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**ENERGY FROM RENEWABLE
SOURCES IN 2016**

WARSAW 2017

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Preface

The publication “Energy from renewable sources in 2016” is the next edition of study prepared by the Central Statistical Office pertaining to renewable energy sources (RES) within the series “Statistical Information and Elaborations”.

Publication contains national energy balances from renewable sources as well as information about the production of electricity and heat obtained from these sources. The data in this respect are presented with the results of the EU and selected countries. The publication also presents information on the share of energy from renewable sources in gross final energy consumption, which is the indicator aimed to monitor realization of the obligations of the EU.

The publication was elaborated by Energy Market Agency staff and by the employees of the Production Department of the Central Statistical Office.

The Central Statistical Office expresses its thanks to all the rapporteurs participating in statistical surveys of the fuel and energy market, thanks to which it was possible to prepare this study. At the same time, we ask for comments and suggestions regarding the content and form of the publication, which will contribute to the improvement of the next edition.

“Energy from renewable sources” and other studies in the field of energy statistics can be found on the Internet at: <http://stat.gov.pl/en/publications/>.



Wanda Tkaczyk

Deputy Director of the Production Department

Warsaw, November 2017

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1. Introduction

1.1. Energy from renewable sources

Demand for energy growing with civilization development, with simultaneous exhaustion of its traditional resources – mainly fossil fuels (coal, oil, natural gas) and an increase in natural environment pollution accompanying their use, brings increased interest in use of renewable energy.

Renewable energy is an energy derived from repeating natural processes, obtained from renewable non-fossil energy sources (energy: water, wind, solar, geothermal, waves, currents and tides, and energy produced from solid biofuels, biogas and liquid biofuels, as well as the energy of the ambient of natural environment used by the heat pump).

Renewable energy sources (RES) are alternative for traditional primary non-renewable energy sources (fossil fuels). Their resources replenish themselves in natural processes, which in practice allows to treat them as inexhaustible. Moreover, obtaining energy from such sources is, as compared to traditional sources (fossil), more environmentally friendly. Use of RES significantly lowers negative impact of power industry on the natural environment, mainly by limiting emission of harmful substances, especially greenhouse gases.

In Polish conditions energy from renewable sources includes energy from direct use of solar energy, wind, geothermal resources (from Earth interior), water, solid biofuels, biogas and liquid biofuels and energy obtained from heat pumps.

The scope of use of renewable energy in EU member states is governed by EU documents and regulations, establishing general and detailed aims pertaining to the obligation to obtain certain indicators of share of renewable energy in use of primary energy, as well as that of electricity produced from renewable sources in total use of this energy. The basic EU documents and legal regulations in this respect are:

- Regulation (EC) No 1099/2008 of the European Parliament and of the Council of 22 October 2008 on energy statistics (O. J. L 304 14.11.2008 as amended),
- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (O. J. L 140 z 5.6.2009),
- Directive (EU) 2015/1513 of the European Parliament and of the Council of 9 September 2015 amending Directive 98/70/EC relating to the quality of petrol

and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources (O. J. L 239 15.9.2015)

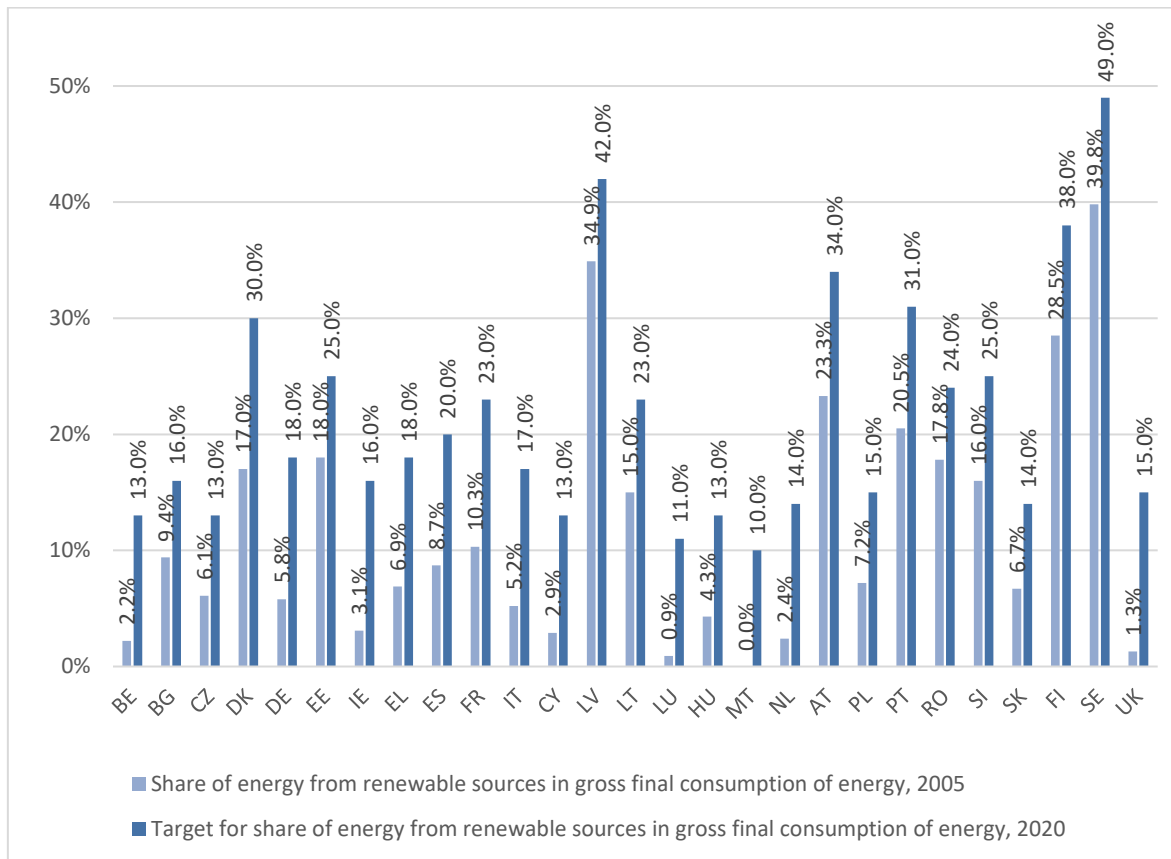
- Commission Decision of 1 March 2013 establishing the guidelines for Member States on calculating renewable energy from heat pumps from different heat pump technologies pursuant to Article 5 of Directive 2009/28/EC of the European Parliament and of the Council (notified under document C(2013) 1082),
- White Paper – Energy for the Future: Renewable sources of energy (1997),
- Green Paper – Towards a European strategy for the security of energy supply (2001).

In adopted on 23 April 2009 by the European Parliament and Council Directive 2009/28/EC on the promotion of energy from renewable sources has identified a number of tasks for the EU Member States, in particular:

- ⇒ the common frameworks for the promotion of renewable energy;
- ⇒ mandatory national overall targets for the total share of renewables in gross final energy consumption and in relation to share of energy from renewable sources in transport;
- ⇒ rules concerning:
 - a) statistical transfers a certain amount of energy from renewable sources between Member States,
 - b) common projects between Member States and third countries,
 - c) guarantees of origin,
 - d) administrative procedures,
 - e) information and training,
 - f) access of renewable energy to the electricity grid;
- ⇒ sustainability criteria for biofuels and bioliquids.

Established in the Directive the overall targets for the share of energy from renewable sources in final energy consumption in 2020 for individual EU Member States are shown in Fig. 1.

Fig. 1. National overall targets for the share of energy from renewable sources in gross final consumption of energy in 2020.



On 15 September 2015 was published in the Official Journal of the European Union Directive (EU) 2015/1513 of the European Parliament and of the Council of 9 September 2015 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources. These changes relate to the algorithms for calculating the share of energy from renewable sources in transport in the case of using biofuels meeting the sustainability criteria and using electricity produced from renewable energy sources. As a result, changes have been made in some articles and in Annex V to that Directive. There were also designed and published the following Annexes:

- **Annex VIII** refers to temporary estimated emissions of raw materials for biofuels and bioliquids, resulting from indirect land use changes,
- **Annex IX**, concerning the raw materials and fuels, which contribute to the objectives defined in Article 3 point 4, first paragraph of the Directive of the European Parliament and of the Council (EU) 2009/28 / EC, is considered to be twice the energy value.

These changes oblige member states to apply the following procedures and arrangements:

- ⇒ for the calculation of the contribution from electricity produced from renewable sources and consumed in all types of electric vehicles and for the production of renewable liquid and gaseous transport fuels of non-biological origin Member States may choose to use either the average share of electricity from renewable energy sources in the Union or the share of electricity from renewable energy sources in their own country as measured two years before the year in question,
- ⇒ furthermore, for the calculation of the electricity from renewable energy sources consumed **by electrified rail transport**, that consumption **shall be considered to be 2,5 times the energy content** of the input of electricity from renewable energy sources,
- ⇒ for the calculation of the electricity from renewable energy sources consumed **by electric road vehicles** that consumption **shall be considered to be five times the energy content** of the input of electricity from renewable energy sources,
- ⇒ biofuels produced from feedstocks listed in Annex IX shall be considered to be twice their energy content for the purpose of complying with the target set out when calculating the share of energy from renewable sources in gross final energy consumption,
- ⇒ each Member State shall seek to achieve the objective of there being a minimum level of consumption on their territory of biofuels produced from feedstocks and of other fuels, listed in part A of Annex IX. To that effect, by 6 April 2017, each Member State shall set a national target, which it shall endeavour to achieve. A reference value for this target is 0,5 percentage points in energy content of the share of energy from renewable sources in all forms of transport in 2020,
- ⇒ in addition, biofuels made from feedstocks not listed in Annex IX that were determined to be wastes, residues, non-food cellulosic material or lignocellulosic material by the competent national authorities and are used in existing installations prior to the adoption of Directive (EU) 2015/1513 of the European Parliament and of the Council, may be counted towards the national target,
- ⇒ the share of energy from biofuels produced from cereal and other starch-rich crops, sugars and oil crops and from crops grown as main crops primarily for energy purposes

on agricultural land shall be no more than 7 % of the final consumption of energy in transport in the Member States in 2020.

The basic legal regulations pertaining to the obligation in respect of RES consumption in Poland are:

- Law of 10 April 1997 – Energy Law (Journal of Laws of 2012, item. 1059 as amended),
- Regulation of the Minister of Economy of 14 August 2008 on the specific responsibilities to obtain and submit to the redemption of certificates of origin to pay the replacement fee, purchase of electricity and heat produced from renewable energy sources and the obligation to confirm the data on the amount of electricity generated in the renewable energy source (Journal of Laws of 2008, No 156, item. 969 as amended),
- Law of 25 August 2006 on biocomponents and liquid biofuels (Journal of Laws of 17 February 2017, item. 285 as amended),
- The Act of 20 February 2015 on renewable energy sources (Journal of Laws of 2015, item. 478 and 2365 and of 2016 item. 925).

In Poland, the assumptions for the development of renewable energy are set out in a government document entitled "Strategy for development of renewable energy" (adopted by the Parliament on 23 August 2001) and in the documents: "Polish Energy Policy until 2030" (adopted by the Council of Ministers on November 10, 2009) and the "Programme for electrical power engineering" (adopted by the Council of Ministers on 28 March 2006). The strategic goal of the state policy is to increase the use of resources of renewable energy, so that the share of this energy in gross final energy consumption in 2020 reached a volume of 15%.

On 7 December 2010, the Council of Ministers adopted, submitted by the Minister of the Economy, "National Action Plan for energy from renewable sources", which was sent to the European Commission. The plan assumes that the development of renewable energy sources will allow to meet the growing demand for energy and increase the degree of independence from imported energy supplies. Promoting the use of renewable energy sources will also allow to increase the level of diversification of supply sources and create conditions for the development of distributed energy, based on locally available raw materials.

The National Action Plan in the field of renewable energy contains forecasts for Poland in 2020 to achieve 15.5% of the share of energy from renewable sources in gross final energy consumption in a sustainable way, taking into account many factors, such as resources of renewable energy, raw materials for the production of fuels and the role of power system. It was assumed that the pillar of increasing the share of energy from renewable sources will be increased use of biomass and wind energy. The document develops and refines the predictions about consumption of renewable energy sources which were contained in the "Polish Energy Policy until 2030".

Development of renewable energy is essential to the fundamental objectives of climate and energy policy. Increasing the use of renewable energy sources offers opportunities to reduce CO₂ emissions and increase energy efficiency.

1.2. Characteristics of renewables (energy commodities)

Occurring in the publication renewable energy carriers are defined as follows:

Hydro power

Water energy (potential and kinetic) is determined on the basis of the amount of electricity produced in hydro-electric power stations. Renewable energy includes only production of electricity in power stations with natural flow.

Geothermal energy

Geothermal energy is heat obtained from Earth interior in the form of hot water or steam.

Geothermal energy is used directly as heat for municipal heating and in production processes in agriculture, as well as for production of electricity (using dry steam or brine with high enthalpy).

Solar energy

Solar energy is energy of solar radiation transformed into heat or electricity. Solar energy is used in:

- flat, vacuum-tube and other types of solar collectors (liquid or air) for heating running water, water in swimming pools, heating rooms, in drying processes, in chemical processes;
- photovoltaic cells for direct production of electricity;

- solar power stations for production of electricity.

Solar energy is used in passive heating systems (by system of direct gains through windows, by annexed greenhouses, and other), cooling and lighting of rooms is not included in the statistical reporting.

Wind energy

Wind energy is a kinetic energy of wind used for production of electricity in wind turbines. Similarly as in the case of hydro-electric power station, the potential of wind power stations is determined by their potential to generate electricity.

Municipal waste

The national statistical reporting on fuel and energy management includes also waste fuels coming from flammable industrial waste and municipal waste, such as: rubber, plastics, waste oils, and other similar products. They have solid or liquid form and are classified as renewable fuels or not, depending on whether they undergo biodegradation.

Renewable fuels used in the process of electricity and/or heat production include renewable solid municipal waste incinerated in appropriately adapted installations. These include wastes from households, hospitals, and services sector (waste biomass) consisting of organic fractions subject to biodegradation.

Solid biofuels

Solid biofuels includes organic, non-fossil material of biological origin, which can be used as fuel to produce heat or electricity generation.

The basic solid fuel is forest biomass (firewood) in the form of chunks, round timber, chips, briquettes, pellets, and waste from forestry, wood and paper industry, i.e. branches, poles, thinning, shrubs, brush-wood, rootwood, bark, sawdust, black liquor. A separate group consist of agricultural biomass fuels from energy crops (fast-growing trees, dicotyledonous perennials, perennial grasses, energy cereals) and organic remnants from agriculture and horticulture (e.g. wastes from horticultural production, animal manure, briquettes and pellets of straw and so on).

The group of solid biofuels also contains charcoal, understood more broadly as the solid residue of the destructive distillation and pyrolysis of wood and other vegetal material.

Biogas

Biogas is a gas composed mostly of methane and carbon dioxide, obtained in the process of anaerobic fermentation of biomass. In statistical reporting, due to the method of production, we distinguish:

- *landfill gas*, obtained from fermentation of wastes in landfills,
- *sludge gas*, produced in result of anaerobic fermentation of sludge
- *other biogases*:
 - a) *agricultural biogas obtained from anaerobic fermentation of biomass from energy crops, residues from crop production and animal manure;*
 - b) *biogas obtained from anaerobic fermentation of biomass from wastes of slaughterhouses, breweries and from other activities in agricultural and food manufacturing.*

Biofuels (liquid biofuels for transport from biomass)

Biofuels are produced from organic materials (from biomass or biodegradable fractions of wastes). The statistical reporting includes the following products: bioethanol, biodiesel, biomethanol, bio-dimethyl-ether, bio-ETBE (ethyl-tertio-butyl-ether produced on the basis of bioethanol), bio-MTBE (methyl-tertio-butyl-ether produced on the basis of biomethanol). Also natural plant oils may serve as biofuels.

The aforementioned products are used as biocomponents added to engine fuels produced from oil. The most frequently used additives are: bioethanol (engine fuels additive) and biodiesel (diesel fuels additive).

Bioliquids (other liquid biofuels)

‘Bioliquids’ means liquid fuel for energy purposes other than for transport, including electricity and heating and cooling, produced from solid biofuels.

Besides these, occurring in the study, renewable energy commodities (covered by the national statistical reporting), for which relevant data are collected under the Regulation of the European Parliament and Council (EC) No 1099/2008 on energy statistics (O. J. L 304 14.11.2008, as amended) in accordance with the provisions of the Directive of the European Parliament and Council 2009/28/EC on the promotion of energy from renewable sources, in calculating the share of energy from renewable sources also is taken into account the heat from heat pumps using energy of environment (natural environment).

The heat of the environment (natural environment) captured by heat pumps

Classified as renewable energy ambient heat is captured by heat pumps from ambient air (outdoor), soil (geothermal shallow), and ground and surface waters (rivers, ponds, lakes). Accepting used in the abovementioned Directive naming of energy commodities, you can call them respectively the energy: aero-thermal (heat contained in the atmospheric air), geothermal (heat accumulated in the soil - the surface layer of the earth) and hydrothermal (heat contained in groundwater and surface water).

2. Methodical notes

2.1. Subject scope of the study

This publication is a “resulting statistical information” containing statistical data on renewable energy sources (RES). This information was collected within statistical surveys on energy included in annual programmes of statistical surveys of the public statistics realized in 2006 – 2015. The scope of the presented data does not give full picture of the situation in respect of production and consumption of energy sources from RES in Poland, mostly due to significant dispersion of sources and to a large degree local character of their use. Low production capacity of the majority of facilities producing and consuming energy from renewable sources make it difficult to include them in the statistical survey.

The publication contains collective statistical data pertaining to production and consumption of energy from renewable energy sources used in Poland, in particular:

- water energy,
- geothermal energy,
- solar energy,
- wind energy,
- municipal waste,
- solid biofuels,
- biogas,
- liquid biofuels for transport,
- ambient heat for heat pumps.

The publication also includes the data pertaining to the amount of electricity and heat obtained from RES.

The statistical data presented in the publication are expressed in energy units (TJ – terajoules, GWh – giga-hours, toe - tons of oil equivalent [1 toe = 41.868×10^9 J]) and for liquid biofuels additionally in natural units (t (Mg) – tons).

The study uses statistical data obtained from questionnaires with symbols:

- **G-02b** – balance report on energy commodities and heating infrastructure,
- **G-02o** – report of a heat from renewable sources,
- **G-03** – report on fuels and energy consumption,
- **E-GD** – questionnaire of the fuel and energy consumption in households
- **G-10.1(w)k** – report on basic operation of hydro (and wind) electric power station,
- **G-10.2** – report on basic operation of thermal main activity producer power station,
- **G-10.3** – report on capacity and production of heat and power of autoproducer (electricity / CHP) plants,
- **G-10.6** – report on capacity and electricity production of the power stations (by: hydro / wind / and other renewable sources),
- **RAF-1** – report on squaring of transformation process in enterprises producing and processing refined petroleum products,
- **RAF-2** – report on production and turnover of petroleum products.

The study also presents data for UE-28, for selected neighbouring countries or for countries with similar climatic conditions according to the statements in balance sheets drawn up and released by EUROSTAT on the website <http://ec.europa.eu/eurostat/data/database>¹ in 2016.

Due to put under the harmonized system of calculation changes of methodology some of the data published in previous editions of the publication have been corrected.

¹ Data for Polish presented in this publication has been updated in accordance with the application SHARES_2016 and may vary from those presented on the basis of Eurostat on the basis of SHARES_2015

Some of the data presented in this publication have been given on the basis of the preliminary data, so that they may be slight changes in the next edition.

Due to the electronic technique of data processing, in some cases, the sum of the components may vary slightly from the stated amount "of the total."

2.2. Definitions

Primary energy is energy contained in primary energy sources obtained directly from natural resources, both renewable and non-renewable.

Renewable primary energy is an energy obtained from natural, constantly repeating natural processes.

Derived energy is energy contained in secondary energy sources, i.e. sources generated in processes of energy transformations.

Indigenous production is the amount of energy obtained from natural primary energy sources.

