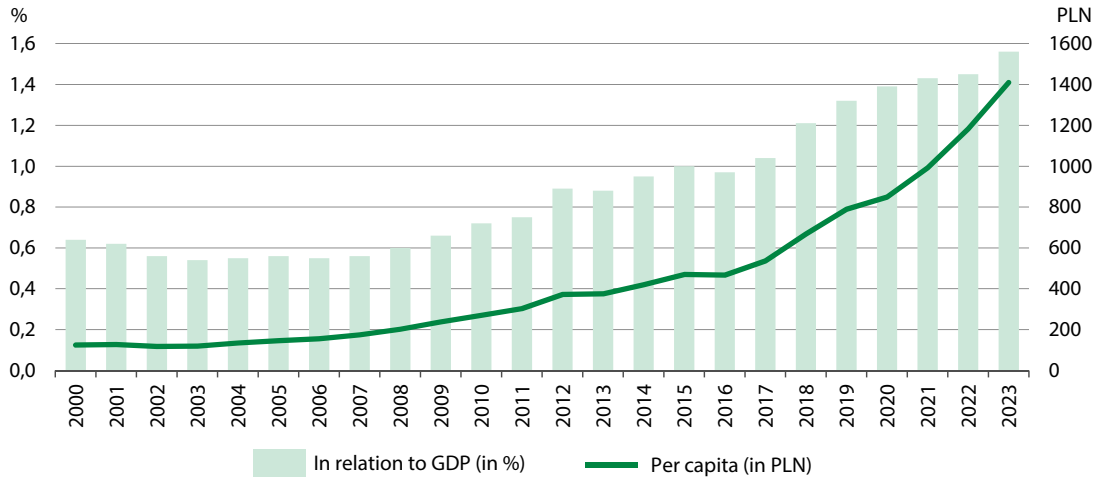
Entities in R&D are grouped in four sectors of performance, i.e. business enterprise, government, higher education and private non-profit. In 2023, the highest intramural expenditure on research and experimental development among the sectors of performance were incurred by the business enterprise sector. Expenditure of this sector accounted for 64.6% of gross domestic expenditure on R&D, whereas the share of higher education sector was 33.4%.

In 2023, as in previous years, the main sectors funding R&D activity were the business enterprise sector and the government sector, whose funds accounted for 54.8% and 31.9% of total internal expenditure on R&D respectively.

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––2023, the minimum value of the indicator was recorded in 2003 (0.54%), while the maximum in 2023 (1.56%).

According to estimated Eurostat data, in 2022, research and development intensity in EU countries amounted to 2.27%, and among individual Member States ranged from 0.46% in Romania to 3.47% in Sweden. Poland, with the indicator at the level of 1.45%, took 15th position among EU countries.

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



a Intramural, excluding depreciation of fixed assets.

While analysing R&B expenditure per capita, since 2003 a growing tendency has been noted in Poland (except for 2016). In 2023, it amounted to PLN 1409, i.e. by 19.2% more than in the previous year and over 11 times more in comparison with 2000.

According to estimated Eurostat data, in 2022, gross domestic expenditure in research and development activity (GERD) per capita in European Union was EUR 812.8. The highest expenditure of this type per capita was recorded in Ireland (EUR 2231.5), Denmark (EUR 1866.2) and Sweden (EUR 1833.1), while the lowest in Romania (EUR 68.5) and Bulgaria (EUR 99.8). Poland, with index value of EUR 258.6, took 18th place among EU Member States.

Activity to protect environment so as to restore or maintain environmental sustainability require financial means. In 2023, within expenditures on fixed assets for environmental protection it was spent as much as PLN 1.3 million on research and development activity in Poland. They were lower than in the previous year and 2000, by 89.8% and 87.2% respectively. Such a significant decline in the value of expenditure on research and development activities in 2023 was influenced, among others, by the completion in the previous year of large multi-year investments carried out by entities incurring expenditure for this purpose and a reduction in the number of entities implementing this type of investments.

5.5. Inventions and patents

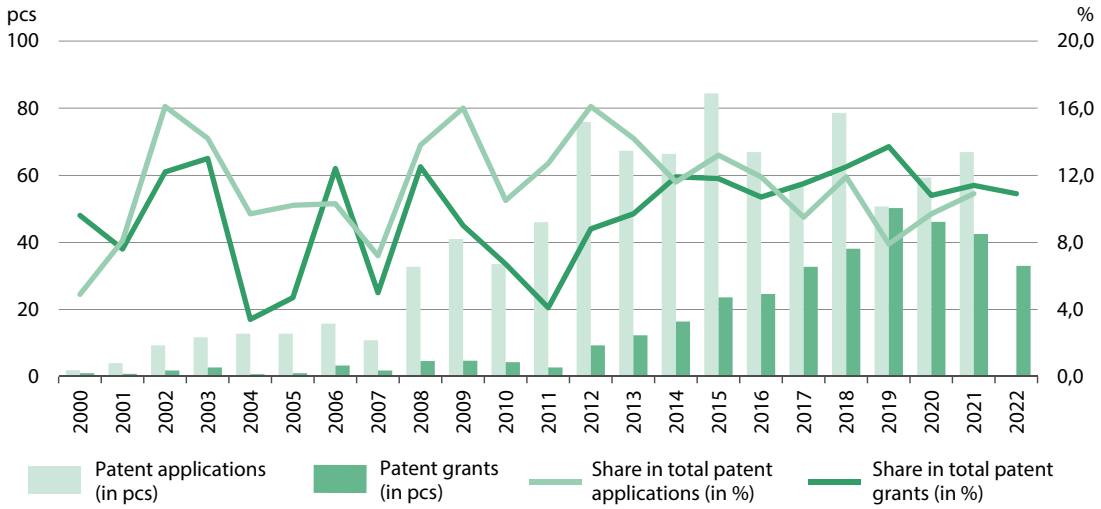
Patentable invention is a new solution of a technical problem which involves an inventive step (i.e. it is not directly derived from the state-of-the-art – it is not obvious) and is industrially applicable. **Patent** is the exclusive right granted for inventions by a competent international body (e.g. the European Patent Office) or a national authority (in Poland – by the Patent Office of the Republic of Poland).