Transformation output is the quantity of energy commodities (the only energy derivative) obtained through the energy transformation processes

Stock change (+/-) any increase in energy commodities stocks is indicated by a sign "-" and reduction by a sign "+".

Energy transformation is the technological process in which one form of energy (mostly primary energy sources) is transformed into other, secondary form of energy.

Energy used in the transformation is used for:

- **transformation sector** (use of energy sources constituting technological material of transformation, being subject to conversion into another energy commodities),
- **own consumption in transformation process** (use of energy by auxiliary devices operating transformation process, such as: fuel feeders, pump drives and ventilators, etc.)

Final energy consumption is the consumption of energy commodities by consumers (industry, services, households) to their technological, productive and living needs. Final consumption does not include the processing to other energy commodities.

Input and needs of energy transformation and losses resulting at the producers' and distributors are not included in this position. The final consumption, on the other hand, includes consumption of fuels for production of heat used entirely by the producer.

Total final consumption is divided into two parts: the consumption of energy and the non-energy consumption (raw materials).

Energy sector is use of a given energy source in energy transformations for own consumption in transformation process.

Gross final consumption of energy means the energy commodities delivered for energy purposes to industry, transport, households, services including public services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution and transmission.

The gross final consumption of energy from renewable sources in each Member State shall be calculated as the sum of:

- gross final consumption of electricity from renewable energy sources;
- gross final consumption of energy from renewable sources for heating and cooling; and
- final consumption of energy from renewable sources in transport.

Ambient heat it is the energy obtained from the environment, i.e. from the air, soil, groundwater and shallow geothermal surface (rocks, waters), using heat pumps.

Heat pump transfers heat from the environment of the lower temperature (lower source) to the environment with higher temperature (upper source), using energy from the outside (in the form of a work or heat).

Installed capacity it is the maximum constant power with which the devices can work having good technical state and in normal operating conditions.

Main Activity Producer Plants include entities for which the basic type of activity is the activity mentioned in Polish Classification of Activities (PKD) in the group 35.1 and 35.3.

Autoproducer Plants includes entities for which the additional type of activity is the activity mentioned in PKD classification in section 35. Usually the energy produced at these facilities is consumed for own needs of these entities.

The full scope of definitions and terms used in energy statistics is contained in the study entitled:

- “Methodological rules of statistical reporting on fuels and energy and definitions of the terms used” – CSO methodological notebook, Warsaw 2006,
- “Methodological rules of statistical reporting on energy from renewable sources” – CSO methodological notebook, Warsaw 2016,

on the website <http://stat.gov.pl/en/topics/environment-energy/energy/>

2.3. Types of activity used in the study according to the Polish Classification of Activities (NACE Rev.2)

No.	Specification	PKD-2007 (NACE Rev 2)
1.	Industry Sector of which:	total from: 2 - 12
2.	Iron and steel	24.1, 24.2, 24.3,24.51, 24.52
3.	Chemical (including Petrochemical)	20
4.	Non-Metallic Minerals	23
5.	Transport Equipment	29,30
6.	Machinery	25,28,26,27
7.	Mining and Quarrying	07,08
8.	Food, Beverages and Tobacco	10,11,12
9.	Paper Pulp and Printing	17,18
10.	Wood and Wood Products	16
11.	Textile and Leather	13,14,15
12.	Non-specified (industry)	22,32,31,38
13.	Construction	41,42,43
14.	Transport Sector	49-51
15.	Other Sectors of which:	
16.	Commerce and Public Services	36, 45, 46, 47, 55, 56, 52, 53, 61 ,64, 65, 66, 68, 77, 62, 63, 72, 58, 69, 70, 71, 73, 74, 78, 79, 80, 81, 82, 33, 95, 84, 85, 75, 86, 87, 88, 37, 38, 39, 94, 59, 60, 90, 91, 92, 93, 96, 97, 98, 99
17.	Agriculture / Forestry	01,02,03

3. Obtaining energy from renewable sources

The data pertaining to the amount of total primary energy (including energy from renewable sources) in 28 states of the European Union (EU-28) in 2011-2015 are presented in table 1.

Table 1. Production of primary energy (including from renewable sources) for EU-28 and Poland in the years 2011 – 2015

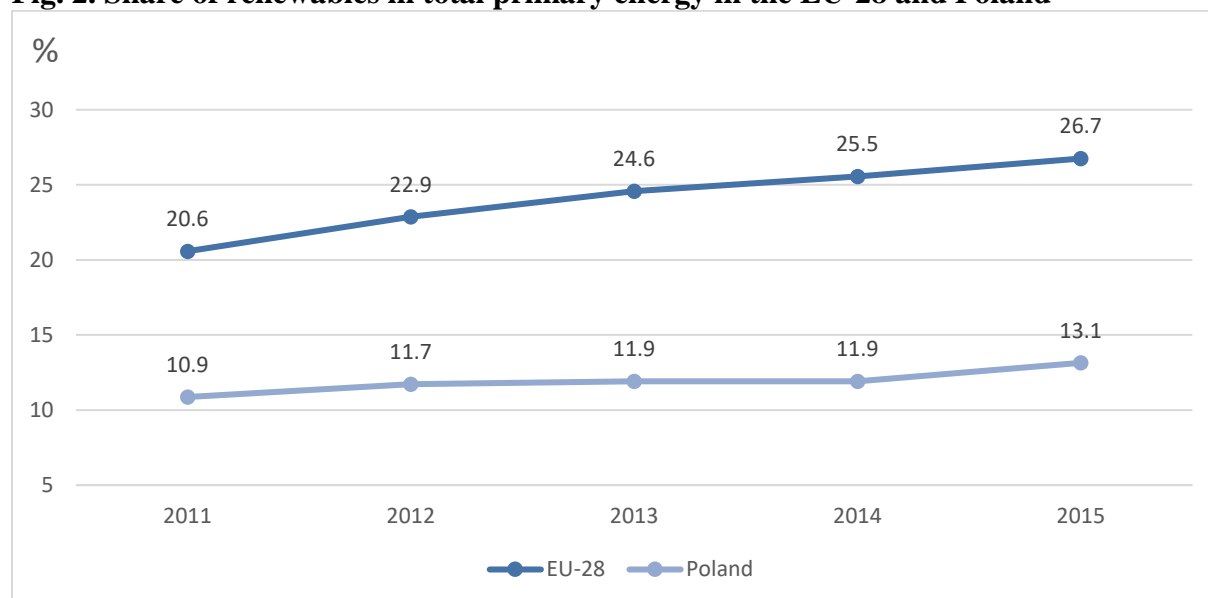
Specification	2011	2012	2013	2014	2015
	Mtoe				
Total primary energy in EU [Mtoe]	804.0	796.8	792.0	772.9	766.6
<i>from renewable sources (RES) in EU [Mtoe]</i>	<i>165.4</i>	<i>182.2</i>	<i>194.6</i>	<i>197.5</i>	<i>205.0</i>
Total primary energy in Poland ² [Mtoe]	68.8	72.6	71.8	68.2	68.5
<i>from renewable sources (RES) in Poland [Mtoe]</i>	<i>7.5</i>	<i>8.5</i>	<i>8.6</i>	<i>8.1</i>	<i>9.0</i>
	%				
Share of energy from RES in the total primary energy in EU [%]	20.6	22.9	24.6	25.5	26.7
Share of energy from RES in the total primary energy in Poland [%]	10.9	11.7	11.9	11.9	13.1

In the years 2011 - 2015 in the EU-28 for the index - production of primary energy - appeared a downward trend, while the index - energy produced from renewable sources - grew steadily.

In 2015, for the EU-28 the share of renewable energy in total primary energy amounted to 26.7%. For Polish, this ratio was 13.1% (Fig. 2). The average annual growth rate of this indicator in the years 2011 - 2015 for the EU-28 is 6.8%, and 4.9% for Polish.

² according to the accepted rules "total primary energy" position does not include energy from coal reclaimed from mine waste dumps and energy from waste fuels of non-organic origin.

Fig. 2. Share of renewables in total primary energy in the EU-28 and Poland

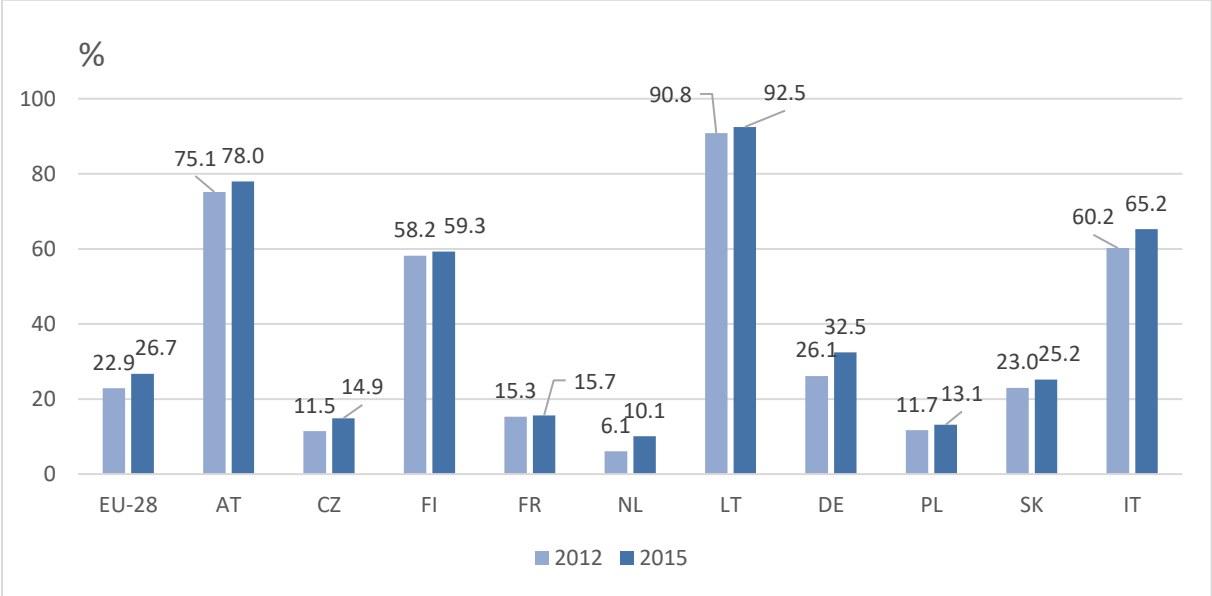


In most EU-28 countries we observed an increase in the share of renewable energy in total primary energy. Table 2 shows how these values developed in selected EU countries.

Table 2. Production of primary energy (including RES) in selected EU countries in the years 2012 – 2015

Specification	2012	2013	2014	2015	2012	2013	2014	2015	2012	2013	2014	2015
	Production of primary energy								Share of energy from renewable sources in the total primary energy [%]			
	total (Mtoe)				from RES [Mtoe]							
EU-28.....	796.8	792.0	772.9	766.6	182.2	194.6	197.5	205.0	22.9	24.6	25.5	26.7
AT.....	12.4	12.2	12.0	11.9	9.3	9.5	9.2	9.3	75.1	77.7	77.0	78.0
CZ.....	32.5	30.4	29.6	28.8	3.7	4.1	4.2	4.3	11.5	13.5	14.2	14.9
FI.....	17.1	18.0	18.1	17.5	10.0	9.9	10.1	10.4	58.2	55.2	55.9	59.3
FR.....	132.8	134.5	135.9	136.7	20.3	22.5	21.0	21.4	15.3	16.8	15.5	15.7
NL.....	64.7	69.3	58.5	47.6	3.9	4.4	4.6	4.8	6.1	6.3	7.8	10.1
LT.....	1.3	1.4	1.5	1.6	1.2	1.3	1.4	1.5	90.8	91.1	91.3	92.5
DE.....	122.7	120.6	119.9	119.8	32.1	33.7	36.0	38.9	26.1	27.9	30.0	32.5
PL.....	72.6	71.8	68.2	68.5	8.5	8.6	8.1	9.0	11.7	11.9	11.9	13.1
SK.....	6.2	6.4	6.3	6.3	1.4	1.5	1.4	1.6	23.0	22.9	22.8	25.2
IT.....	35.1	36.9	36.8	36.1	21.1	23.5	23.6	23.6	60.2	63.7	64.2	65.2

Fig. 3. Share of renewables in total primary energy in selected EU countries and Poland



The structure of the obtaining renewable energy (by source) in selected EU countries in the years 2012-2015 are presented in Table 3.

Figure 4 shows the obtaining of energy from renewable sources by energy commodities in the EU-28, and in Fig. 5 the share of solid biofuels, wind and water in obtaining energy from renewable sources in selected EU countries in 2015.

Fig. 4. Structure of energy generation from renewable sources gained by EU-28 in 2015

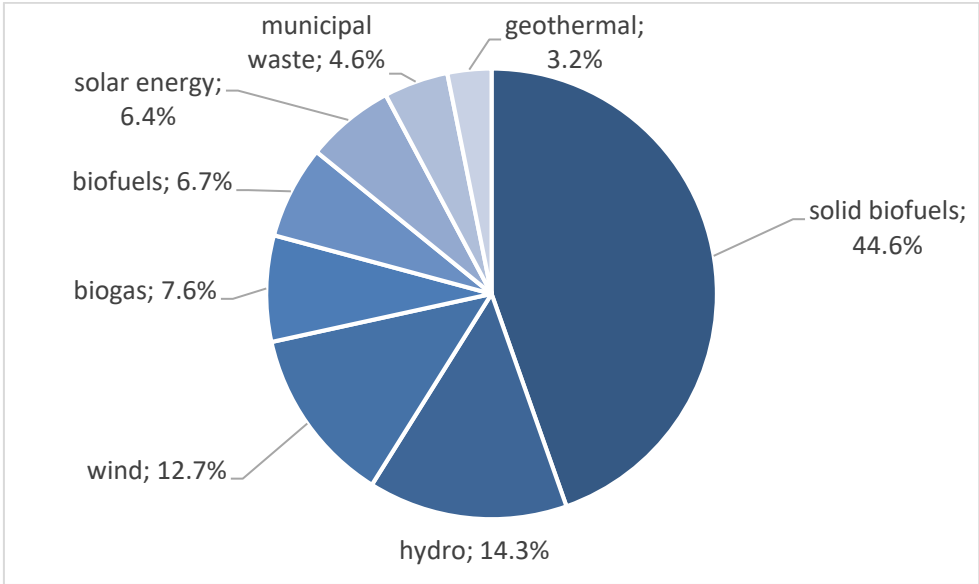
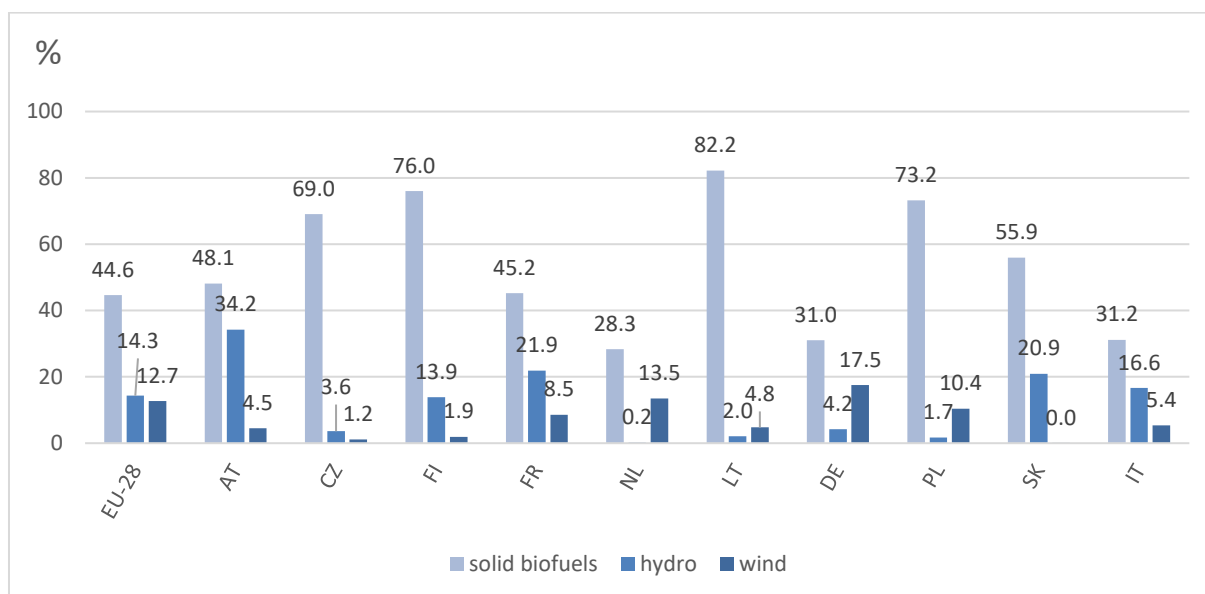


Table 3. The structure of energy production from renewable sources in selected EU countries in the years 2012 - 2015

Specification		EU-28	AT	CZ	FI	FR	NL	LT	DE	PL	SK	IT
		%										
Solid biofuels	2012	48.7	48.3	70.6	79.7	46.0	31.6	82.8	34.1	82.1	55.9	34.4
	2013	46.4	49.9	67.3	81.4	46.0	27.5	80.8	32.4	79.9	52.4	31.7
	2014	44.2	45.9	67.7	80.2	43.3	28.3	82.2	31.7	76.1	52.7	27.7
	2015	44.6	48.1	69.0	76.0	45.2	28.3	82.2	31.0	73.2	55.9	31.2
Solar energy	2012	4.9	2.2	5.3	0.0	2.1	1.1	0.0	8.9	0.2	2.9	8.4
	2013	5.5	2.4	4.6	0.0	2.2	1.6	0.3	9.6	0.3	3.8	8.6
	2014	6.1	2.7	4.7	0.0	2.9	2.1	0.5	10.3	0.4	4.0	8.9
	2015	6.4	2.9	5.0	0.0	3.4	2.6	0.4	10.3	0.5	3.1	9.2
Hydro	2012	15.9	40.3	4.9	14.5	24.9	0.2	3.0	5.8	2.1	24.6	17.1
	2013	16.4	38.2	5.7	11.1	27.0	0.2	3.5	5.9	2.5	28.4	19.3
	2014	16.3	38.3	3.9	11.4	25.8	0.2	2.5	4.7	2.3	25.1	21.3
	2015	14.3	34.2	3.6	13.9	21.9	0.2	2.0	4.2	1.7	20.9	16.6
Wind	2012	9.7	2.3	1.0	0.4	6.3	10.9	3.9	13.6	4.8	0.0	5.5
	2013	10.4	2.9	1.0	0.7	5.8	11.1	4.0	13.2	6.0	0.0	5.5
	2014	11.0	3.6	1.0	0.9	7.1	10.9	4.0	13.7	8.1	0.0	5.5
	2015	12.7	4.5	1.2	1.9	8.5	13.5	4.8	17.5	10.4	0.0	5.4
Biogas	2012	6.7	2.2	10.1	0.6	1.9	7.4	1.0	20.0	2.0	4.3	5.6
	2013	7.2	2.1	13.9	0.9	1.9	7.0	1.2	20.4	2.1	3.7	7.7
	2014	7.6	3.2	14.5	1.0	2.3	6.9	1.5	20.6	2.6	6.7	8.3
	2015	7.6	3.2	14.3	1.0	2.5	6.8	1.6	20.2	2.5	9.3	7.9
Biofuels	2012	6.3	2.8	5.9	2.8	11.7	26.6	9.0	9.3	8.0	10.5	1.8
	2013	6.5	2.4	5.5	3.7	10.7	33.9	9.2	9.4	8.2	10.1	2.3
	2014	7.1	4.1	6.2	4.0	12.1	33.4	8.2	10.0	9.2	10.2	2.6
	2015	6.7	4.8	5.0	4.6	11.8	29.9	7.8	8.5	10.4	9.4	2.9
Geothermal energy	2012	3.1	0.4	-	-	0.9	0.3	0.3	0.3	0.2	0.4	23.5
	2013	3.0	0.4	-	-	1.0	0.5	0.1	0.4	0.2	0.4	21.3
	2014	3.1	0.3	-	-	1.0	0.8	0.1	0.5	0.2	0.5	22.1
	2015	3.2	0.4	-	-	1.0	1.2	0.1	0.5	0.2	0.4	23.2
Municipal waste	2012	4.6	1.5	2.2	1.9	6.2	21.8	-	8.1	0.4	1.3	3.8
	2013	4.5	1.6	2.0	2.2	5.3	18.3	0.9	8.7	0.4	1.1	3.5
	2014	4.6	1.9	2.0	2.4	5.6	17.4	0.8	8.4	0.5	0.8	3.6
	2015	4.6	2.0	1.9	2.6	5.7	17.5	1.1	7.7	0.4	0.9	3.6

Fig. 5. Share of renewable energy obtained from solid biofuels, wind and water in selected EU countries in 2015



During this period, in the EU-28, there was a decrease in the share of solid biofuels in obtaining energy from renewable sources from 48.7% to 44.6%. In contrast, we saw an increase in the share of solar energy from 4.9% to 6.4%, wind energy from 9.7% to 12.7% and biogas from 6.7% to 7.6%. The decrease in the share of solid biofuels was noted especially in Poland, the Netherlands, Germany and Italy. The largest increase in the share of solar energy occurred in Germany, the Netherlands and France. Clear increase in the share of wind energy were recorded in Poland, Germany and the Netherlands. With regard to biogas, the increase of its use occurred in Slovakia, Czech Republic and Italy.