Patent applications and grants are classified according to the International Patent Classification (IPC). 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 and 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 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 2021, according to OECD database, Polish residents filed 67 patent applications in 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 84 patent files. The percentage of patent applications in environment-related technologies in comparison to the total patent applications filed by Polish residents in 2021 comprised 10.9%, i.e. higher than in the previous year and 2000 by 1.2 pp and 6.0 pp respectively.

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



a Based on fractional counting to eliminate multiple counting of patent applications/grants (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 (access date 2 October 2024).

In 2021, residents of EU countries filed 7.0 thousand patent applications in environment-related technologies to the European Patent Office, which accounted for 14.8% of total number of inventions. The most active countries in this respect were Germany, with 2739 inventions of this type, i.e. 39.2% of total patent applications in environment-related technologies reported in European Union, France – 1271 (18.2%) and Denmark – 500 (7.2%). Poland, with a share of 1.0% of the total number of patent applications in environment-related technologies in the EU, came 11th.

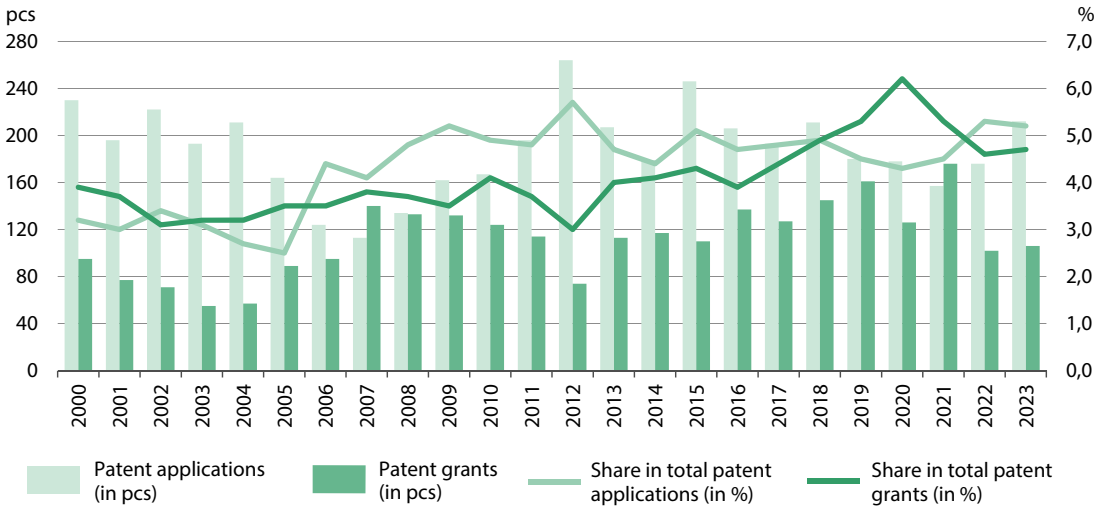
In 2022, the European Patent Office granted 33 patents in environment-related technologies to Polish residents. These patents constituted 10.9% of the total number of patents granted to Polish residents. In relation to the previous year their share decreased by 0.5 pp, but increased in comparison with the year 2000 by 1.3 pp.

In 2022, in European Union EPO granted 4.0 thousand patents in environment-related technologies, which accounted for 12.9% of total number of patents. Most of them were granted to Germany – 1632, i.e. 40.9% of all patents granted in environment-related technologies in European Union as well as to France – 729 (18.3%). Poland, with a share of 0.8% of total number of patents in environment-related technologies in the EU, achieved 11th position among 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 2023, the total number of patent applications in environmental technologies submitted to the Patent Office of the Republic of Poland equalled 212 (of which by domestic entities – 207), which constituted 5.2% of total patent applications. It is an increase by 20.5% in relation to the previous year, but a decrease to 2000 by 7.8%. From 2000 to 2023 the highest number of this type of inventions was noted in 2012 – 264 (5.7% of total patent applications). The greatest number was submitted by domestic entities – 253.

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 (according to the database as of 24 September 2024).

The Patent Office of the Republic of Poland, in 2023, granted 106 environmental technology patents, of which 103 ones to domestic entities. Compared to the previous year and the year 2000, their number increased by 3.9% and 11.6%. Their share in total patent number constituted 4.7%. The highest score of this type of patents – 176 was noted in 2021. They accounted for 5.3% of all patents granted.