Structure obtaining energy from renewable sources for Poland in 2015 (data according to Table 3) differs substantially from shown in Fig. 4 the structure of energy generation from renewable sources for the EU-28. This structure is primarily due to the characteristic of the Polish geographical conditions and possible development of the land.

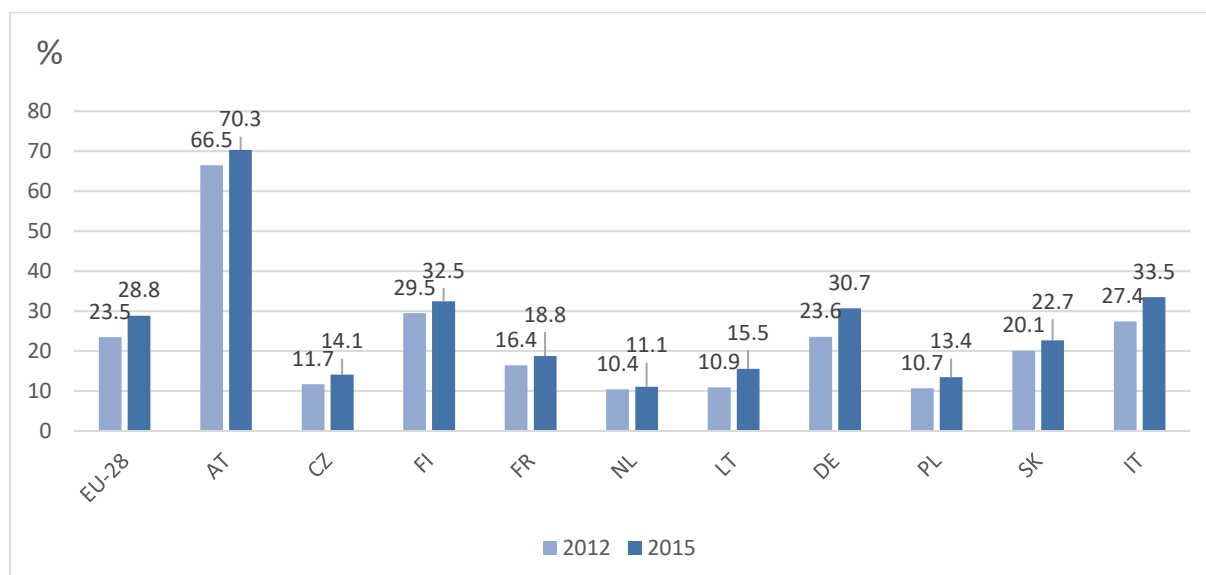
One of the objectives of the European Union in the field of renewable energy development is to increase the share of electricity produced from renewable energy sources in gross final consumption. The values of this index for selected EU countries in the years 2012 - 2015 are presented in Table 4.

Table 4. The share of electricity from renewable sources in the gross final electricity consumption in the selected countries of EU-28 in the years 2012 - 2015

Specification	2012	2013	2014	2015
	%			
EU-28	23.5	25.4	27.5	28.8
AT	66.5	68.0	70.1	70.3
CZ.....	11.7	12.8	13.9	14.1
FI	29.5	30.9	31.4	32.5
FR.....	16.4	16.9	18.3	18.8
NL	10.4	10.0	10.0	11.1
LT.....	10.9	13.1	13.7	15.5
DE	23.6	25.3	28.2	30.7
PL.....	10.7	10.7	12.4	13.4
SK.....	20.1	20.8	22.9	22.7
IT.....	27.4	31.3	33.4	33.5

In the years 2012 - 2015 the share of electricity produced from renewable energy sources in the final gross electricity consumption in the EU increased from 23.5% to 28.8%. In individual countries this ratio is varied as shown in Fig. 6. The largest increase in the share occurred in Germany - 7.2 percentage points, Italy – 6.0 and Lithuania - 4.7 percentage points. In Poland, this share increased by 2.8 percentage points. The smallest increases were observed in the Netherlands - 0.7 percentage points.

Fig. 6. Share of electricity from renewable sources in gross final electricity consumption in the selected countries of EU in the years 2012 and 2015



The share of individual renewable energy commodities in electricity generation in selected EU countries in the years 2012 - 2014 are given in Table 5. In addition, in Fig. 7 and 8 show the share of solid biofuels, water and wind energy in electricity production from renewable sources for the EU and Polish.

Table 5. The structure of electricity production from renewable energy sources in selected EU countries in the years 2012 - 2015

Specification		EU-28	AT	CZ	FI	FR	NL	LT	DE	PL	SK	IT
		%										
Solid biofuels	2012	10.4	7.3	22.5	37.5	1.7	31.6	14.9	8.4	56.5	13.2	2.8
	2013	9.4	7.4	18.1	44.1	1.4	23.8	18.3	7.6	46.5	10.7	3.3
	2014	9.4	6.9	21.7	41.7	1.9	17.9	19.4	7.3	46.2	14.7	3.2
	2015	9.7	7.4	22.2	34.7	2.4	13.9	19.0	5.9	39.8	18.2	3.6
Solar energy	2012	9.3	0.7	26.6	0.0	4.9	1.8	0.2	18.4	0.0	7.7	20.5
	2013	10.0	1.2	21.8	0.0	5.0	4.0	2.9	20.4	0.0	9.3	19.3
	2014	10.9	1.6	23.1	0.0	6.5	6.7	4.8	22.2	0.0	9.6	18.5
	2015	11.5	2.0	24.0	0.0	8.2	8.2	4.4	20.7	0.3	8.4	21.1
Hydro	2012	43.8	85.5	26.4	59.0	71.1	0.8	35.8	15.2	12.1	75.0	45.4
	2013	43.4	83.5	29.4	50.1	74.2	0.9	34.1	15.1	14.3	76.3	47.1
	2014	41.7	82.1	20.8	51.0	68.8	1.0	26.4	12.1	11.0	67.6	48.5
	2015	36.5	78.4	19.1	54.9	61.3	0.7	20.8	10.1	8.1	64.0	41.8
Wind	2012	26.9	4.8	5.2	1.7	18.1	39.8	45.6	35.3	28.1	0.1	14.5
	2013	27.5	6.3	5.2	3.0	15.8	46.2	39.5	33.9	35.2	0.1	13.3
	2014	28.1	7.7	5.2	4.2	18.9	49.5	42.3	35.3	38.7	0.1	12.6
	2015	32.3	10.2	6.1	7.6	23.9	55.1	48.3	42.3	47.9	0.1	13.6
Biogas	2012	6.0	1.2	18.2	0.6	1.6	8.1	3.6	19.0	3.3	3.5	5.0
	2013	6.3	1.3	24.6	1.2	1.6	8.0	3.9	19.2	4.0	3.4	6.6
	2014	6.4	1.2	28.2	1.3	1.8	8.6	5.2	19.1	4.1	7.7	6.8
	2015	6.5	1.3	27.7	1.2	2.0	7.6	5.1	17.7	4.0	9.0	7.5
Biofuels	2012	0.5	-	-	-	-	-	-	0.2	-	-	3.4
	2013	0.5	-	-	-	-	-	-	0.2	0.0	-	3.4
	2014	0.5	-	-	-	-	-	-	0.2	-	-	3.6
	2015	0.6	-	-	0.0	-	-	-	0.2	0.0	-	4.5
Geothermal energy	2012	0.8	0.0	-	-	-	-	-	0.0	-	-	6.1
	2013	0.7	-	-	-	-	-	-	0.1	-	-	5.1
	2014	0.7	-	-	-	-	-	-	0.1	-	-	4.9
	2015	0.7	-	-	-	-	-	-	0.1	-	-	5.7
Municipal waste	2012	2.4	0.5	1.1	1.2	2.7	17.9	-	3.5	-	0.5	2.3
	2013	2.2	0.5	0.9	1.5	2.0	17.0	1.2	3.6	-	0.3	2.0
	2014	2.2	0.5	1.0	1.7	2.2	16.3	1.9	3.7	-	0.4	2.0
	2015	2.2	0.6	0.9	1.5	2.2	14.6	2.5	3.1	-	0.4	2.2

Fig. 7. The share of energy of solid biofuels, wind and water in the production of electricity from renewable sources in the European Union (EU-28)

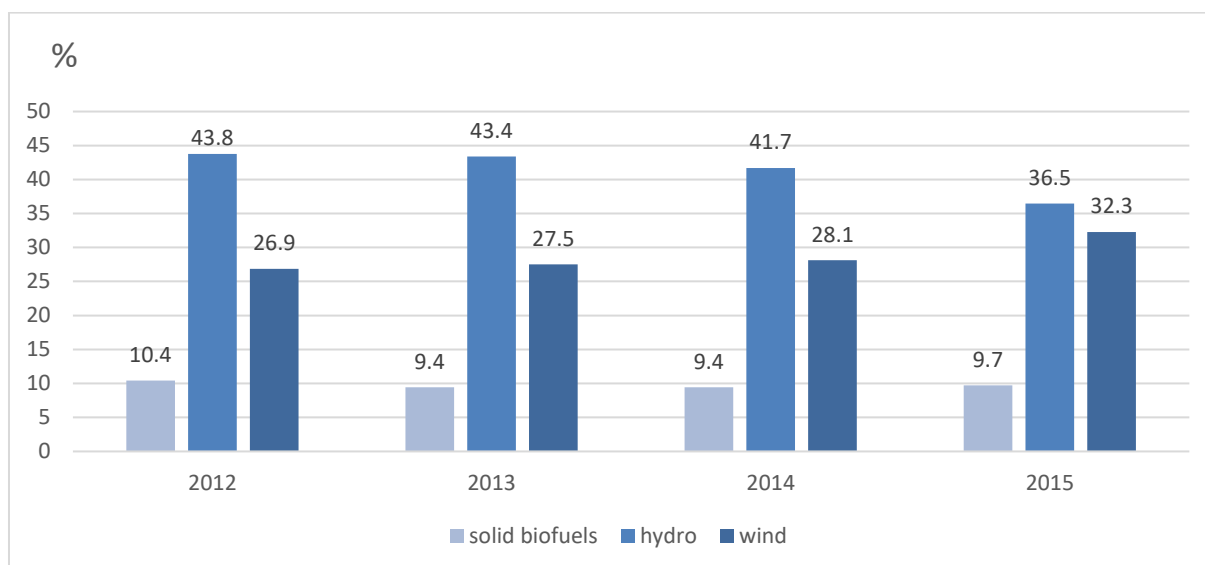
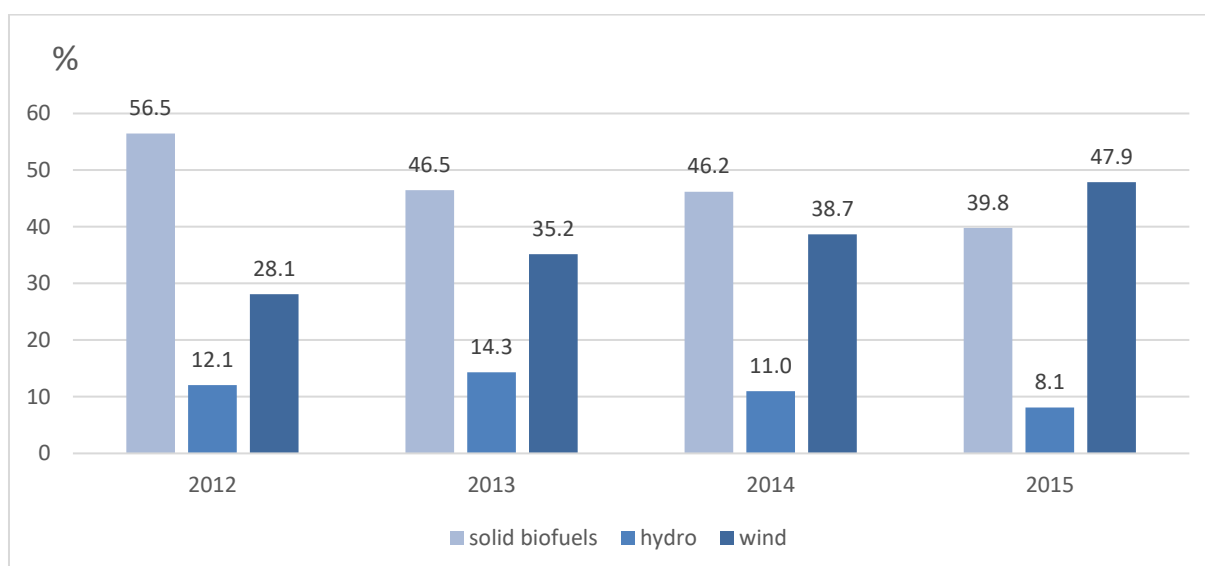


Fig. 8. The share of energy of solid biofuels, wind and water in the production of electricity from renewable sources in Poland



In the reported period (2012 - 2015), in the EU-28 was an increase in the share of solar energy in electricity production (from 9.3% to 11.5%). The largest increase occurred in the Netherlands (from 1.8% to 8.2%), Lithuania (from 0.2% to 4.4%) and France (from 4.9% to 8.2%). There has also been an increase in the share of electricity generated by wind power in UE-28, particularly in Poland (from 28.1% to 47.9%). While the decline in the share of renewable energy in electricity production was observed in the case of solid biofuels and energy of water.

4. The use of renewable energy sources

The national renewable energy commodities balances for the years 2012 - 2016, based on the results of statistical surveys, are presented in Appendix 1 of this study. These balances illustrate the trends of use of various renewable energy commodities.

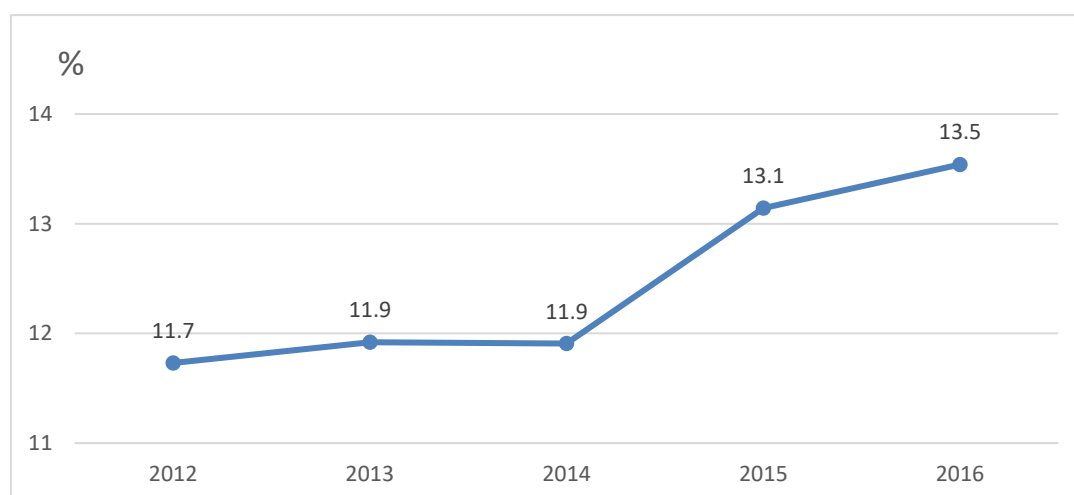
Data concerning obtaining of total primary energy in the years 2012 - 2016, including renewable energy, presented in Table 6.

Table 6. The share of renewable energy in the overall obtaining of the primary energy in the years 2012 – 2016

Specification	2012	2013	2014	2015	2016
	TJ				
Production of total primary energy	3,038,921	3,006,461	2,853,825	2,869,751	2,804,263
Production of total energy from RES.....	356,474	358,337	339,810	377,158	379,687
	%				
Share of energy from renewable sources in the total primary energy	11.7	11.9	11.9	13.1	13.5

In the reporting period, with the level of obtaining primary energy remaining at a similar level, there was a systematic increase in the level of energy obtained from renewable sources (in 2016, higher by 6.5% as compared to 2012). The share of renewable energy in the total primary energy has increased - from 11.7% in 2012 to 13.5% in 2016. (Fig. 9).

Fig. 9. The share of energy from renewables in the total primary energy

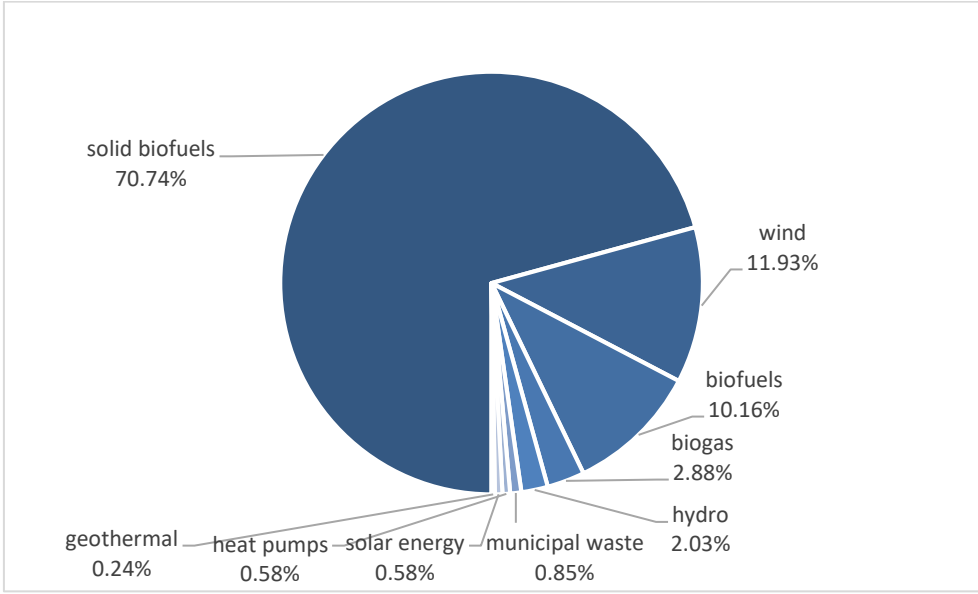


The structure of obtaining energy from renewable sources in Poland by the share of the renewable energy commodities are shown in Table 7 for the years 2012-2016, and in Fig. 10 for the year 2016.

Table 7. The share of renewable energy commodities in the total renewable energy obtained in the years 2012 – 2016

Specification	2012	2013	2014	2015	2016
	%				
Solid biofuels.....	82.07	79.88	76.14	73.23	70.74
Solar energy.....	0.17	0.29	0.43	0.50	0.58
Hydro.....	2.06	2.45	2.31	1.75	2.03
Wind.....	4.79	6.03	8.13	10.36	11.93
Biogas.....	1.97	2.12	2.56	2.54	2.88
Biofuels	7.96	8.18	9.18	10.39	10.16
Geothermal energy	0.19	0.22	0.25	0.24	0.24
Municipal waste	0.38	0.39	0.45	0.44	0.85
Heat pumps.....	0.41	0.44	0.55	0.54	0.58

Fig. 10. The share of renewable energy commodities in the total renewable energy obtained in Poland in the year 2016



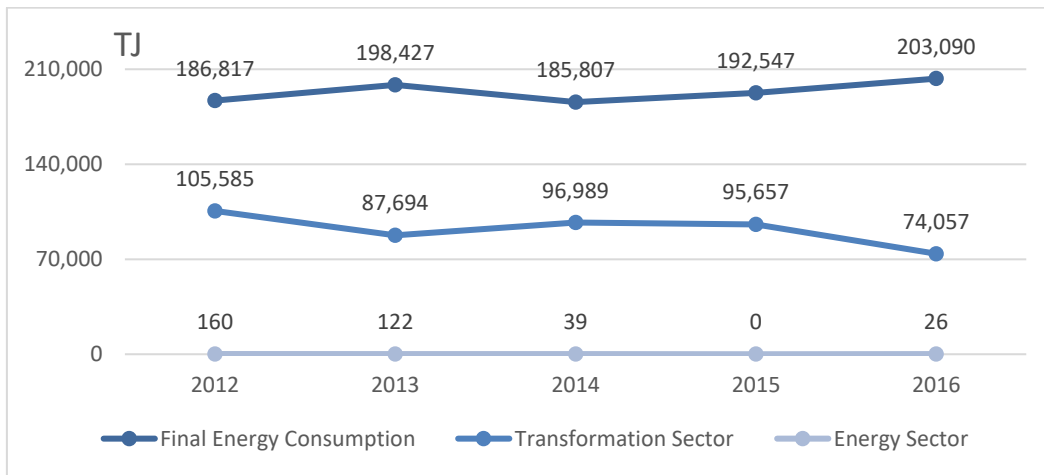
Solid biofuels have a dominant position in the domestic production and consumption of energy from renewable sources. Their participation in obtaining energy from renewable sources in 2016 accounted for 70.74% of acquired energy from renewable sources. In the reported period (2012-2016) the share of wind energy increased from 4.79% to 11.93%, liquid biofuels from 7.96% to 10.16%, biogas from 1.97% to 2.88%, solar energy from 0.17% to 0.58%, while the share of energy of water decreased from 2.06% to 2.03%.

Solid biofuels

Presented in Appendix. 1 balance of solid biofuels shows that in the years 2012-2016 there were fluctuations of origin produced and consumed energy. National obtaining solid biofuels in 2016 was lower by 8.2% compared to 2012, and consumption decreased by 5.3%. In 2016, it was reported import of these fuels equivalent to the energy 24,305 TJ, which accounted for 8.8% of inland consumption and export 15,709 TJ, ie. 5.8% of indigenous production.

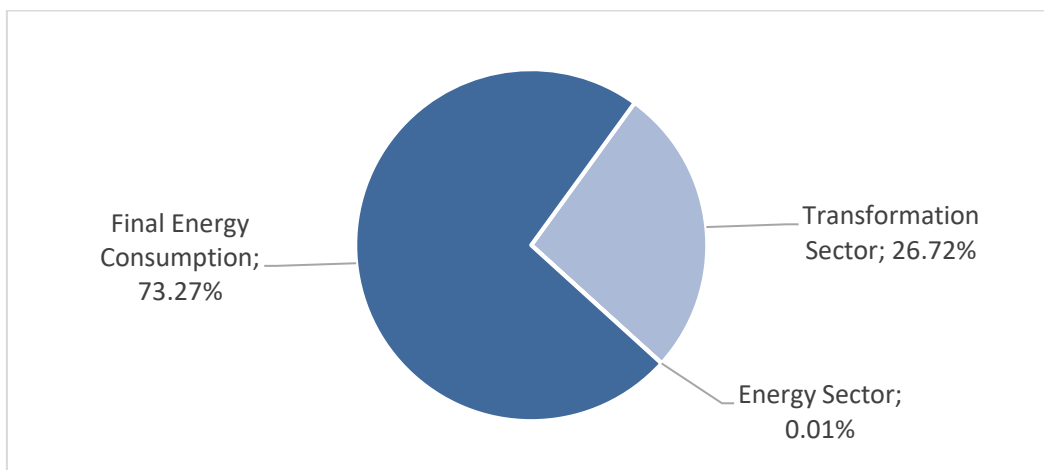
A simplified balance of consumption of solid biofuels in 2012-2016 and the structure of their consumption in 2016 are presented in Figures 11 and 12.

Fig. 11. Simplified balance of consumption of solid biofuels in 2012-2016



In the years 2012 - 2016 there were varying trends in the structure of consumption of solid biofuels. Their consumption as input energy to transformations sector were decreasing, while increasing their consumption in the final sector.

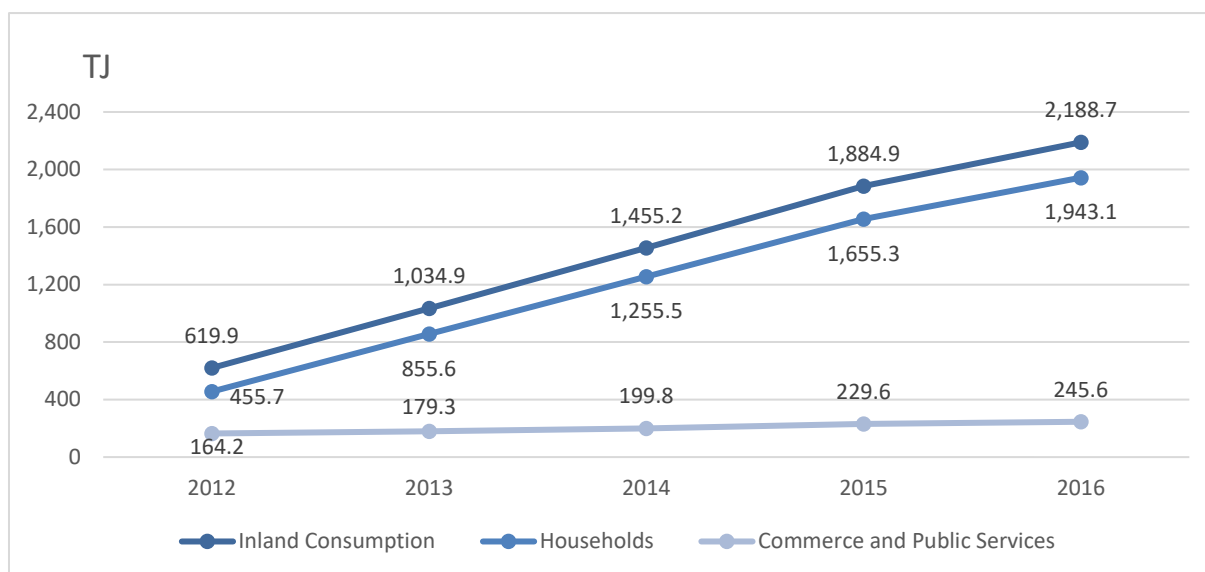
Fig. 12. The structure of consumption of solid biofuels in 2016



Solar energy

In the balance sheet data on solar energy (Annex 1) show a steady increase, and so in 2016 the energy consumption was 3.5 times higher compared to 2012. Solar energy was used in the household and in the commerce and public services. In 2016, households accounted for 88.8% of inland consumption, and the remaining 11.2% in the commerce and public services. Consumption of solar energy in this period shows the figure 13.

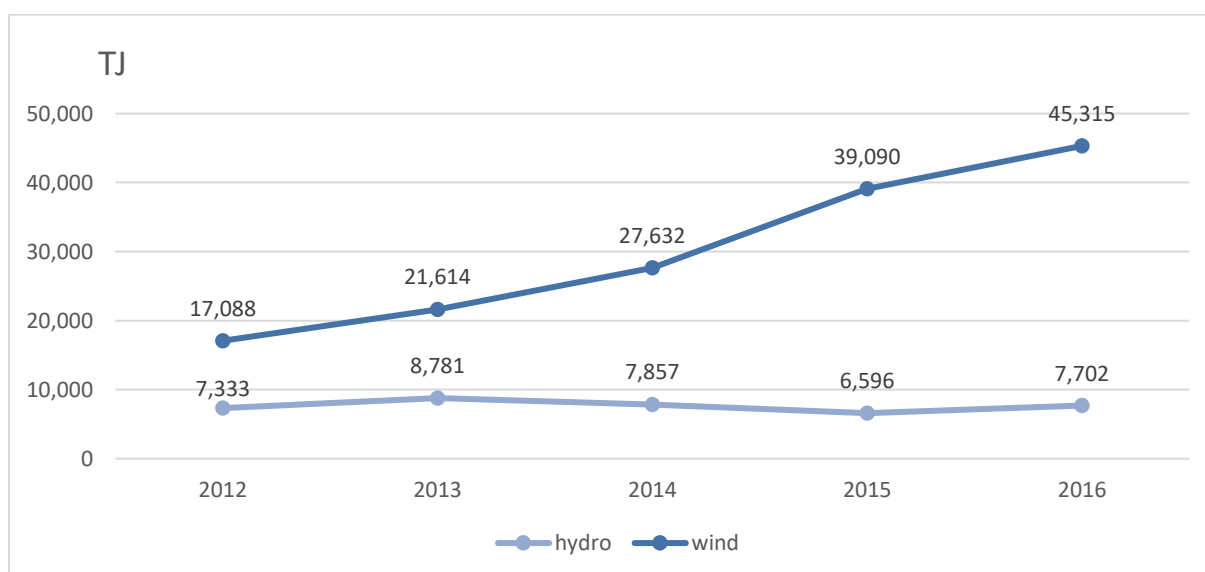
Fig. 13. Consumption of solar energy in the years 2012 - 2016



Hydro and wind energy

Data concerning acquisition and use of water and wind energy in the years 2012-2016 are presented in Appendix 1 and Fig. 14.

Fig. 14. Inland Consumption of wind and hydro energy



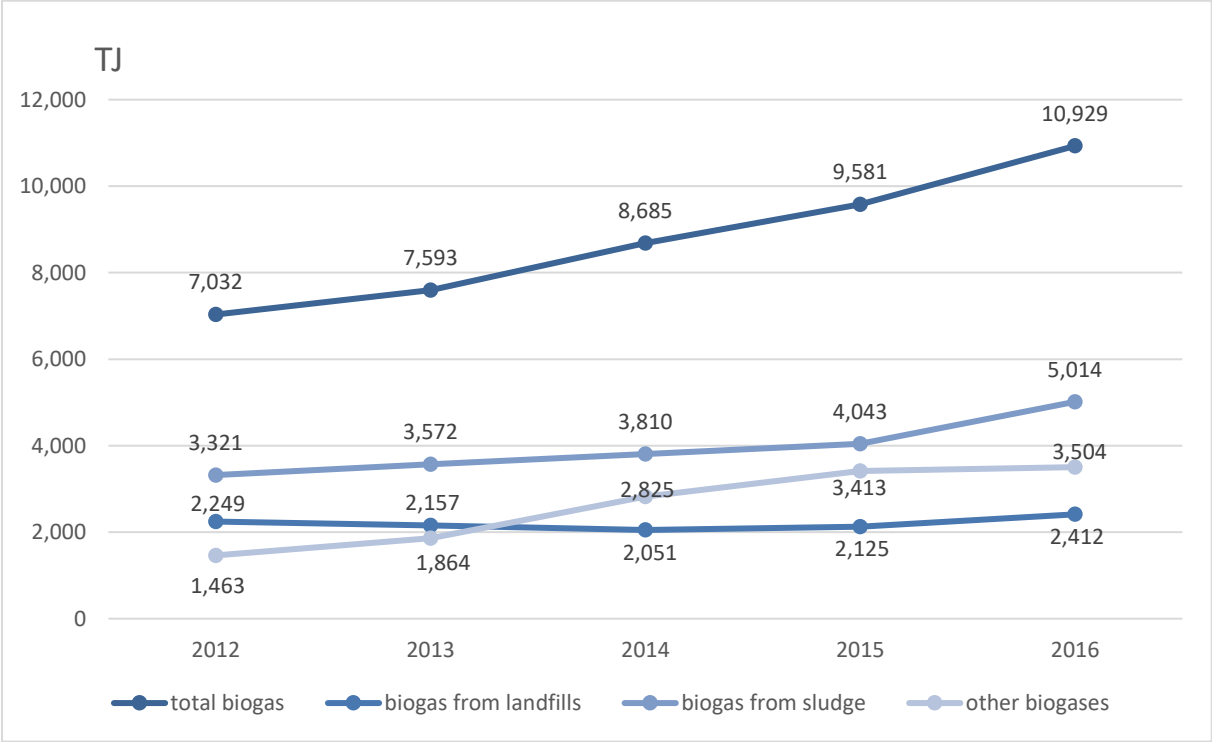
During this period, the water energy was consumed at a similar level, while there was a significant increase in the amount of energy produced in wind power plants. In 2016, electricity production in wind power plants was by 15.9% higher than the electricity generated in 2015 and more than 2.7 times higher than that produced in 2012.

Detailed data on electricity generation in hydropower and wind farms is presented in Chapter 5 of this study

Biogas

Balance sheet data on biogas detailing the sources of origin: landfills, sewage and other biogases is presented in Annex 1. During this period, the amount of produced biogas increased steadily and in 2016 was obtained about 55.4% more than in 2012.

Fig. 15. Obtaining and consumption of biogas in the years 2012 - 2016

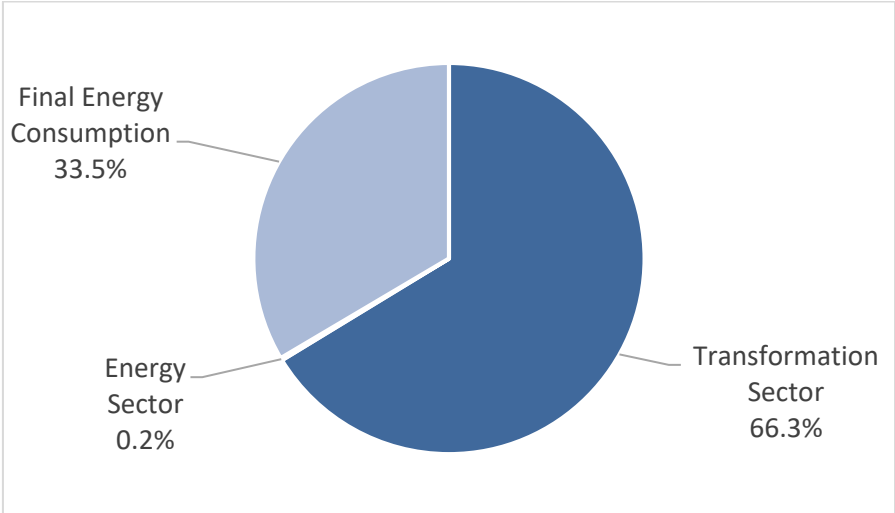


The largest increase occurred in the group of „other biogases " (in 2016, almost 2.4 times higher compared to 2012).

Obtaining biogas from sewage treatment plants increased in 2016 by 51.0% compared with 2012. While obtaining biogas from landfills remained in this period at a similar level.

Biogas is mainly used as an input of energy transformations (production of electricity and heat). The structure of the use of biogas is presented in Fig. 16.

Fig. 16. The structure of biogas consumption in 2016



Consumption of biogas on the input of energy transformations accounted for 66.3% of the total inland consumption of biogas in 2016. The remaining 33.5% was the final energy consumption, mainly in the commerce and services sector (25% of inland consumption), at the same time, own consumption of the energy sector amounted to 0.2% of the obtained biogas.

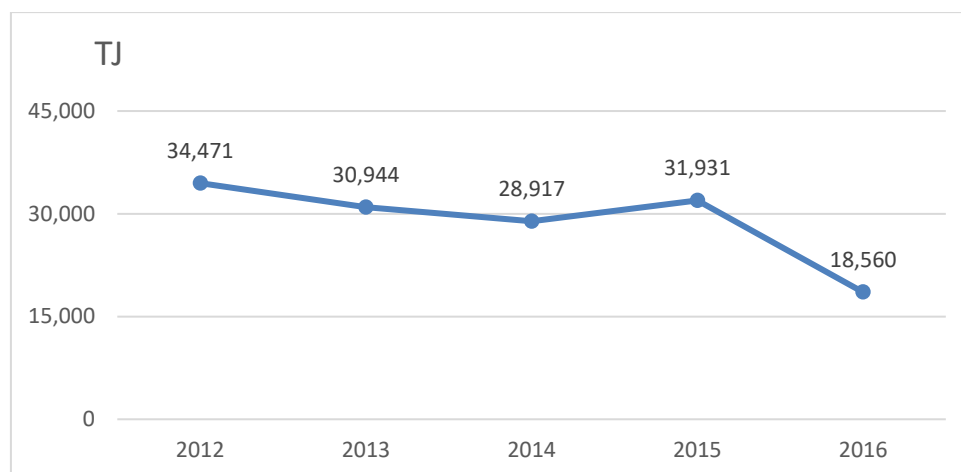
Liquid biofuels (for transport)

The balances of liquid biofuels for transport (bioethanol and biodiesel), in energy units (TJ) is included in Annex 1, and in natural units (Mg - tonnes) are shown in Table 8.

Table 8. The balance of bioethanol and biodiesel in the years 2012 - 2016

Specification	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
	Mg (tona)									
	bioethanol					biodiesel				
Indigenous Production	172,530	190,919	142,787	173,933	195,368	605,385	642,371	739,013	931,856	900,562
Imports(+)	43,828	41,158	64,196	65,680	69,023	181,390	156,218	129,880	189,296	216,645
Exports (-)	1,900	2,725	2,192	2,326	2,953	48,508	157,984	235,038	420,170	797,270
Stock Changes (+/-).....	2,480	-3,038	1,431	741	-1,432	-8,365	19,915	-2,801	-11,673	-7,997
Inland Consumption	216,938	226,314	206,222	238,028	260,006	729,902	660,520	631,054	689,309	311,940
of which:										
Main Activity Producer Electricity Plants.....	-	-	-	-	-	71	192	101	1,768	2,084
For Blending to Motor Gasoline/Diesel	205,823	195,228	195,717	215,699	231,009	693,451	654,211	621,103	542,252	304,987
Finale consumption in transport.....	11,115	31,086	10,505	22,329	28,997	36,380	6,117	9,850	145,289	4,869

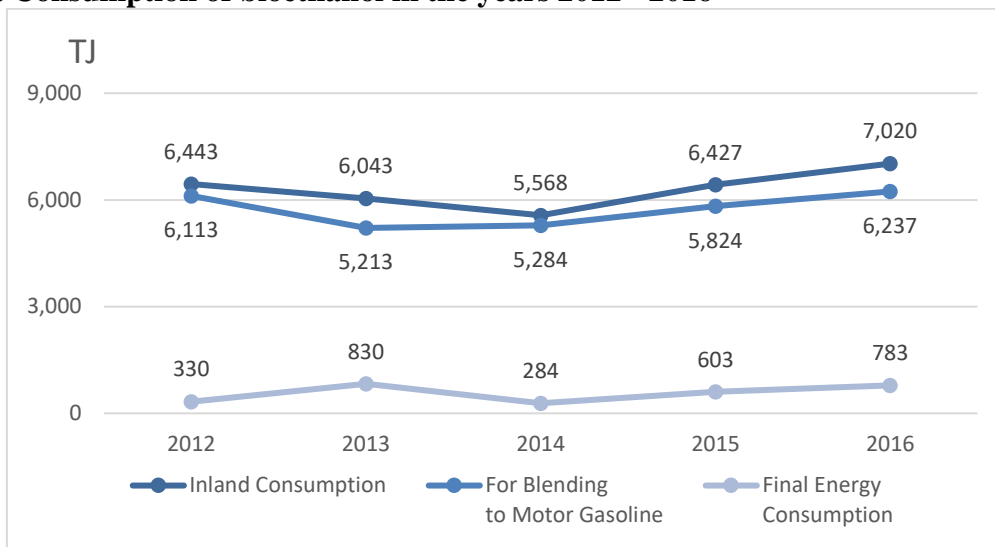
Fig. 17. Total consumption of liquid biofuels in the years 2012 - 2016



The presented data show that from 2012 to 2016, there was a gradual decline in inland consumption of biofuels, despite the fact that in 2015 its consumption increased by 10.4% compared to 2014 however, it still remained at a level lower by 8.8% compared to 2012. In 2016, there was a decrease in domestic consumption of liquid biofuels amounting to 41.9% compared to 2015 and almost 46.2% in comparison with 2012, which was caused by the increase in exports of liquid biofuels (biodiesel).