5.6. Eco-innovation

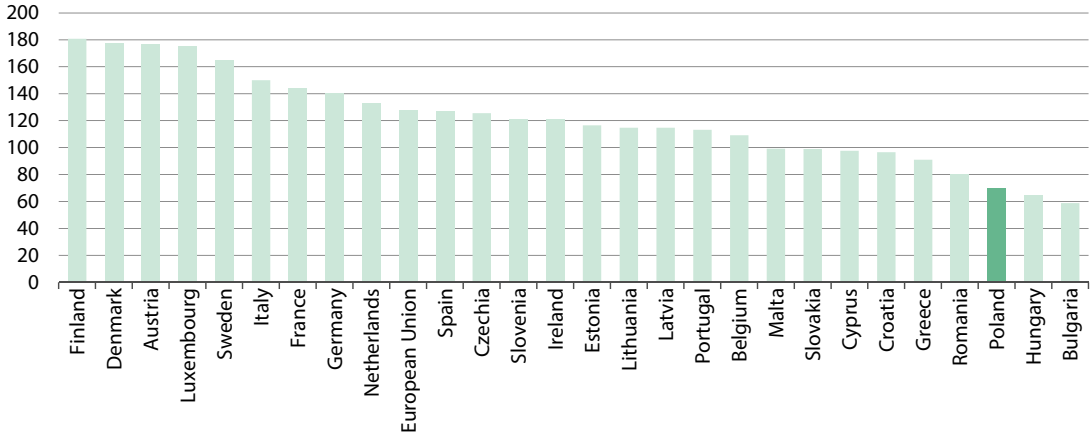
Eco-innovation is a new or significantly improved product (goods or service), process, organizational or marketing method, which brings benefits to environment.

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 competitiveness of the entity.

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 12 indicators grouped according to 5 thematic areas. It comprehensively compares eco-innovation results achieved by individual EU countries in 2024 compared to the EU average in 2014 (EU 2014=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 2024, it came in 25th position (with a score of 69,7) in the eco-innovation ranking of EU countries. Together with Bulgaria, Hungary, Romania, Greece, Croatia, Cyprus, Slovakia and Malta it was classified to the group of "countries catching up in eco-innovation", achieving results below 100% of the EU average from 2014.

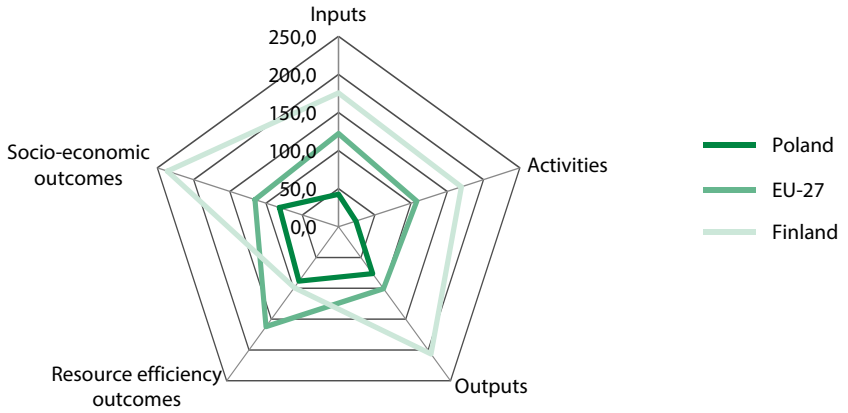
Chart 33. Eco-innovation index 2024 (EU 2014=100)



Source: data of the European Commission – https://green-business.ec.europa.eu/eco-innovation_en (access date 14 November 2024).

While analysing the results in 5 thematic areas in the field of eco-innovation (chart 34), it can be stated that, in 2024, the relatively strongest areas of Polish eco-innovation, in which Poland took 22nd position against the background of EU countries, were: socio-economic outcomes, being the result of introducing eco-innovations (with a score of 81.5), eco-innovation outputs (76.0) and incurred eco-innovation inputs (42.7). In the case of the group of indicators presenting resource efficiency outcomes, Poland was ranked 25th (with a score of 88.2), whereas in terms of eco-innovation activities – 27th (24.0).

Chart 34. Poland against the background of the EU and Finland (the country with the highest eco-innovation index) in 5 thematic areas in 2024 (UE 2014=100)



Source: data of the European Commission – https://green-business.ec.europa.eu/eco-innovation_en (access date 14 November 2024).

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

5.7. Green technology

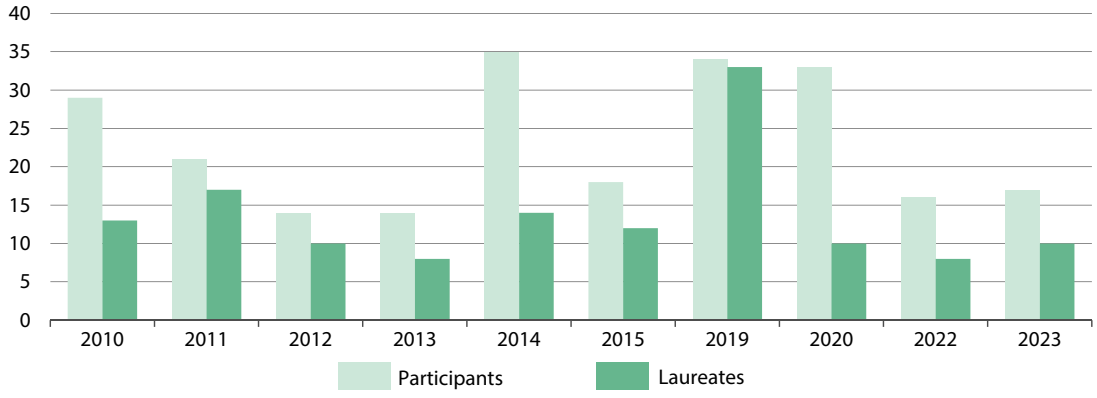
Green Technology Accelerator (GreenEvo) is an innovative project of the Ministry of Climate and Environment whose aim is both to promote the development of environment protection technology sector offered by Polish entrepreneurs and to transfer green technologies within Poland and abroad.

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 within Poland and abroad. Entities taking part in the Accelerator are given aid catering for their substantial and educational needs, such as participation in free trainings and the possibility for the laureates to present eco-technologies during national and foreign economic endeavours. 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. Since 2018, the GreenEvo program has been financed by the National Fund for Environmental Protection and Water Management.

In 2018, the Ministry of Environment resumed the implementation of the GreenEvo program– Green Technology Accelerator. The 7th edition of the program was intended only for the laureates of the previous GreenEvo editions and was aimed at using the existing potential of proven technologies of entrepreneurs who, together with the Ministry of Environment, had built the GreenEvo brand. In 2019, 34 participants took part in the competition (launched in 2018) and 33 winners were selected, while in 2020 – 33 and 10 respectively. In 2022, 16 participants joined the 9th edition of the program (launched in 2021), of whom 8 laureates were selected (chart 35). The competition was addressed to entrepreneurs who were laureates of the 7th or 8th edition of the Programme, as well as to new entrepreneurs who had not yet participated in the competition.

Chart 35. Participants and laureates of Green Technology Accelerator



Source: data of the Ministry of Climate and Environment.

In 2023, in the 10th edition of the GreenEvo program – Green Technology Accelerator, the Ministry of Climate and Environment prepared the competition to select new environmental technologies from nine areas of green technologies covered by the program, such as: renewable energy sources, environmentally friendly solutions for the mining industry, solutions supporting energy efficiency, systems supporting

monitoring, gathering and analysing information on the natural environment, on the processes and dependencies of sustainable development factors, technologies supporting air protection, technologies supporting the circular economy and waste management, water and sewage technologies, low-emission transport technologies and technologies supporting the protection of biodiversity and based on natural resources. The competition was open to entrepreneurs who: were not laureates of the program, were winners of the program and submitted a new technology that was not subject to assessment under the program or were winners of the Programme and submitted the same technology, but the technology was not covered by the program on the day of submitting applications. 17 participants entered the programme. The jury of the competition selected 10 laureates of modern solutions with a high potential for foreign growth and a positive environmental effect.

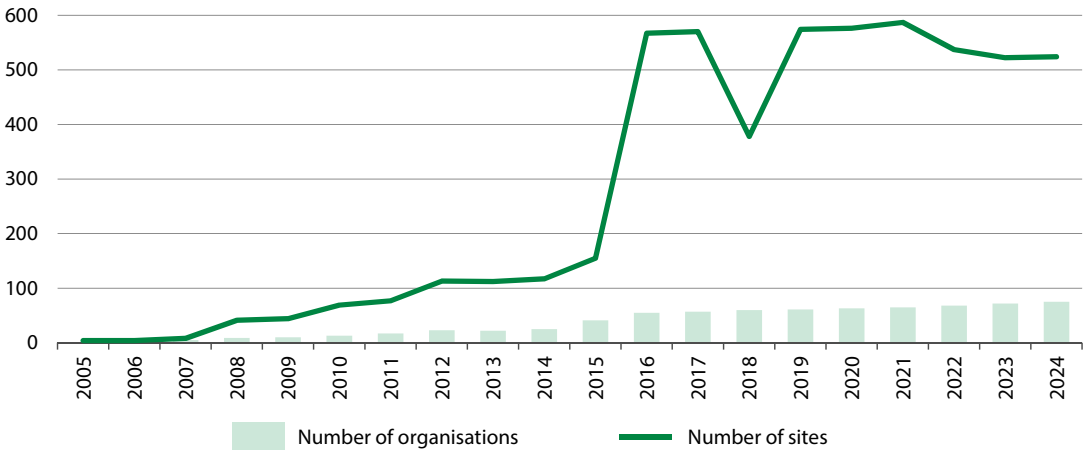
5.8. Eco-Management and Audit Scheme (EMAS)

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 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 public about 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. entities 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.

Chart 36. Organisations and their sites with Eco-Management and Audit Scheme (EMAS) registration[a]
As of 31 December



a Data for 2024 – as of 4 December.

Source: data for the years 2005–2021 – the EMAS register of the European Commission, https://webgate.ec.europa.eu/emas2/public/registration/list and data since 2022 – the EMAS register of the General Directorate for Environmental Protection, https://www.gov.pl/web/gdos/rejestr-emas (access date 4 December 2024).

According to the EMAS register of the General Directorate for Environmental Protection, as of 4 December 2024, 75 organisations and 524 sites of these organizations operated in the EMAS Eco-Management and Audit Scheme in Poland, i.e. 3 organisations and 2 sites more than at the end of 2023 (chart 36). It was the largest number of organisations in the years of operation of the EMAS system in Poland since 2005.

Based on data from the EMAS register of the European Commission, in European Union countries, as of the end of 2023, there were 3.8 thousand organisations and 14.4 thousand sites of these organisations operating in the Eco-Management and Audit Scheme, employing 2397.6 thousand persons. Most organisations of this type were registered in Germany – 1.1 thousand (2.5 thousand sites of these organisations and 1225.0 thousand employees) and in Italy – 1.1 thousand (6.1 thousand sites and 281.1 thousand employees), while in Latvia such units were not recorded at all. Organisations in the EMAS system in Poland constituted 1.8% of their total number in European Union countries, their sites – 3.8% of total number of sites in EU and employees working in these organisations and sites – 1.5% of their total number in 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 the 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.