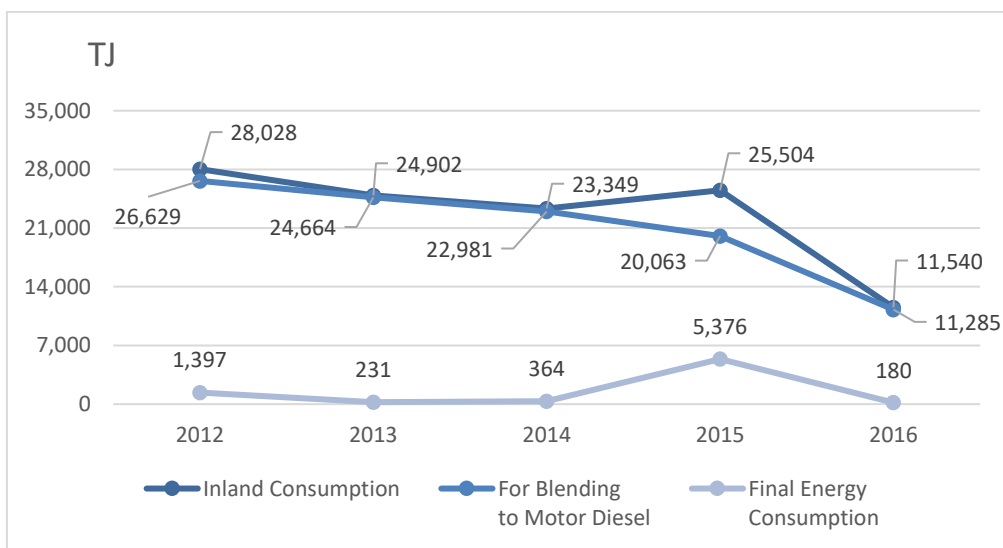
Fig. 18 and 19 show the energy of inland consumption of bioethanol and biodiesel in total, broken down on the consumption of petroleum products blending and final consumption in transport.

Fig. 18. Consumption of bioethanol in the years 2012 - 2016



In the discussed period there was a slight increase in the consumption of bioethanol and a significant decrease in biodiesel consumption. In 2016, consumption of bioethanol increased by 9.0%, and biodiesel consumption decreased by 58.8%, compared to consumption in 2012. Both of these biofuels are mainly used as components of motor fuels in the blending of petroleum products.

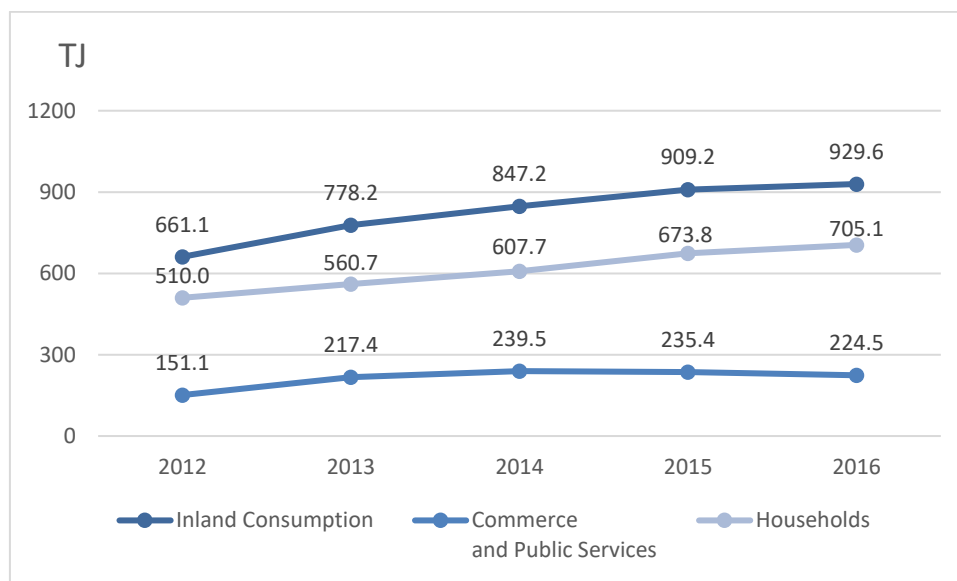
Fig. 19. Consumption of biodiesel in the years 2012 - 2016



Geothermal energy

Geothermal energy has been used mainly to satisfy the heat demand, in 2016 - 75.9% of consumption in households and 24.1% in commerce and public services. Fig. 20 shows the directions of use of this energy.

Fig. 20. Consumption of geothermal energy in the years 2012 - 2016

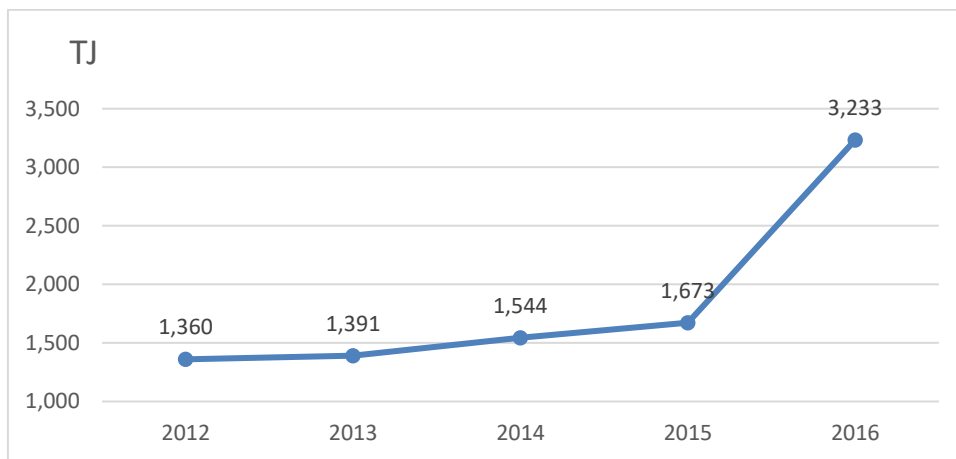


The data indicate that in the years 2012 - 2016 a gradual increase in the use of geothermal energy has performed. In 2016, the consumption was about 40.6% higher than the consumption in 2012.

Energy of renewable municipal waste

Energy of biodegradable municipal waste in the years 2012 - 2016 was used in the mineral industry. In the period 2014-2015, it is observed little consumption of the energy in main activity producer heating plants (1% of inland consumption), which in 2016 increases to the level of 10%. Fig. 21 shows the consumption of biodegradable municipal waste in the subsequent years of the discussed period.

Fig. 21. Consumption of biodegradable municipal waste



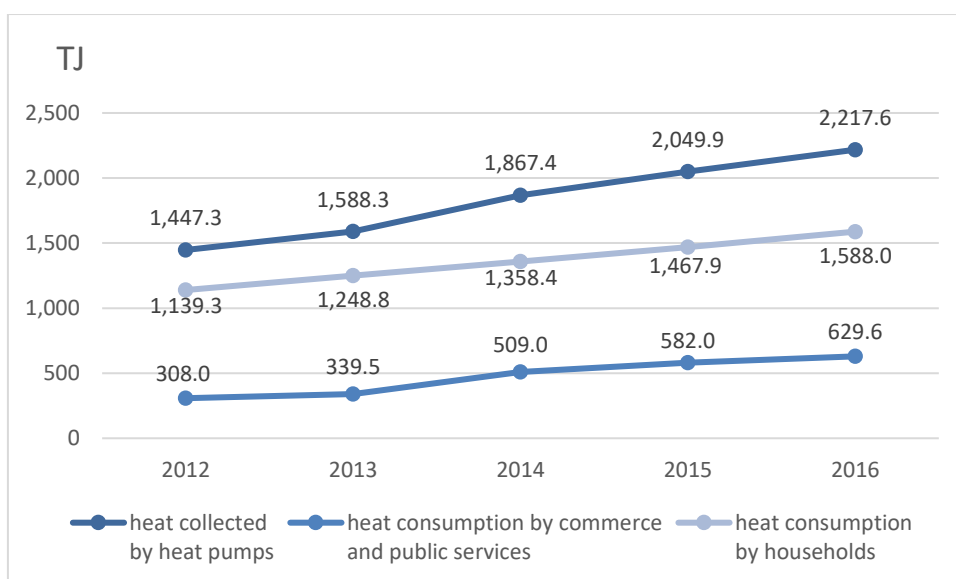
The above statistical data shows that in 2016 there was a significant increase in consumption of this energy in comparison with the previous year and amounted to 93.2%. In the earlier years, these increases have been not very big compared to the previous year and amounted in 2013 - 2.3% and in 2014 - 11% and in 2015 – 8.4%. In the years 2012 - 2016 the energy consumption of biodegradable municipal waste increased by 137.7%.

Ambient heat obtained by the heat pumps

Energy collected by the heat pumps in full was used in the sectors of commerce and public services and households.

Energy consumption gained by the heat pumps in the years 2012 - 2016 is shown in Fig. 22.

Fig. 22. Consumption of heat collected by the heat pumps



During this period it was a systematic increase in the use of energy produced by the heat pumps. In 2016, the heat obtained in this way was 53.2% higher compared to 2012. At the same time in this period, renewable energy of heat pumps consumed in the household sector increased by 39.4% and in the sector of commerce and public services by 104.4%.

5. Production of electricity and heat from renewables

The amount of electricity produced from renewable energy sources in the years 2012 - 2016 are presented in Table 9 and Annex 2 presents the breakdown by the manufacturing sites.

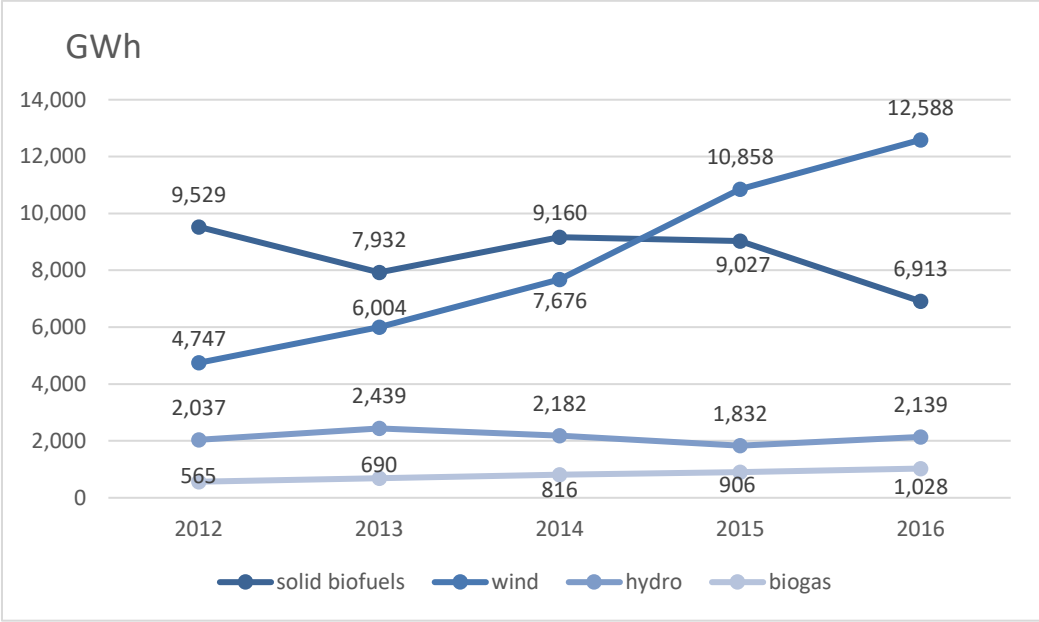
Table 9. Generation of electricity from renewables in the years 2012 – 2016

Specification	2012	2013	2014	2015	2016
	GWh				
Total	16878.9	17066.5	19841.8	22684.1	22807.4
Hydro	2036.9	2439.1	2182.5	1832.2	2139.4
of which:					
Hydro-1 MW	320.7	351.9	322.0	328.0	320.5
Hydro 1-10 MW	619.5	645.3	564.6	493.5	588.3
Hydro 10+ MW	1096.7	1442.0	1295.9	1010.7	1230.6
Wind	4746.6	6003.8	7675.6	10858.4	12587.6
Solid biomass	9528.7	7931.8	9160.2	9026.6	6912.7
<i>in which co-combustion</i>	7238.6	3928.5	4510.5	4286.1	2087.9
Municipal waste	-	-	-	-	12.7
Biogas	565.4	689.7	816.3	906.4	1027.6
of which:					
Landfill gas.....	236.5	240.7	225.3	226.8	223.5
Sludge gas	193.7	233.5	252.5	275.6	364.4
Other biogas	135.1	215.5	338.4	404.0	439.7
Biofuels	0.2	0.6	0.3	3.8	3.4
Photovoltaics	1.1	1.5	6.9	56.6	123.9

In the years 2012 - 2016 the production of electricity from renewable sources increased steadily. At the same time changes followed in amounts of shares of individual carriers in the production of this energy.

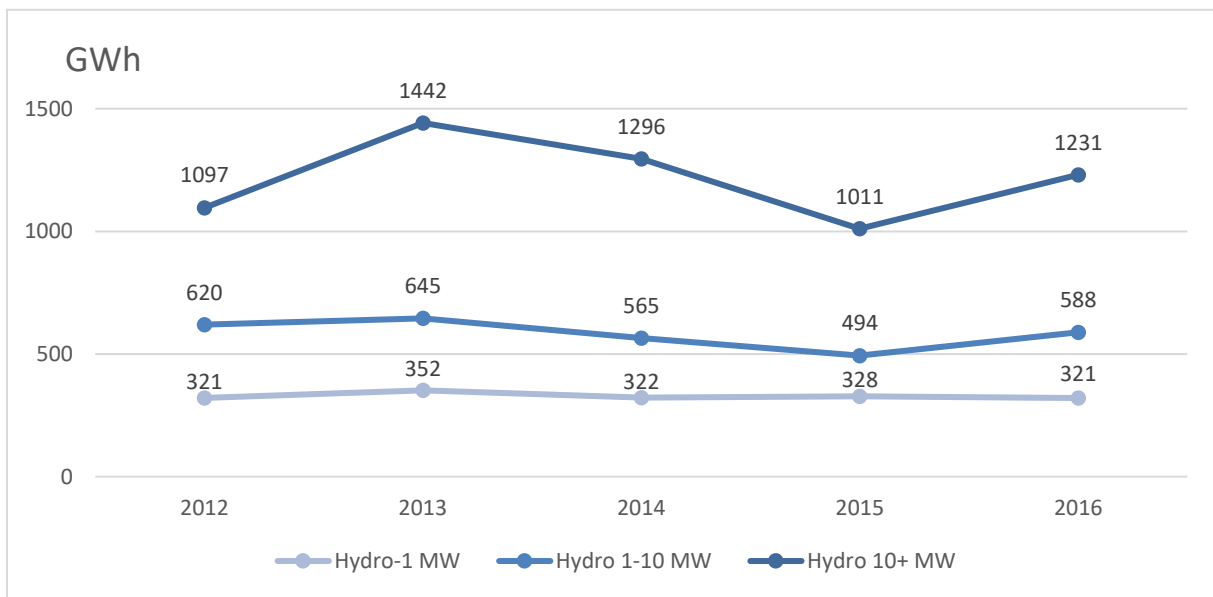
Fig. 23 shows the amount of electricity produced by dominant in this field renewable energy commodities, i.e. solid biofuels, wind, water and biogas.

Fig. 23. Electricity generation from renewable energy sources



During this period, production of electricity from wind power rapidly grew. The size of this production in 2016 was more than three times higher than in 2012. During burning solid biofuels the production of electricity in electricity plants and CHP plants persisted at a high level, although fluctuations occurred here annually with downward tendency. Electricity generation in these facilities was in 2015 bigger by 27.5% as compared to 2012. Also in relation to the installations using biogas an increase of electricity production was recorded, what resulted electricity generation in 2016 was 81.8% bigger then in 2012. The increase in production of electricity from biogas was caused by dynamic increase using of biogases belonging to the group of "other biogases" (in 2016, more than 3 times higher compared to 2012). Electricity produced in small- and medium- hydro power plants (<1 MW, 1 - 10 MW) shows a relatively stable tendency without sudden increases and decreases. In high-power plants (> 10 MW), can be observed its increases and decreases compared to the previous year, which range from plus 31.5% in 2013 to minus 22% in 2015, after which in 2016 its increase by 21.8% compared to 2015. Volume of the electricity production in hydro power plants, in three intervals generating capacity (Hydro-1 MW, Hydro 1-10 MW, Hydro 10+ MW), is shown in Fig. 24.

Fig. 24. Electricity generation by hydro power stations in the years 2012 - 2016



Changes in the structure of the use of renewable energy sources for electricity generation in the years 2012 and 2016 are presented in fig. 25 and 26.

Fig. 25. The share of renewable commodities in production of electricity in 2012

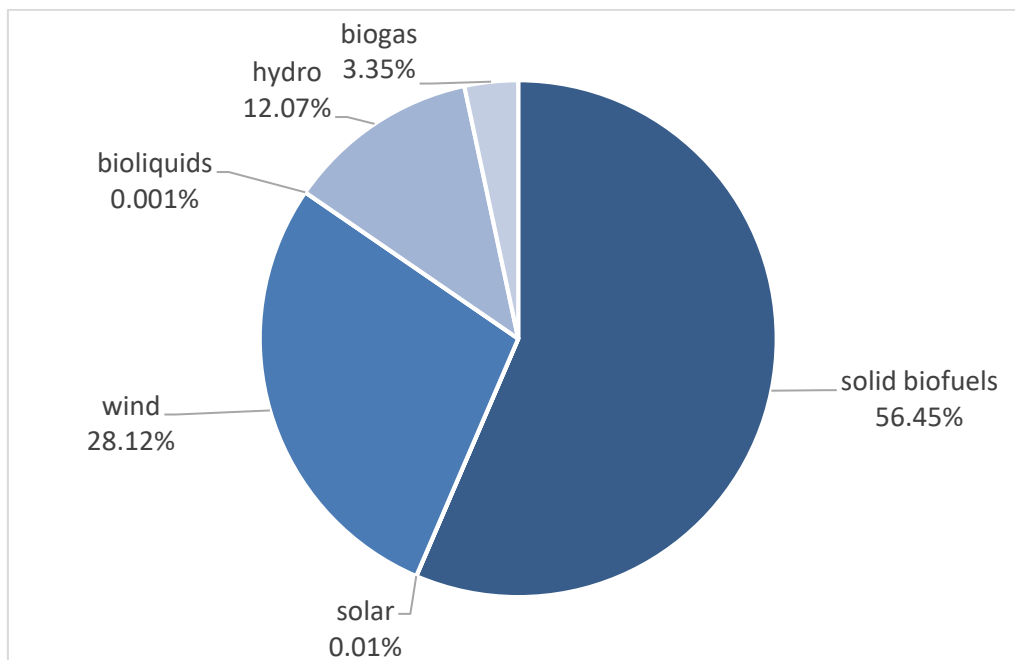
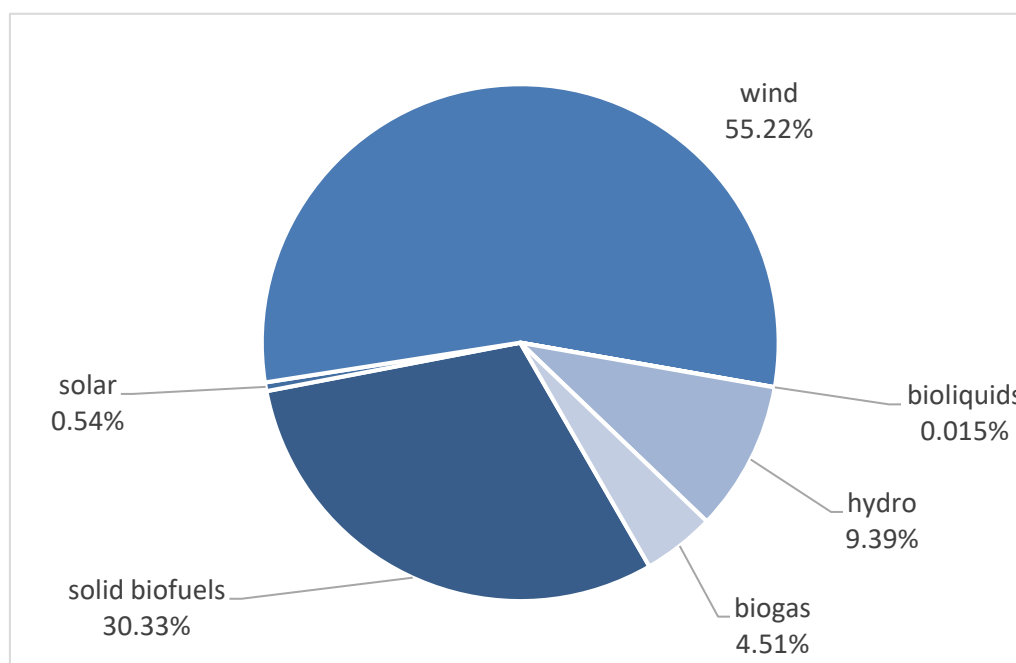


Fig. 26. The share of renewable commodities in production of electricity in 2016



In the structure of use of renewable energy sources for electricity production the share of wind energy is increasing, but decreasing share of water and solid biofuels. In recent years, there has been a gradual increase in the production of electricity from photovoltaic cells.

Table 10 and in the Annex 2 presents the breakdown by manufacturing sites production of heat from renewables in CHP plants and heating plants in the years 2012 – 2016.

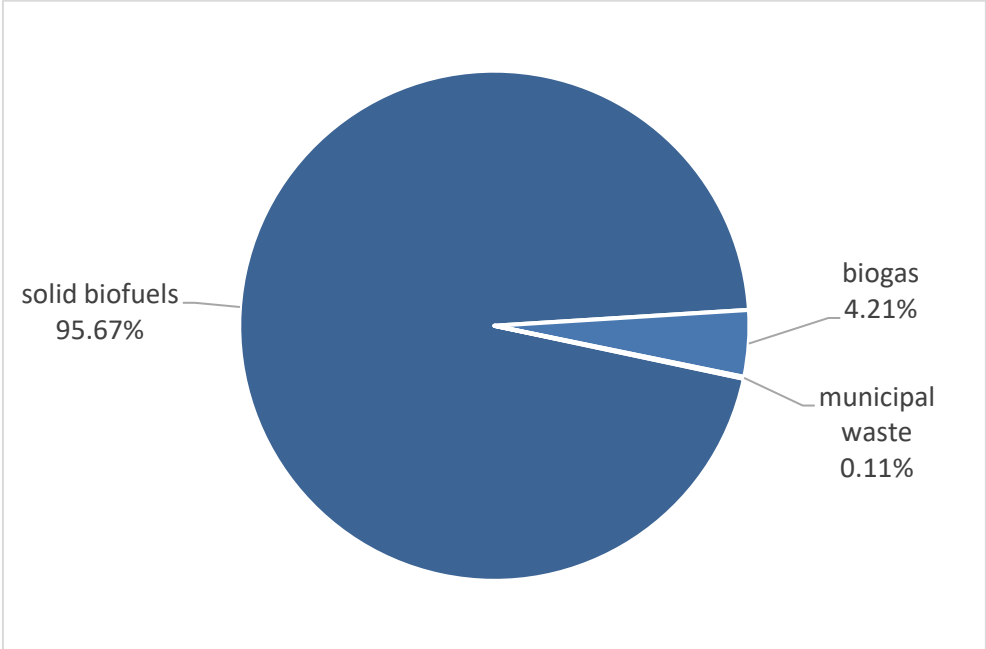
Table 10. Production of heat from renewables in the years 2012 - 2016

Specification	2012	2013	2014	2015	2016
	TJ				
Total	19,052	15,988	14,272	12,882	13,974
Solid biofuels	18,840	15,611	13,960	12,420	13,370
Municipal wastes	-	-	13	7	16
Biogas	212	377	299	436	588
of which:					
Landfill gas.....	69	74	69	67	18
Sludge gas.....	40	128	86	203	417
Other biogas.....	103	174	144	165	154
Biofuels	0	0	-	19	-

In the reporting period there were fluctuations in the amount of heat generated on the basis of renewable fuels in CHP plants and heating plants (main activity producer and autoproducer). Total heat production from 2013 to 2015 was systematically decreasing in relation to the previous year by 16.1%; 10.7%; 9.7%, while in 2016 it increased by 8.5% compared to 2015, but it was still lower compared to: 2012 by 26.6%, 2013 by 12.6% and 2014 by 21%.

The reason for decreasing of heat generation was gradually reducing the share of solid biofuels in heat production, whose share of 2012 was 98.89%, and then in 2016 decreased to 95.67%.

Fig. 27. The share of renewable commodities in production of heat in 2016



In 2016, solid biofuels were the basic carrier for the production of heat from RES (95.67%). The remaining carriers played only a "trace" role, eg biogas whose annual share in heat production systematically increased constituted a little over 4.21%, and municipal waste was about 0.11% of the heat produced.

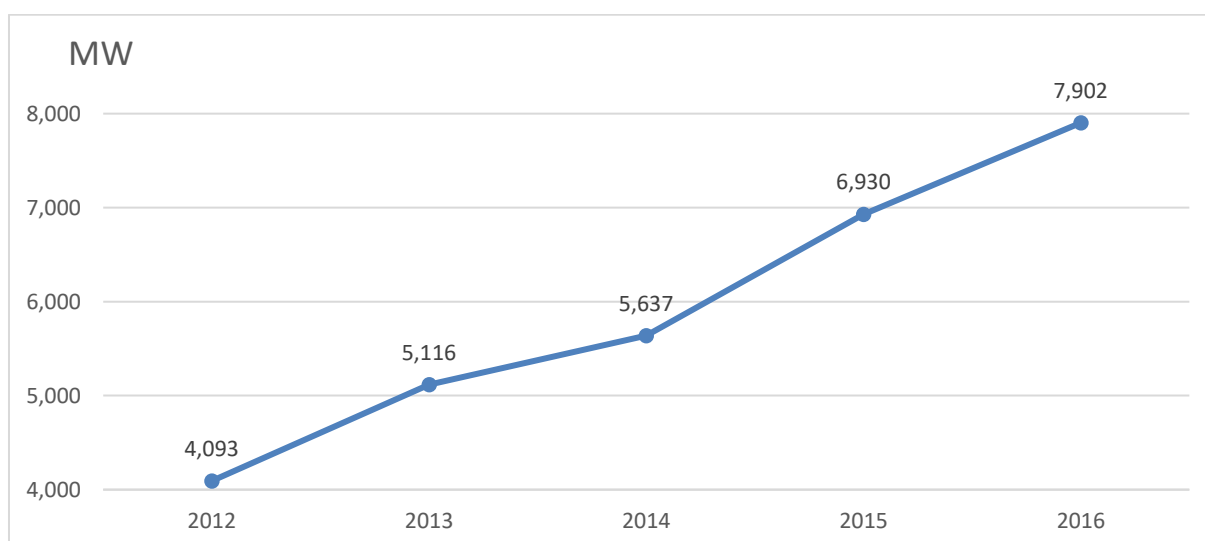
6. Achievable capacity of power plants using renewable sources for generation of electricity

Generating capacities of power stations using renewable energy sources in 2012 – 2016 are presented in Table 11 and Figure 28.

Table 11. Capacities of power stations using renewable energy sources in the years 2012 - 2016

Specification	2012	2013	2014	2015	2016
	MW				
Total	4,093	5,116	5,637	6,930	7,902
Hydro	945	949	958	964	972
of which:					
Hydro-1 MW.....	88	88	89	91	93
Hydro 1-10 MW.....	185	189	185	188	186
Hydro 10+ MW.....	672	672	684	685	693
Wind	2,564	3,429	3,836	4,886	5,747
Solid biofuels	455	582	629	740	727
Municipal wastes	-	-	0	15	44
Biogas	128	154	187	217	225
of which:					
Landfill gas	57	56	59	64	65
Sludge gas	42	51	60	73	77
Other biogas.....	29	47	68	80	83
Photovoltaics	1	2	27	108	187

Fig. 28. Capacities of power stations fueled by renewable energy commodities



In the analysed period there was a steady increase in generating capacity of power plants using renewable energy sources. In 2016, the total achievable capacity of generating facilities was by 93.1% higher compared to 2012. There was also a significant increase in comparison with 2012, the share of the available capacity of solid biofuels (by 59.8%), wind (by 124.1%) and biogas (by 76.0%).

In 2016, power capacity of wind power accounted for 72.7% of power plants using renewable energy sources. At the same time, installations using water energy delivers to 12.3%, and solid biofuels 9.2% of available capacity.

In recent years it has increased of capacity of solar power plants (photovoltaic) from 1 MW in 2012 to 187 MW in 2016 and It constituted in 2016 of 2.4% of generating capacity of power plants using renewable energy sources.

7. The share of energy from renewables in gross final energy consumption

In accordance with the Directive 2009/28/EC each Member State shall ensure that the share of energy from renewable sources, in gross final consumption of energy in 2020 is at least its national overall target for the share of energy from renewable sources in that year, as set out and specified in the Directive.

Such mandatory national overall targets are consistent with a target of at least a 20% share of energy from renewable sources in the Community's gross final consumption of energy (in 2020).

The share of energy from renewable sources in the gross final energy consumption is calculated as the quotient of the final gross energy consumption from renewable sources and the value of final gross energy consumption from all sources and is expressed as a percentage (%).

This goal has been set for Poland at 15%. Moreover, each Member State shall ensure that the share of energy from renewable sources in all forms of transport in 2020 is at least 10% of the final consumption of energy in transport in that Member State.

In the tables 12 – 13 are presented data on gross final energy consumption from renewable sources by sectors and the sectoral and total share of energy from renewable sources in gross final energy consumption in the years 2012 – 2016 (for Poland).

Table 12. Gross final energy consumption from renewable sources in the years 2012 – 2016

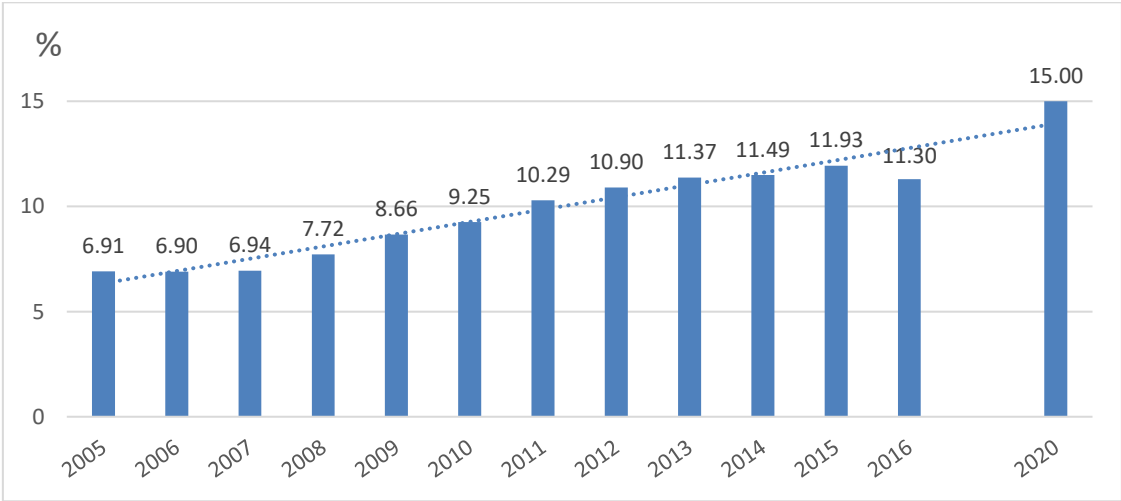
Specification	2012	2013	2014	2015	2016
	TJ				
<i>Gross final consumption of RES for heating and cooling.....</i>	211,887	220,978	207,824	214,212	228,965
<i>Gross final consumption of electricity from RES</i>	58,813	59,153	69,203	76,471	77,626
<i>Gross final consumption of energy from RES in transport.....</i>	36,068	33,763	32,076	35,508	22,401
<i>Gross total RES consumption.....</i>	306,768	313,894	309,103	326,192	328,991

Table 13. Sectoral and total share of energy from renewable sources in gross final energy consumption in the years 2012 - 2016

Specification	2012	2013	2014	2015	2016
	%				
The share of renewable energy in heating and cooling sector	13.37	14.10	14.01	14.54	14.70
The share of RES in electricity	10.68	10.73	12.40	13.43	13.36
The share of renewable energy in transport.....	6.46	6.59	6.25	6.44	3.93
The share of energy from renewable sources in gross final energy consumption	10.90	11.37	11.49	11.93	11.30

Data presented in Tables 12 and 13 were based on statistical surveys of public statistics and calculated by using application of SHARES_2016 (SHort Assessment of Renewable Energy Sources), which was made available by Eurostat to calculate the share of energy from renewable sources in gross final energy consumption.

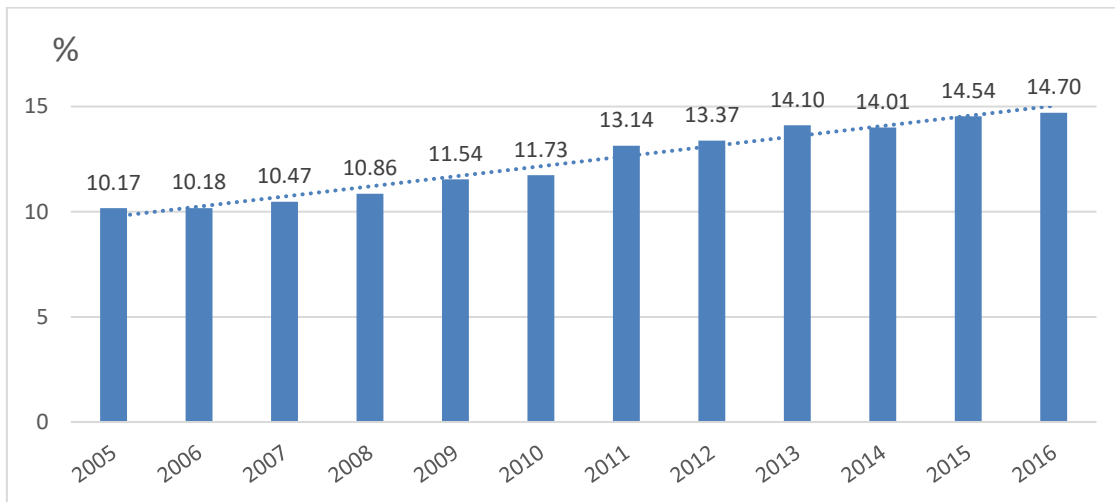
Fig. 29. Share of renewable energy in gross final energy consumption in the years 2005 – 2016



Indicator of share of energy from renewable sources in gross final energy consumption in 2016 amounted 11.30% and increased by 4.39 percentage points compared to 2005.

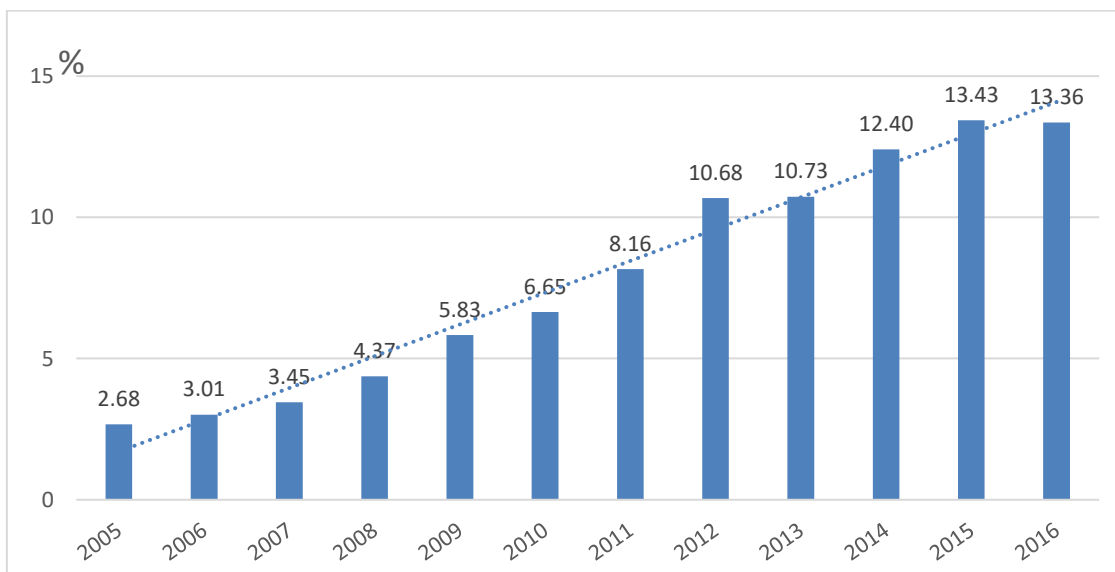
The average annual growth rate of the share of energy from renewable sources in gross final energy consumption in the years 2005 - 2016 amounted to 4.6%.

Fig. 30. Share of renewable energy in gross final energy consumption in heating and cooling



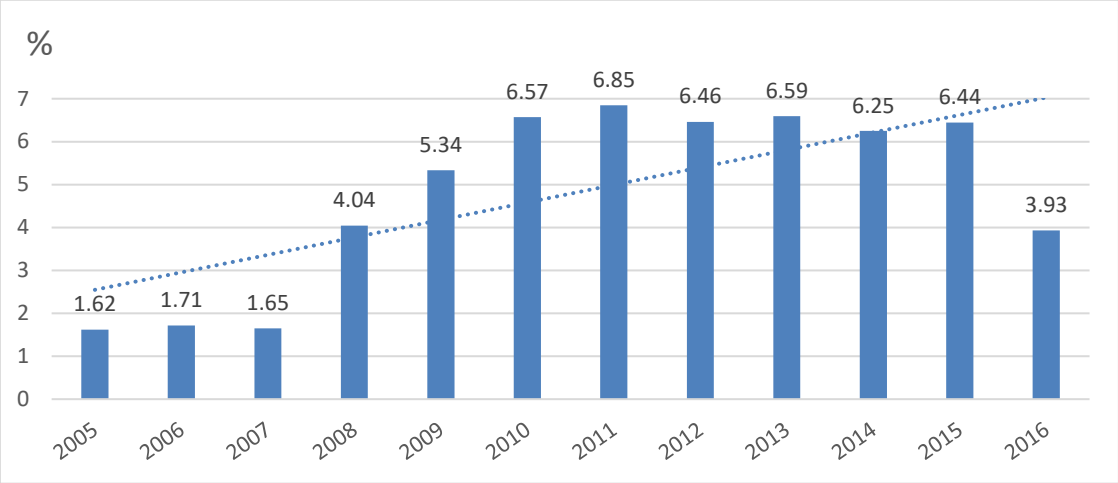
Indicator of share of RES in gross final energy consumption for heating and cooling is growing steadily and in 2016 amounted 14.70% and increased of 4.53 percentage points compared to 2005. The average annual growth rate of this indicator in the period 2005-2016 amounted to 3.4%.

Fig. 31. Share of renewable energy in gross final energy consumption in electricity



Indicator of share of RES in gross final energy consumption in the electric power is also growing steadily and in 2016 amounted 13.36% and increased of 10.68 percentage points compared to 2005. The average annual growth rate of this indicator in the period 2005-2016 amounted to 15.7%.