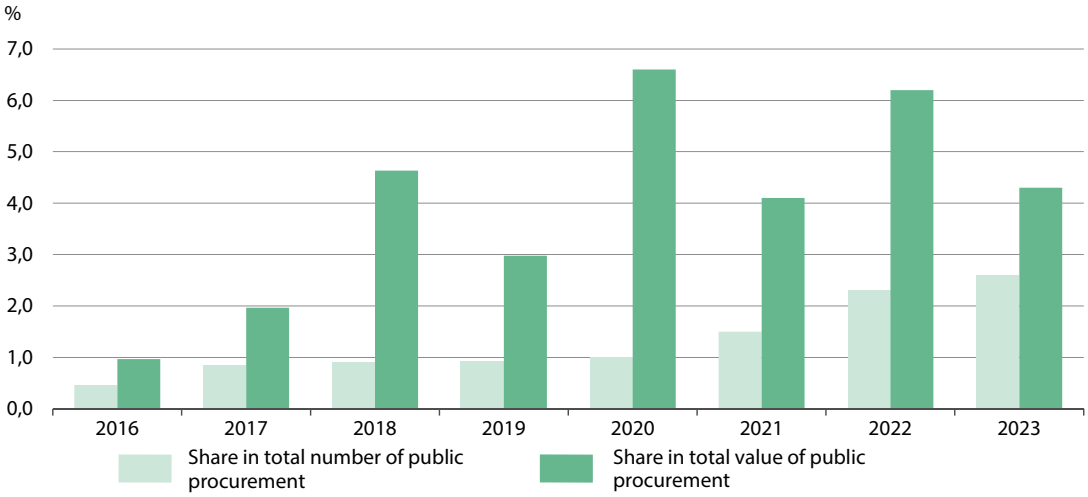
Public procurement sets production and consumption trends. Taking into account environmental criteria in public procurement may support the implementation of the state environmental policy. A significant demand of public authorities on greener products can lead to the creation or to the growth of environmentally 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[2]. 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 since 2016 are incomparable with the data for previous years and the scope of data presentation was limited to 2016––2023.

According to the data provided by contracting authorities to the Public Procurement Office, in 2023, 4.1 thousand green public procurement, i.e. taking into account environmental aspects, were awarded. Their share in the total number of public procurement was 2.6% (chart 37). Compared to the previous year and 2016, their number increased by 22.0% and more than 6 times respectively.

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

Chart 37. Green public procurement



Source: data of the Public Procurement Office.

The total value of green public procurement (excluding value added tax) amounted to PLN 11.9 billion, i.e. 4.3% of total value of awarded public procurement. It means that despite the increase in the number of green public procurement in relation to the previous year, its value decreased by 30.6%. Compared to 2016, this value increased more than 11 times.

Methodological notes

Information on the methodology of green economy research, of which the origins, definitions of green economy, subjective and objective scope, characteristics of main variables and indicators, as well as data sources are included in *Methodological report Green economy in Poland* available on Statistics Poland website at:
https://stat.gov.pl/obszary-tematyczne/srodowisko-energia/srodowisko/zeszyt-metodologiczny-zielona-gospodarka-w-polsce,18,1.html.

The methodology of the research is updated in connection with changes resulting from, among others, legal regulations, obtaining new data sources or method of data presentation.

Major changes compared to the *Methodological report* introduced in this edition of the research *Green economy in Poland* (as of 17 December 2024) are:

- freshwater resources: water exploitation index (WEI) due to unavailability of data was replaced by the indicator – water stress level. It determines the share of freshwater (underground or surface water) abstraction in total amount of available renewable freshwater resources (including water inflows from neighbouring countries). It illustrates the intensity of use of freshwater resources and provides information on the level of pressure exerted by humans on natural freshwater resources of a given territory. The data source is OECD database,
- greenhouse gas emissions: in Polish version variable name was clarified, in English version the variable name was left unchanged – greenhouse gas emissions in sectors not covered by the European Union Emissions Trading System (in non-ETS sectors). In addition, until 2022 edition of the research, the above variable was presented as an indicator defining the percentage change in total annual greenhouse gas emissions in non-ETS sectors compared to the emission level in the base year 2005, in order to monitor Poland's achievement of its emission reduction target by 2020. As Poland has entered the next emissions accounting period in the years 2021–2030, the final version of emission reduction targets has not yet been drafted. However, the values of annual emission allocations are being defined,
- particulate air pollutants: presentation in the research of indicator of urban population exposure to air pollution by PM_{10} has been declined due to the discontinuation of its release by the European Environment Agency and Eurostat (last available data for 2019).

Calculations per capita (1000 population etc.) were prepared using as the starting basis:
- for the years 2000–2009 – the results of the National Population and Housing Census 2002,
- for the years 2010–2019 – the results of the National Population and Housing Census 2011,
- since 2020 – the results of the National Population and Housing Census 2021.

Due to the rounding of data, in some cases component totals can slightly differ from the amount given in the item "total".

Statistical information originating from sources other than Statistics Poland is indicated in the appropriate notes.

Table 2 shows green economy monitoring indicators used in the research.

Table 2. Green economy monitoring indicators

Objective scope	Variable / indicator
Natural asset base	
Biodiversity	1. Share of areas under legal protection in total area of the country 2. Farmland Bird Index (FBI) 3. Forest Bird Index 4. Share of endangered species in total number of species
Land use	1. Agricultural land designated for non-agricultural purposes and forest land designated for non-forest purposes 2. Degree of reclamation / management of devastated and degraded land
Forest resources	1. Forest cover 2. Timber resources (growing stock of standing wood) 3. Removals 4. Share of damaged tree stands area in total forest area
Freshwater resources	1. Indicator of surface water availability per capita 2. Exploitable resources of underground waters 3. Level of water stress
Mineral resources	1. Share of hard coal extraction in hard coal resources 2. Share of lignite extraction in lignite resources 3. Share of natural gas extraction in natural gas resources
Environmental and resource productivity of the economy	
Water productivity	1. Consumption of water for needs of the national economy and population per capita 2. Water productivity index 3. Water use intensity of industry 4. Water use intensity of households
Domestic material consumption	1. Resource productivity index (GDP/DMC) 2. Domestic material consumption (DMC) per capita
Waste management	1. Share of recovered waste in total waste generated 2. Municipal waste collected per capita 3. Municipal waste collected separately in relation to total municipal waste 4. Recycling rate of municipal waste
Nitrogen and phosphorus balances	1. Gross nitrogen balance 2. Gross phosphorus balance
Energy productivity	1. Primary energy productivity indicator 2. Final energy intensity of economy
Renewable energy	1. Share of energy from renewable sources in gross final energy consumption
Greenhouse gas emissions	1. Greenhouse gas emissions (base year = 100) 2. Greenhouse gas emissions by sectors 3. Greenhouse gas emissions in sectors not covered by the European Union Emissions Trading System (in non-ETS sectors)

Table 2. Green economy monitoring indicators (cont.)

Objective scope	Variable / indicator
Environmental quality of life	
Gaseous air pollutants	1. Average number of days with exceeded value of 120 µg/m^3 by 8-hour ozone concentration 2. Urban population exposure to air pollution by ozone (SOMO35) 3. Premature deaths attributable to ozone exposure
Particulate air pollutants	1. Emissions of PM_{10} and $PM_{2.5}$ per capita 2. National $PM_{2.5}$ average exposure indicator 3. Premature deaths attributable to $PM_{2.5}$ exposure
Noise	1. Percentage of population exposed to road traffic/railway/industrial noise in agglomerations over 100 thousand inhabitants 2. Percentage of population exposed to aviation noise in agglomerations with an airport located within their boundaries 3. Share of entities exceeding industrial noise limits in total number of inspected companies 4. Percentage of households experiencing excessive noise coming from neighbours or from the street
Access to drinking water	1. Percentage of population using water supply network 2. Percentage of population supplied with water meeting requirements
Municipal sewage treatment	1. Percentage of population using sewage network 2. Wastewater treatment facilities per 1000 population not using sewage network
Green areas	1. Green areas in cities per capita 2. Percentage of green areas in cities
Economic opportunities and policy responses	
Organic farms	1. Organic agricultural land in total agricultural land 2. Percentage of payments for farms carrying out organic farming
Outlays on environmental protection	1. Outlays on fixed assets for environmental protection in relation to GDP 2. Share of outlays on fixed assets for environmental protection in investment outlays of national economy 3. Expenditures on environmental protection incurred by households per capita
Environmental taxes	1. Share of environmental taxes in GDP 2. Share of environmental taxes in total revenues from taxes and social contributions
Research and development (R&D) activity	1. Research and development intensity 2. Expenditure on research and development (R&D) activity per capita
Inventions and patents	1. Share of patent applications in environment-related technologies in total patent applications filed to the European Patent Office 2. Share of patents in environment-related technologies in total patents granted by the European Patent Office 3. Share of patent applications in environmental technologies in total patent applications filed to the Patent Office of the Republic of Poland 4. Share of patents in environmental technologies in total patents granted by the Patent Office of the Republic of Poland
Eco-innovation	1. Eco-innovation index
Green technology	1. Participants / laureates of Green Technology Accelerator (GreenEvo)
Eco-Management and Audit Scheme (EMAS)	1. Organisations with Eco-Management and Audit Scheme (EMAS) registration 2. Sites of organisations with Eco-Management and Audit Scheme (EMAS) registration
Green public procurement	1. Share of number of green public procurement in total number of public procurement 2. Share of value of green public procurement in total value of public procurement

Bibliography

Legislative acts

Decyzja Parlamentu Europejskiego i Rady Nr 2009/406/WE z dnia 23 kwietnia 2009 r. w sprawie wysiłków podjętych przez państwa członkowskie, zmierzających do zmniejszenia emisji gazów cieplarnianych w celu realizacji do roku 2020 zobowiązań Wspólnoty dotyczących redukcji emisji gazów cieplarnianych (Dz. Urz. L 140/136 z 05.06.2009).

Decyzja wykonawcza Komisji (UE) 2020/2126 z dnia 16 grudnia 2020 r. w sprawie ustalenia rocznych limitów emisji państw członkowskich na lata 2021–2030 zgodnie z rozporządzeniem Parlamentu Europejskiego i Rady (UE) 2018/842 (Dz. U. L 426 z 17.12.2020).

Dyrektywa Rady 91/271/EWG z dnia 21 maja 1991 roku dotycząca oczyszczania ścieków komunalnych (Dz. Urz. L 135/40 z 30.05.1991).

Dyrektywa 2000/60/WE Parlamentu Europejskiego i Rady z dnia 23 października 2000 r. ustanawiająca ramy wspólnotowego działania w dziedzinie polityki wodnej (Dz. Urz. L 327/1 z 22.12.2000).

Dyrektywa 2002/49/WE Parlamentu Europejskiego i Rady z dnia 25 czerwca 2002 r. odnosząca się do oceny i zarządzania poziomem hałasu w środowisku (Dz. Urz. L 189/12 z 18.07.2002).

Dyrektywa Parlamentu Europejskiego i Rady 2008/50/WE z dnia 21 maja 2008 roku w sprawie jakości powietrza i czystszego powietrza dla Europy (Dz. Urz. L 152/1 z 11.06.2008).