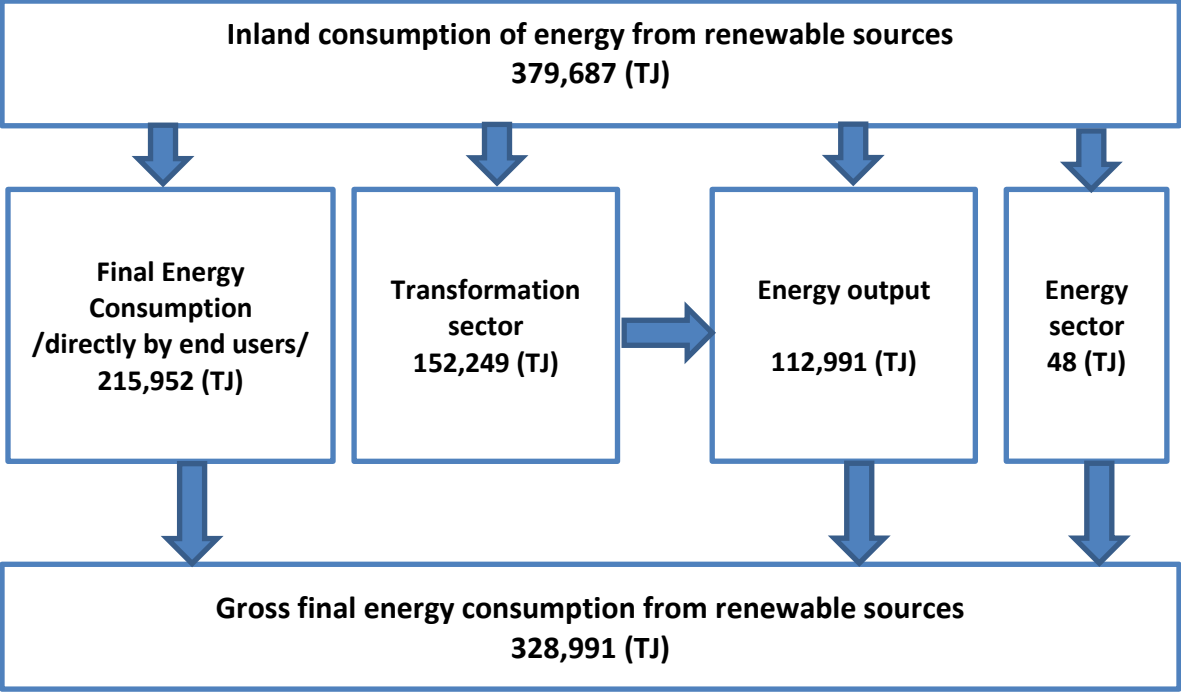
Fig. 32. Share of renewable energy in final energy consumption in transport



Indicator of share of RES in gross final energy consumption in transport was subject to large fluctuations. In 2016 amounted 3.93%, an increase of 2.31 percentage points compared to 2005. The average annual growth rate of this indicator in the period 2005-2016 amounted to 8.4%.

Diagram showing the structure of the gross final energy consumption from renewable sources is shown in Fig. 33.

Fig. 33. Structure of gross final energy consumption from renewable sources (for 2016)³



³ In Figure 33 the size of the energy consumption is indicated on the basis of Annex 1 and Table 12.

The balance of renewable energy commodities in the years 2012 – 2016

Specification	2012	2013	2014	2015	2016
	TJ				
	Total				
Indigenous Production	356,474	358,337	339,810	377,158	379,687
Imports(+)	8,267	6,988	39,625	36,120	34,185
Exports (-)	1,919	6,029	17,730	30,947	45,288
Stock Changes (+/-)	-248	670	-65	-412	-335
Inland Consumption	362,575	359,967	361,640	381,919	368,249
Transformation Sector	166,969	152,859	166,495	173,618	152,249
of which:					
Main Activity Producer Electricity /CHP Plants	119,408	106,309	123,012	131,462	117,241
Main Activity Producer Heat Plants	1,430	1,553	1,368	1,217	2,502
Autoproducer Electricity/CHP Plants	13,120	14,663	13,476	14,750	14,706
Autoproducer Heat Plants.....	270	457	374	302	278
For Blending to Motor Gasoline/Diesel	32,741	29,876	28,265	25,887	17,522
Energy Sector	160	122	39	-	48
of which:					
Own Use in Electricity, CHP and Heat Plants	108	77	-	-	22
Mining of coal and lignite	52	45	39	-	26
Oil and Natural Gas Extraction Plants.	-	-	-	-	-
Final Energy Consumption	195,446	206,986	195,106	208,302	215,952
of which:					
Industry Sector	43,708	54,776	56,446	59,033	65,170
of which:					
Iron and Steel.....	-	1	1	1	1
Non-Metallic Minerals	1,767	1,889	2,296	2,328	2,643
Transport Equipment	4	3	2	14	15
Machinery.....	27	56	93	73	105
Food, Beverages and Tobacco.....	635	866	1,098	1,479	1,790
Paper, Pulp and Printing	20,441	27,243	27,092	27,156	30,526
Wood and Wood Products	17,675	21,012	20,391	23,011	24,821
Non-specified (industry).....	3,159	3,706	5,473	4,971	5,269
Construction	120	115	81	6	10
Transport Sector	1,727	1,061	648	5,979	963
Other Sectors	149,891	151,034	137,932	143,284	149,810
of which:					
Commerce and Public Services	9,736	10,295	9,623	10,451	12,323
Households	118,955	119,515	108,672	112,192	115,671
Agriculture / Forestry	21,200	21,223	19,638	20,641	21,815

The balance of renewable energy commodities in the years 2012 – 2016 (cont.)

Specification	2012	2013	2014	2015	2016
	TJ				
	Solid biofuels				
Indigenous Production	292,562	286,243	258,723	276,199	268,577
Imports(+)	-	-	33,086	27,343	24,305
Exports (-)	-	-	8,974	15,338	15,709
Stock Changes (+/-)	-	-	-	-	-
Inland Consumption	292,562	286,243	282,835	288,204	277,173
Transformation Sector	105,585	87,694	96,989	95,657	74,057
of which:					
Main Activity Producer Electricity /CHP Plants	92,840	73,237	84,159	81,982	59,860
Main Activity Producer Heat Plants	1,424	1,546	1,344	1,201	2,162
Autoproducer Electricity/CHP Plants	11,060	12,462	11,118	12,181	11,764
Autoproducer Heat Plants.....	261	449	368	293	271
For Blending to Motor Gasoline/Diesel	-	-	-	-	-
Energy Sector	160	122	39	-	26
of which:					
Own Use in Electricity, CHP and Heat Plants	108	77	-	-	-
Mining of coal and lignite	52	45	39	-	26
Oil and Natural Gas Extraction Plants.	-	-	-	-	-
Final Energy Consumption	186,817	198,427	185,807	192,547	203,090
of which:					
Industry Sector	42,066	53,092	54,410	56,847	62,472
of which:					
Iron and Steel.....	-	1	1	1	1
Non-Metallic Minerals	407	498	724	623	511
Transport Equipment	4	3	2	14	15
Machinery.....	27	56	93	73	105
Food, Beverages and Tobacco.....	436	664	747	1,134	1,383
Paper, Pulp and Printing	20,358	27,152	26,987	27,070	30,415
Wood and Wood Products	17,675	21,012	20,391	22,967	24,779
Non-specified (industry).....	3,159	3,706	5,465	4,965	5,263
Construction	120	115	81	6	10
Transport Sector	-	-	-	-	-
Other Sectors	144,631	145,220	131,316	135,694	140,608
of which:					
Commerce and Public Services	6,833	7,433	6,556	7,043	7,715
Households	116,850	116,850	105,450	108,395	111,435
Agriculture / Forestry	20,948	20,937	19,310	20,256	21,458

The balance of renewable energy commodities in the years 2012 – 2016 (cont.)

Specification	2012	2013	2014	2015	2016
	TJ				
	Solar energy				
Indigenous Production	620	1,035	1,455	1,885	2,189
Imports(+)	-	-	-	-	-
Exports (-)	-	-	-	-	-
Stock Changes (+/-)	-	-	-	-	-
Inland Consumption	620	1,035	1,455	1,885	2,189
Transformation Sector	-	-	-	-	-
of which:					
Main Activity Producer Electricity /CHP Plants	-	-	-	-	-
Main Activity Producer Heat Plants	-	-	-	-	-
Autoproducer Electricity/CHP Plants	-	-	-	-	-
Autoproducer Heat Plants.....	-	-	-	-	-
For Blending to Motor Gasoline/Diesel	-	-	-	-	-
Energy Sector	-	-	-	-	-
of which:					
Own Use in Electricity, CHP and Heat Plants	-	-	-	-	-
Mining of coal and lignite	-	-	-	-	-
Oil and Natural Gas Extraction Plants.	-	-	-	-	-
Final Energy Consumption	620	1,035	1,455	1,885	2,189
of which:					
Industry Sector	-	-	-	-	-
of which:					
Iron and Steel.....	-	-	-	-	-
Non-Metallic Minerals	-	-	-	-	-
Transport Equipment.....	-	-	-	-	-
Machinery.....	-	-	-	-	-
Food, Beverages and Tobacco.....	-	-	-	-	-
Paper, Pulp and Printing	-	-	-	-	-
Wood and Wood Products.....	-	-	-	-	-
Non-specified (industry).....	-	-	-	-	-
Construction	-	-	-	-	-
Transport Sector	-	-	-	-	-
Other Sectors	620	1,035	1,455	1,885	2,189
of which:					
Commerce and Public Services	164	179	200	230	246
Households	456	856	1,255	1,655	1,943
Agriculture / Forestry	-	-	-	-	-

The balance of renewable energy commodities in the years 2012 – 2016 (cont.)

Specification	2012	2013	2014	2015	2016
	TJ				
	Hydro				
Indigenous Production	7,333	8,781	7,857	6,596	7,702
Imports(+)	-	-	-	-	-
Exports (-)	-	-	-	-	-
Stock Changes (+/-)	-	-	-	-	-
Inland Consumption	7,333	8,781	7,857	6,596	7,702
Transformation Sector	7,333	8,781	7,857	6,596	7,702
of which:					
Main Activity Producer Electricity /CHP Plants	7,326	8,769	7,847	6,586	7,691
Main Activity Producer Heat Plants	-	-	-	-	-
Autoproducer Electricity/CHP Plants	7	12	10	10	11
Autoproducer Heat Plants.....	-	-	-	-	-
For Blending to Motor Gasoline/Diesel	-	-	-	-	-
Energy Sector	-	-	-	-	-
of which:					
Own Use in Electricity, CHP and Heat Plants	-	-	-	-	-
Mining of coal and lignite	-	-	-	-	-
Oil and Natural Gas Extraction Plants.	-	-	-	-	-
Final Energy Consumption	-	-	-	-	-
of which:					
Industry Sector	-	-	-	-	-
of which:					
Iron and Steel.....	-	-	-	-	-
Non-Metallic Minerals	-	-	-	-	-
Transport Equipment	-	-	-	-	-
Machinery.....	-	-	-	-	-
Food, Beverages and Tobacco.....	-	-	-	-	-
Paper, Pulp and Printing	-	-	-	-	-
Wood and Wood Products.....	-	-	-	-	-
Non-specified (industry).....	-	-	-	-	-
Construction	-	-	-	-	-
Transport Sector	-	-	-	-	-
Other Sectors	-	-	-	-	-
of which:					
Commerce and Public Services	-	-	-	-	-
Households	-	-	-	-	-
Agriculture / Forestry	-	-	-	-	-

The balance of renewable energy commodities in the years 2012 – 2016 (cont.)

Specification	2012	2013	2014	2015	2016
	TJ				
	Wind				
Indigenous Production	17,088	21,614	27,632	39,090	45,315
Imports(+)	-	-	-	-	-
Exports (-)	-	-	-	-	-
Stock Changes (+/-)	-	-	-	-	-
Inland Consumption	17,088	21,614	27,632	39,090	45,315
Transformation Sector	17,088	21,614	27,632	39,090	45,315
of which:					
Main Activity Producer Electricity /CHP Plants	17,088	21,614	27,632	39,090	45,315
Main Activity Producer Heat Plants	-	-	-	-	-
Autoproducer Electricity/CHP Plants	-	-	-	-	-
Autoproducer Heat Plants.....	-	-	-	-	-
For Blending to Motor Gasoline/Diesel	-	-	-	-	-
Energy Sector	-	-	-	-	-
of which:					
Own Use in Electricity, CHP and Heat Plants	-	-	-	-	-
Mining of coal and lignite	-	-	-	-	-
Oil and Natural Gas Extraction Plants.	-	-	-	-	-
Final Energy Consumption	-	-	-	-	-
of which:					
Industry Sector	-	-	-	-	-
of which:					
Iron and Steel.....	-	-	-	-	-
Non-Metallic Minerals	-	-	-	-	-
Transport Equipment	-	-	-	-	-
Machinery.....	-	-	-	-	-
Food, Beverages and Tobacco.....	-	-	-	-	-
Paper, Pulp and Printing	-	-	-	-	-
Wood and Wood Products.....	-	-	-	-	-
Non-specified (industry).....	-	-	-	-	-
Construction	-	-	-	-	-
Transport Sector	-	-	-	-	-
Other Sectors	-	-	-	-	-
of which:					
Commerce and Public Services	-	-	-	-	-
Households	-	-	-	-	-
Agriculture / Forestry	-	-	-	-	-

The balance of renewable energy commodities in the years 2012 – 2016 (cont.)

Specification	2012	2013	2014	2015	2016
	TJ				
	Biogas from landfills				
Indigenous Production	2,249	2,157	2,051	2,125	2,412
Imports(+)	-	-	-	-	-
Exports (-)	-	-	-	-	-
Stock Changes (+/-)	-	-	-	-	-
Inland Consumption	2,249	2,157	2,051	2,125	2,412
Transformation Sector	1,908	1,961	1,825	1,861	2,102
of which:					
Main Activity Producer Electricity /CHP Plants	1,608	1,595	1,435	1,518	1,629
Main Activity Producer Heat Plants	-	-	-	-	-
Autoproducer Electricity/CHP Plants	300	367	391	343	472
Autoproducer Heat Plants.....	-	-	-	-	-
For Blending to Motor Gasoline/Diesel	-	-	-	-	-
Energy Sector	-	-	-	-	-
of which:					
Own Use in Electricity, CHP and Heat Plants	-	-	-	-	-
Mining of coal and lignite	-	-	-	-	-
Oil and Natural Gas Extraction Plants.	-	-	-	-	-
Final Energy Consumption	340	196	225	265	311
of which:					
Industry Sector	-	-	8	6	6
of which:					
Iron and Steel.....	-	-	-	-	-
Non-Metallic Minerals	-	-	-	-	-
Transport Equipment	-	-	-	-	-
Machinery.....	-	-	-	-	-
Food, Beverages and Tobacco.....	-	-	-	-	-
Paper, Pulp and Printing	-	-	-	-	-
Wood and Wood Products.....	-	-	-	-	-
Non-specified (industry).....	-	-	8	6	6
Construction	-	-	-	-	-
Transport Sector	-	-	-	-	-
Other Sectors	340	196	217	259	304
of which:					
Commerce and Public Services	340	196	217	259	304
Households	-	-	-	-	-
Agriculture / Forestry	-	-	-	-	-

The balance of renewable energy commodities in the years 2012 – 2016 (cont.)

Specification	2012	2013	2014	2015	2016
	TJ				
	Biogas from sludge				
Indigenous Production	3,321	3,572	3,810	4,043	5,014
Imports(+)	-	-	-	-	-
Exports (-)	-	-	-	-	-
Stock Changes (+/-)	-	-	-	-	-
Inland Consumption	3,321	3,572	3,810	4,043	5,014
Transformation Sector	1,160	1,381	1,593	1,698	2,251
of which:					
Main Activity Producer Electricity /CHP Plants	150	119	209	201	499
Main Activity Producer Heat Plants	6	7	8	7	9
Autoproducer Electricity/CHP Plants	995	1,247	1,371	1,483	1,737
Autoproducer Heat Plants.....	9	8	6	9	7
For Blending to Motor Gasoline/Diesel	-	-	-	-	-
Energy Sector	-	-	-	-	6
of which:					
Own Use in Electricity, CHP and Heat Plants	-	-	-	-	6
Mining of coal and lignite	-	-	-	-	-
Oil and Natural Gas Extraction Plants.	-	-	-	-	-
Final Energy Consumption	2,161	2,191	2,217	2,345	2,757
of which:					
Industry Sector	258	261	346	316	394
of which:					
Iron and Steel.....	-	-	-	-	-
Non-Metallic Minerals	-	-	-	-	-
Transport Equipment	-	-	-	-	-
Machinery.....	-	-	-	-	-
Food, Beverages and Tobacco.....	175	169	241	229	283
Paper, Pulp and Printing	83	91	105	86	111
Wood and Wood Products.....	-	-	-	-	-
Non-specified (industry).....	-	-	-	-	-
Construction	-	-	-	-	-
Transport Sector	-	-	-	-	-
Other Sectors	1,903	1,931	1,871	2,029	2,363
of which:					
Commerce and Public Services	1,903	1,931	1,871	2,029	2,363
Households	-	-	-	-	-
Agriculture / Forestry	-	-	-	-	-

The balance of renewable energy commodities in the years 2012 – 2016 (cont.)

Specification	2012	2013	2014	2015	2016
	TJ				
	Biogas – other biogas				
Indigenous Production	1,463	1,864	2,825	3,413	3,504
Imports(+)	-	-	-	-	-
Exports (-)	-	-	-	-	-
Stock Changes (+/-)	-	-	-	-	-
Inland Consumption	1,463	1,864	2,825	3,413	3,504
Transformation Sector	1,151	1,545	2,313	2,754	2,894
of which:					
Main Activity Producer Electricity /CHP Plants	393	969	1,726	2,086	2,247
Main Activity Producer Heat Plants	-	-	-	-	-
Autoproducer Electricity/CHP Plants	758	576	587	668	647
Autoproducer Heat Plants.....	-	-	-	-	-
For Blending to Motor Gasoline/Diesel	-	-	-	-	-
Energy Sector	-	-	-	-	16
of which:					
Own Use in Electricity, CHP and Heat Plants	-	-	-	-	16
Mining of coal and lignite	-	-	-	-	-
Oil and Natural Gas Extraction Plants.	-	-	-	-	-
Final Energy Consumption	312	319	512	659	594
of which:					
Industry Sector	24	33	154	201	204
of which:					
Iron and Steel.....	-	-	-	-	-
Non-Metallic Minerals	-	-	44	41	38
Transport Equipment	-	-	-	-	-
Machinery.....	-	-	-	-	-
Food, Beverages and Tobacco.....	24	33	109	116	124
Paper, Pulp and Printing	-	-	-	-	-
Wood and Wood Products.....	-	-	-	44	42
Non-specified (industry).....	-	-	-	-	-
Construction	-	-	-	-	-
Transport Sector	-	-	-	-	-
Other Sectors	288	286	358	458	390
of which:					
Commerce and Public Services	37	-	30	73	33
Households	-	-	-	-	-
Agriculture / Forestry	252	286	328	385	357

The balance of renewable energy commodities in the years 2012 – 2016 (cont.)