Dyrektywa Parlamentu Europejskiego i Rady (UE) 2018/2001 z dnia 11 grudnia 2018 r. w sprawie promowania stosowania energii ze źródeł odnawialnych (Dz. Urz. L 328/82 z 21.12.2018).

Dyrektywa Parlamentu Europejskiego i Rady 2009/29/WE z dnia 23 kwietnia 2009 r. zmieniająca dyrektywę 2003/87/WE w celu usprawnienia i rozszerzenia wspólnotowego systemu handlu uprawnieniami do emisji gazów cieplarnianych (Dz. Urz. L 140/63 z 05.06.2009).

Dyrektywa Parlamentu Europejskiego i Rady 2012/27/UE z dnia 25 października 2012 r. w sprawie efektywności energetycznej, zmiany dyrektyw 2009/125/WE i 2010/30/UE oraz uchylenia dyrektyw 2004/8/WE i 2006/32/WE (Dz. Urz. L 315/1 z 14.11.2012).

Konwencja o różnorodności biologicznej, sporządzona w Rio de Janeiro dnia 5 czerwca 1992 r. (Dz. U. z 2002 r. poz. 1532).

Protokół z Kioto do Ramowej Konwencji Narodów Zjednoczonych w sprawie Zmian Klimatu (Dz. U. z 2005 r. poz. 1684).

Rozporządzenie Ministra Rozwoju, Pracy i Technologii z dnia 27 lipca 2021 r. w sprawie ewidencji gruntów i budynków (Dz. U. poz. 1390).

Rozporządzenie Ministra Środowiska z dnia 14 czerwca 2007 r. w sprawie dopuszczalnych poziomów hałasu w środowisku (Dz. U. poz. 826).

Rozporządzenie Ministra Środowiska z dnia 14 sierpnia 2012 r. w sprawie krajowego celu redukcji narażenia (Dz. U. poz. 1030).

Rozporządzenie Ministra Środowiska z dnia 24 sierpnia 2012 r. w sprawie poziomów niektórych substancji w powietrzu (Dz. U. poz. 1031).

Rozporządzenie Ministra Klimatu i Środowiska z dnia 14 listopada 2022 r. w sprawie sposobu obliczania wskaźników średniego narażenia oraz sposobu oceny dotrzymania pułapu stężenia ekspozycji (Dz. U. poz. 2430).

Rozporządzenie Ministra Klimatu z dnia 2 stycznia 2020 r. w sprawie katalogu odpadów (Dz. U. poz. 10).

Rozporządzenie Ministra Zdrowia z dnia 7 grudnia 2017 r. w sprawie jakości wody przeznaczonej do spożycia przez ludzi (Dz. U. poz. 2294).

Rozporządzenie Parlamentu Europejskiego i Rady (UE) Nr 691/2011 z dnia 6 lipca 2011 r. w sprawie europejskich rachunków ekonomicznych środowiska (Dz. Urz. L 192/1 z 22.07.2011).

Rozporządzenie Parlamentu Europejskiego i Rady (UE) 2018/848 z dnia 30 maja 2018 r. w sprawie produkcji ekologicznej i znakowania produktów ekologicznych i uchylające rozporządzenie Rady (WE) nr 834/2007 (Dz. Urz. L 150/1 z 14.06.2018).

Rozporządzenie Parlamentu Europejskiego i Rady (UE) 2018/842 z dnia 30 maja 2018 r. w sprawie wiążących rocznych redukcji emisji gazów cieplarnianych przez państwa członkowskie od 2021 r. do 2030 r. przyczyniających się do działań na rzecz klimatu w celu wywiązania się z zobowiązań wynikających z Porozumienia paryskiego oraz zmieniające rozporządzenie (UE) nr 525/2013 (Dz. Urz. L 156 z 19.6.2018).

Rozporządzenie Parlamentu Europejskiego i Rady (UE) 2018/1999 z dnia 11 grudnia 2018 r. w sprawie zarządzania unią energetyczną i działaniami w dziedzinie klimatu, zmiany rozporządzeń Parlamentu Europejskiego i Rady (WE) nr 663/2009 i (WE) nr 715/2009, dyrektyw Parlamentu Europejskiego i Rady 94/22/WE, 98/70/WE, 2009/31/WE, 2009/73/WE, 2010/31/UE, 2012/27/UE i 2013/30/UE, dyrektyw Rady 2009/119/WE i (EU) 2015/652 oraz uchylenia rozporządzenia Parlamentu Europejskiego i Rady (UE) nr 525/2013 (Dz. Urz. L 328 z 21.12.2018).

Rozporządzenie Parlamentu Europejskiego i Rady (UE) 2019/1700 z dnia 10 października 2019 r. ustanawiające wspólne ramy statystyk europejskich dotyczących osób i gospodarstw domowych, opartych na danych na poziomie indywidualnym zbieranych metodą doboru próby, zmieniające rozporządzenia Parlamentu Europejskiego i Rady (WE) nr 808/2004, (WE) nr 452/2008 i (WE) nr 1338/2008 oraz uchylające rozporządzenie Parlamentu Europejskiego i Rady (WE) nr 1177/2003 i rozporządzenie Rady (WE) nr 577/98 (Dz. Urz. L 2611/1 z 14.10.2019).

Rozporządzenie Parlamentu Europejskiego i Rady (UE) 2021/1119 z dnia 30 czerwca 2021 r. w sprawie ustanowienia ram na potrzeby osiągnięcia neutralności klimatycznej i zmiany rozporządzeń (WE) nr 401/2009 i (UE) 2018/1999 (Europejskie prawo o klimacie) (Dz. Urz. L 243 z 9.7.2001).

Rozporządzenie Parlamentu Europejskiego i Rady (WE) nr 1099/2008 z dnia 22 października 2008 r. w sprawie statystyki energii (Dz. Urz. L 304/1 z 14.11.2008).

Rozporządzenie Parlamentu Europejskiego i Rady (WE) nr 1221/2009 z dnia 25 listopada 2009 r. w sprawie dobrowolnego udziału organizacji w systemie ekozarządzania i audytu we Wspólnocie (EMAS), uchylające rozporządzenie (WE) nr 761/2001 oraz decyzje Komisji 2001/681/WE i 2006/193/WE (Dz. Urz. L 342/1 z 22.12.2009).

Ustawa z dnia 28 września 1991 r. o lasach (Dz. U. z 2022 r. poz. 672, z późn. zm.).

Ustawa z dnia 3 lutego 1995 r . o ochronie gruntów rolnych i leśnych (Dz. U. z 2021 r. poz. 1326, z późn. zm.).

Ustawa z dnia 27 kwietnia 2001 r. Prawo ochrony środowiska (Dz. U. z 2021 r. poz. 1973, z późn. zm.).

Ustawa z dnia 7 czerwca 2001 r. o zbiorowym zaopatrzeniu w wodę i zbiorowym odprowadzaniu ścieków (Dz. U. z 2020 r. poz. 2028, z późn. zm.).

Ustawa z dnia 11 września 2019 r. – Przepisy wprowadzające ustawę – Prawo zamówień publicznych (Dz. U. poz. 2020, z późn. zm.).

Ustawa z dnia 16 kwietnia 2004 r. o ochronie przyrody (Dz. U. z 2022 r. poz. 916, z późn. zm.).

Ustawa z dnia 23 czerwca 2022 r. o rolnictwie ekologicznym i produkcji ekologicznej (Dz. U. poz. 1370, z późn. zm.).

Ustawa z dnia 17 lipca 2009 r. o systemie zarządzania emisjami gazów cieplarnianych i innych substancji (Dz. U. z 2022 r. poz. 673).

Ustawa z dnia 20 maja 2016 r. o efektywności energetycznej (Dz. U. z 2021 r. poz. 2166).

Ustawa z dnia 15 lipca 2011 r. o krajowym systemie ekozarządzania i audytu (EMAS) (Dz. U. z 2022 r. poz. 2013).

Ustawa z dnia 14 grudnia 2012 r. o odpadach (Dz. U. z 2022 r. poz. 699, z późn. zm.).

Reports

Air Quality in Europe, Europejska Agencja Środowiska, Kopenhaga.

Bilans zasobów złóż kopalin w Polsce, Państwowy Instytut Geologiczny – Państwowy Instytut Badawczy, Warszawa.

Krajowy Raport Inwentaryzacyjny 2024. Inwentaryzacja emisji i pochłaniania gazów cieplarnianych w Polsce dla lat 1988–2022. Raport syntetyczny. Warszawa 2024.

Raport o stanie akustycznym środowiska w Polsce na podstawie wyników realizacji strategicznych map hałasu – wyniki IV rundy mapowania, Główny Inspektorat Ochrony Środowiska, Instytut Ochrony Środowiska – Państwowy Instytut Badawczy, Warszawa 2024.

Raport o stanie rolnictwa ekologicznego w Polsce, Główny Inspektorat Jakości Handlowej Artykułów Rolno-Spożywczych, Warszawa.

Raport roczny, Urząd Patentowy Rzeczypospolitej Polskiej, Warszawa.

Stan środowiska w Polsce, Główny Inspektorat Ochrony Środowiska, Biblioteka Monitoringu Środowiska, Warszawa.

Internet pages

Baza danych Banku Światowego, https://databank.worldbank.org/home.aspx [21.11.2024].

Baza danych Europejskiej Agencji Środowiska, https://www.eea.europa.eu/data-and-maps/data#c0=5&c11=&c5=all&b_start=0 [21.11.2024].

Baza danych Eurostatu, https://ec.europa.eu/eurostat/web/main/data/database [22.11.2024].

Baza danych FAO, https://www.fao.org/faostat/en/#data [27.08.2024].

Bank Danych Lokalnych, https://bdl.stat.gov.pl/BDL/dane/podgrup/temat [29.11.2024].

Baza danych OECD, https://stats.oecd.org/ [29.11.2024].

Baza danych Organizacji Narodów Zjednoczonych – Global SDG Indicators Database, https://unstats.un.org/sdgs/indicators/database/ [26.11.2024].

Baza danych Organizacji Narodów Zjednoczonych do spraw Wyżywienia i Rolnictwa, http://www.fao.org/faostat/en/#home [04.11.2024].

Eco-Innovation, http://ec.europa.eu/environment/ecoap/ [06.11.2024].

GreenEvo – Akcelerator Zielonych Technologii, https://www.gov.pl/web/klimat/greenevo [21.11.2024].

KOBiZE, https://www.kobize.pl/pl/fileCategory/id/16/krajowa-inwentaryzacja-emisji [21.11.2024].

Rejestr EMAS GDOŚ, https://www.gov.pl/web/gdos/rejestr-emas [29.11.2024].

Rejestr EMAS Komisji Europejskiej, https://webgate.ec.europa.eu/emas2/public/registration/list [29.11.2024].

WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP), https://washdata.org/ [20.11.2024].