Specification	2012	2013	2014	2015	2016
	TJ				
	Biogas - Total				
Indigenous Production	7,032	7,593	8,685	9,581	10,929
Imports(+)	-	-	-	-	-
Exports (-)	-	-	-	-	-
Stock Changes (+/-)	-	-	-	-	-
Inland Consumption	7,032	7,593	8,685	9,581	10,929
Transformation Sector	4,219	4,887	5,732	6,313	7,246
of which:					
Main Activity Producer Electricity /CHP Plants	2,151	2,682	3,370	3,804	4,375
Main Activity Producer Heat Plants	6	7	8	7	9
Autoproducer Electricity/CHP Plants	2,054	2,190	2,348	2,494	2,856
Autoproducer Heat Plants.....	9	8	6	9	7
For Blending to Motor Gasoline/Diesel	-	-	-	-	-
Energy Sector	-	-	-	-	22
of which:					
Own Use in Electricity, CHP and Heat Plants	-	-	-	-	22
Mining of coal and lignite	-	-	-	-	-
Oil and Natural Gas Extraction Plants.	-	-	-	-	-
Final Energy Consumption	2,813	2,706	2,954	3,268	3,661
of which:					
Industry Sector	282	293	508	522	604
of which:					
Iron and Steel.....	-	-	-	-	-
Non-Metallic Minerals	-	-	44	41	38
Transport Equipment	-	-	-	-	-
Machinery.....	-	-	-	-	-
Food, Beverages and Tobacco.....	199	202	351	345	407
Paper, Pulp and Printing	83	91	105	86	111
Wood and Wood Products.....	-	-	-	44	42
Non-specified (industry).....	-	-	8	6	6
Construction	-	-	-	-	-
Transport Sector	-	-	-	-	-
Other Sectors	2,532	2,413	2,446	2,746	3,058
of which:					
Commerce and Public Services	2,280	2,126	2,118	2,361	2,701
Households	-	-	-	-	-
Agriculture / Forestry	252	286	328	385	357

The balance of renewable energy commodities in the years 2012 – 2016 (cont.)

Specification	2012	2013	2014	2015	2016
	TJ				
	Biofuels - bioethanol				
Indigenous Production	5,124	5,098	3,855	4,696	5,275
Imports(+)	1,302	1,099	1,733	1,773	1,864
Exports (-)	56	73	59	63	80
Stock Changes (+/-)	74	-81	39	20	-39
Inland Consumption	6,443	6,043	5,568	6,427	7,020
Transformation Sector	6,113	5,213	5,284	5,824	6,237
of which:					
Main Activity Producer Electricity /CHP Plants	-	-	-	-	-
Main Activity Producer Heat Plants	-	-	-	-	-
Autoproducer Electricity/CHP Plants	-	-	-	-	-
Autoproducer Heat Plants.....	-	-	-	-	-
For Blending to Motor Gasoline/Diesel	6,113	5,213	5,284	5,824	6,237
Energy Sector	-	-	-	-	-
of which:					
Own Use in Electricity, CHP and Heat Plants	-	-	-	-	-
Mining of coal and lignite	-	-	-	-	-
Oil and Natural Gas Extraction Plants	-	-	-	-	-
Final Energy Consumption	330	830	284	603	783
of which:					
Industry Sector	-	-	-	-	-
of which:					
Iron and Steel.....	-	-	-	-	-
Non-Metallic Minerals	-	-	-	-	-
Transport Equipment	-	-	-	-	-
Machinery.....	-	-	-	-	-
Food, Beverages and Tobacco.....	-	-	-	-	-
Paper, Pulp and Printing	-	-	-	-	-
Wood and Wood Products.....	-	-	-	-	-
Non-specified (industry).....	-	-	-	-	-
Construction	-	-	-	-	-
Transport Sector	330	830	284	603	783
Other Sectors	-	-	-	-	-
of which:					
Commerce and Public Services	-	-	-	-	-
Households	-	-	-	-	-
Agriculture / Forestry	-	-	-	-	-

The balance of renewable energy commodities in the years 2012 – 2016 (cont.)

Specification	2012	2013	2014	2015	2016
	TJ				
	Biofuels - biodiesel				
Indigenous Production	23,247	24,217	27,343	34,479	33,319
Imports(+)	6,965	5,889	4,806	7,004	8,016
Exports (-)	1,863	5,956	8,696	15,546	29,499
Stock Changes (+/-)	-321	751	-104	-432	-296
Inland Consumption	28,028	24,902	23,349	25,504	11,540
Transformation Sector	26,631	24,671	22,985	20,129	11,360
of which:					
Main Activity Producer Electricity /CHP Plants	3	7	4	-	-
Main Activity Producer Heat Plants	-	-	-	-	-
Autoproducer Electricity/CHP Plants	-	-	-	65	75
Autoproducer Heat Plants.....	-	-	-	-	-
For Blending to Motor Gasoline/Diesel	26,629	24,664	22,981	20,063	11,285
Energy Sector	-	-	-	-	-
of which:					
Own Use in Electricity, CHP and Heat Plants	-	-	-	-	-
Mining of coal and lignite	-	-	-	-	-
Oil and Natural Gas Extraction Plants.	-	-	-	-	-
Final Energy Consumption	1,397	231	364	5,376	180
of which:					
Industry Sector	-	-	-	-	-
of which:					
Iron and Steel.....	-	-	-	-	-
Non-Metallic Minerals	-	-	-	-	-
Transport Equipment	-	-	-	-	-
Machinery.....	-	-	-	-	-
Food, Beverages and Tobacco.....	-	-	-	-	-
Paper, Pulp and Printing	-	-	-	-	-
Wood and Wood Products.....	-	-	-	-	-
Non-specified (industry).....	-	-	-	-	-
Construction	-	-	-	-	-
Transport Sector	1,397	231	364	5,376	180
Other Sectors	-	-	-	-	-
of which:					
Commerce and Public Services	-	-	-	-	-
Households	-	-	-	-	-
Agriculture / Forestry	-	-	-	-	-

The balance of renewable energy commodities in the years 2012 – 2016 (cont.)

Specification	2012	2013	2014	2015	2016
	TJ				
	Biofuels - Total				
Indigenous Production	28,371	29,315	31,199	39,175	38,594
Imports(+)	8,267	6,988	6,539	8,777	9,880
Exports (-)	1,919	6,029	8,756	15,609	29,579
Stock Changes (+/-)	-248	670	-65	-412	-335
Inland Consumption	34,471	30,944	28,917	31,931	18,560
Transformation Sector	32,744	29,884	28,269	25,953	17,597
of which:					
Main Activity Producer Electricity /CHP Plants	3	7	4	-	-
Main Activity Producer Heat Plants	-	-	-	-	-
Autoproducer Electricity/CHP Plants	-	-	-	65	75
Autoproducer Heat Plants.....	-	-	-	-	-
For Blending to Motor Gasoline/Diesel	32,741	29,876	28,265	25,887	17,522
Energy Sector	-	-	-	-	-
of which:					
Own Use in Electricity, CHP and Heat Plants	-	-	-	-	-
Mining of coal and lignite	-	-	-	-	-
Oil and Natural Gas Extraction Plants.	-	-	-	-	-
Final Energy Consumption	1,727	1,061	648	5,979	963
of which:					
Industry Sector	-	-	-	-	-
of which:					
Iron and Steel.....	-	-	-	-	-
Non-Metallic Minerals	-	-	-	-	-
Transport Equipment	-	-	-	-	-
Machinery.....	-	-	-	-	-
Food, Beverages and Tobacco.....	-	-	-	-	-
Paper, Pulp and Printing	-	-	-	-	-
Wood and Wood Products.....	-	-	-	-	-
Non-specified (industry).....	-	-	-	-	-
Construction	-	-	-	-	-
Transport Sector	1,727	1,061	648	5,979	963
Other Sectors	-	-	-	-	-
of which:					
Commerce and Public Services	-	-	-	-	-
Households	-	-	-	-	-
Agriculture / Forestry	-	-	-	-	-

The balance of renewable energy commodities in the years 2012 – 2016 (cont.)

Specification	2012	2013	2014	2015	2016
	TJ				
	Geothermal energy				
Indigenous Production	661	778	847	909	930
Imports(+)	-	-	-	-	-
Exports (-)	-	-	-	-	-
Stock Changes (+/-)	-	-	-	-	-
Inland Consumption	661	778	847	909	930
Transformation Sector	-	-	-	-	-
of which:					
Main Activity Producer Electricity /CHP Plants	-	-	-	-	-
Main Activity Producer Heat Plants.....	-	-	-	-	-
Autoproducer Electricity/CHP Plants	-	-	-	-	-
Autoproducer Heat Plants.....	-	-	-	-	-
For Blending to Motor Gasoline/Diesel	-	-	-	-	-
Energy Sector	-	-	-	-	-
of which:					
Own Use in Electricity, CHP and Heat Plants	-	-	-	-	-
Mining of coal and lignite	-	-	-	-	-
Oil and Natural Gas Extraction Plants.....	-	-	-	-	-
Final Energy Consumption	661	778	847	909	930
of which:					
Industry Sector	-	-	-	-	-
of which:					
Iron and Steel.....	-	-	-	-	-
Non-Metallic Minerals	-	-	-	-	-
Transport Equipment	-	-	-	-	-
Machinery.....	-	-	-	-	-
Food, Beverages and Tobacco.....	-	-	-	-	-
Paper, Pulp and Printing	-	-	-	-	-
Wood and Wood Products.....	-	-	-	-	-
Non-specified (industry).....	-	-	-	-	-
Construction	-	-	-	-	-
Transport Sector	-	-	-	-	-
Other Sectors	661	778	847	909	930
of which:					
Commerce and Public Services	151	217	239	235	224
Households	510	561	608	674	705
Agriculture / Forestry	-	-	-	-	-

The balance of renewable energy commodities in the years 2012 – 2016 (cont.)

Specification	2012	2013	2014	2015	2016
	TJ				
	Municipal waste				
Indigenous Production	1,360	1,391	1,544	1,673	3,233
Imports(+)	-	-	-	-	-
Exports (-)	-	-	-	-	-
Stock Changes (+/-)	-	-	-	-	-
Inland Consumption	1,360	1,391	1,544	1,673	3,233
Transformation Sector	-	-	16	9	331
of which:					
Main Activity Producer Electricity /CHP Plants	-	-	-	-	-
Main Activity Producer Heat Plants	-	-	16	9	331
Autoproducer Electricity/CHP Plants	-	-	-	-	-
Autoproducer Heat Plants.....	-	-	-	-	-
For Blending to Motor Gasoline/Diesel	-	-	-	-	-
Energy Sector	-	-	-	-	-
of which:					
Own Use in Electricity, CHP and Heat Plants	-	-	-	-	-
Mining of coal and lignite	-	-	-	-	-
Oil and Natural Gas Extraction Plants	-	-	-	-	-
Final Energy Consumption	1,360	1,391	1,528	1,664	2,902
of which:					
Industry Sector	1,360	1,391	1,528	1,664	2,094
of which:					
Iron and Steel.....	-	-	-	-	-
Non-Metallic Minerals	1,360	1,391	1,528	1,664	2,094
Transport Equipment	-	-	-	-	-
Machinery.....	-	-	-	-	-
Food, Beverages and Tobacco.....	-	-	-	-	-
Paper, Pulp and Printing	-	-	-	-	-
Wood and Wood Products.....	-	-	-	-	-
Non-specified (industry).....	-	-	-	-	-
Construction	-	-	-	-	-
Transport Sector	-	-	-	-	-
Other Sectors	-	-	-	-	808
of which:					
Commerce and Public Services	-	-	-	-	808
Households	-	-	-	-	-
Agriculture / Forestry	-	-	-	-	-

The balance of renewable energy commodities in the years 2012 – 2016 (end)

Specification	2012	2013	2014	2015	2016
	TJ				
	Heat pumps (ambient heat)				
Indigenous Production	1,447	1,588	1,867	2,050	2,218
Imports(+)	-	-	-	-	-
Exports (-)	-	-	-	-	-
Stock Changes (+/-)	-	-	-	-	-
Inland Consumption	1,447	1,588	1,867	2,050	2,218
Transformation Sector	-	-	-	-	-
of which:					
Main Activity Producer Electricity /CHP Plants	-	-	-	-	-
Main Activity Producer Heat Plants	-	-	-	-	-
Autoproducer Electricity/CHP Plants	-	-	-	-	-
Autoproducer Heat Plants.....	-	-	-	-	-
For Blending to Motor Gasoline/Diesel	-	-	-	-	-
Energy Sector	-	-	-	-	-
of which:					
Own Use in Electricity, CHP and Heat Plants	-	-	-	-	-
Mining of coal and lignite	-	-	-	-	-
Oil and Natural Gas Extraction Plants.	-	-	-	-	-
Final Energy Consumption	1,447	1,588	1,867	2,050	2,218
of which:					
Industry Sector	-	-	-	-	-
of which:					
Iron and Steel.....	-	-	-	-	-
Non-Metallic Minerals	-	-	-	-	-
Transport Equipment	-	-	-	-	-
Machinery.....	-	-	-	-	-
Food, Beverages and Tobacco.....	-	-	-	-	-
Paper, Pulp and Printing	-	-	-	-	-
Wood and Wood Products.....	-	-	-	-	-
Non-specified (industry).....	-	-	-	-	-
Construction	-	-	-	-	-
Transport Sector	-	-	-	-	-
Other Sectors	1,447	1,588	1,867	2,050	2,218
of which:					
Commerce and Public Services	308	339	509	582	630
Households	1,139	1,249	1,358	1,468	1,588
Agriculture / Forestry	-	-	-	-	-

Production of electricity and heat in the units of main activity producers and autoproducers in the years 2012 - 2016

Generation of electricity from renewables by main activity producers and autoproducers

Specification	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
	GWh									
	Main Activity Producer Plants					Autoproducer Plants				
Total	15,106.9	15,123.2	17,745.3	20,395.1	20,630.3	1,772.0	1,943.4	2,096.4	2,289.0	2,177.0
Hydro	2,035.1	2,435.8	2,179.7	1,829.5	2,136.5	1.8	3.3	2.7	2.7	2.9
of which:										
Hydro-1 MW	318.9	348.6	319.3	325.2	317.6	1.8	3.3	2.7	2.7	2.9
Hydro 1-10 MW	619.5	645.3	564.6	493.5	588.3	-	-	-	-	-
Hydro 10+ MW	1,096.7	1,442.0	1,295.9	1,010.7	1,230.6	-	-	-	-	-
Wind	4,746.6	6,003.8	7,675.6	10,858.4	12,587.6	-	-	-	-	-
Solid biofuels	8,325.0	6,682.9	7,889.7	7,707.3	5,360.7	1,203.7	1,248.9	1,270.5	1,319.4	1,552.0
<i>in which co-combustion</i>	<i>6,742.8</i>	<i>3,443.6</i>	<i>4,021.4</i>	<i>3,787.1</i>	<i>1,513.6</i>	<i>495.7</i>	<i>485.0</i>	<i>489.1</i>	<i>499.1</i>	<i>574.3</i>
Municipal wastes	-	-	-	-	0.3					12.4
Biogas	-	-	-	-	545.2	565.4	689.7	816.3	906.4	482.4
of which:										
Landfill gas.....	-	-	-	-	176.5	236.5	240.7	225.3	226.8	47.0
Sludge gas	-	-	-	-	66.1	193.7	233.5	252.5	275.6	298.3
Other biogas	-	-	-	-	302.6	135.1	215.5	338.4	404.0	137.1
Biofuels	0.2	0.6	0.3	-	-				3.8	3.4
Photovoltaics	-	-	-	-	-	1.1	1.5	6.9	56.6	123.9

Generation of electricity from renewables by main activity producers

Specification	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
	GWh									
	Electricity (only)					CHP				
Total	6,781.7	8,439.6	9,855.4	12,687.8	14,724.1	8,325.3	6,683.5	7,890.0	7,707.3	5,906.2
Hydro	2,035.1	2,435.8	2,179.7	1,829.5	2,136.5	-	-	-	-	-
of which:										
Hydro-1 MW	318.9	348.6	319.3	325.2	317.6	-	-	-	-	-
Hydro 1-10 MW	619.5	645.3	564.6	493.5	588.3	-	-	-	-	-
Hydro 10+ MW	1,096.7	1,442.0	1,295.9	1,010.7	1,230.6	-	-	-	-	-
Wind	4,746.6	6,003.8	7,675.6	10,858.4	12,587.6	-	-	-	-	-
Solid biofuels	-	-	-	-	-	8,325.0	6,682.9	7,889.7	7,707.3	5,360.7
<i>in which co-combustion</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>-</i>	<i>6,742.8</i>	<i>3,443.6</i>	<i>4,021.4</i>	<i>3,787.1</i>	<i>1,513.6</i>
Municipal wastes	-	-	-	-	-	-	-	-	-	0.3
Biogas	-	-	-	-	-	-	-	-	-	545.2
of which:										
Landfill gas.....	-	-	-	-	-	-	-	-	-	176.5
Sludge gas	-	-	-	-	-	-	-	-	-	66.1
Other biogas	-	-	-	-	-	-	-	-	-	302.6
Biofuels	-	-	-	-	-	0.2	0.6	0.3	-	-

Generation of electricity from renewables by autoproducers

Specification	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
	GWh									
	Electricity (only)					CHP				
Total	3.0	4.8	9.6	59.4	126.8	1,769.0	1,938.6	2,086.8	2,229.6	2,050.2
Hydro	1.8	3.3	2.7	2.7	2.9	-	-	-	-	-
of which:										
Hydro-1 MW	1.8	3.3	2.7	2.7	2.9	-	-	-	-	-
Hydro 1-10 MW	-	-	-	-	-	-	-	-	-	-
Hydro 10+ MW	-	-	-	-	-	-	-	-	-	-
Wind	-	-	-	-	-	-	-	-	-	-
Solid biofuels	-	-	-	-	-	1,203.7	1,248.9	1,270.5	1,319.4	1,552.0
<i>in which co-combustion</i>	-	-	-	-	-	495.7	485.0	489.1	499.1	574.3
Municipal wastes	-	-	-	-	-	-	-	-	-	12.4
Biogas	-	-	-	-	-	565.4	689.7	816.3	906.4	482.4
of which:										
Landfill gas.....	-	-	-	-	-	236.5	240.7	225.3	226.8	47.0
Sludge gas	-	-	-	-	-	193.7	233.5	252.5	275.6	298.3
Other biogas	-	-	-	-	-	135.1	215.5	338.4	404.0	137.1
Photovoltaics	-	-	-	-	-	-	-	-	3.8	3.4
Total	1.1	1.5	6.9	56.6	123.9	-	-	-	-	-

Generation of heat from renewables by main activity producers and autoproducers plant

Specification	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
	TJ									
	Main Activity Producer Plants					Autoproducer Plants				
Total	17,808	13,823	12,630	11,135	12,863	1,244	2,165	1,642	1,747	1,112
Solid biofuels	17,803	13,817	12,611	11,123	12,441	1,037	1,794	1,349	1,297	929
Municipal wastes	-	-	13	7	5	-	-	-	-	11
Biogas	5	6	6	5	417	207	371	293	431	172
of which:										
Landfill gas.....	-	-	-	-	18	69	74	69	67	-
Sludge gas	5	6	6	5	250	35	122	79	198	167
Other biogas	-	-	-	-	149	103	174	144	165	4
Biofuels	0	0	-	-	-	-	-	-	19	-

Generation of heat from renewables by main activity producers

Wyszczególnienie	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
	TJ									
	CHP					Heat (only)				
Total	16,635	12,554	11,509	10,137	11,051	1,173	1,269	1,121	998	1,812
Solid biofuels.....	16,635	12,554	11,509	10,137	10,642	1,168	1,263	1,102	986	1,799
Municipal wastes	-	-	-	-	-	-	-	13	7	5
Biogas	-	-	-	-	409	5	6	6	5	8
of which:										
Landfill gas.....	-	-	-	-	18	-	-	-	-	-
Sludge gas	-	-	-	-	242	5	6	6	5	8
Other biogas	-	-	-	-	149	-	-	-	-	-
Biofuels.....	0	0	-	-	-	-	-	-	-	-

Generation of heat from renewables by autoproducers

Wyszczególnienie	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016
	TJ									
	CHP					Heat (only)				
Total	1,059	1,819	1,357	1,517	899	185	346	284	230	213
Solid biofuels.....	858	1,454	1,070	1,074	721	179	340	279	223	208
Municipal wastes	-	-	-	-	11	-	-	-	-	-
Biogas	201	365	287	424	167	6	6	5	7	5
of which:										
Landfill gas.....	69	74	69	67	-	-	-	-	-	-
Sludge gas	29	116	74	191	162	6	6	5	7	5
Other biogas	103	174	144	165	4	-	-	-	-	-
Biofuels.....	-	-	-	19	-	-	-	-	-	-

Units of measure to be applied in energy statistics

Units commonly used to express the amount of fuel and energy are the units that define: volume, mass and energy of carrier.

Units which are accepted in the international turnovers, cover the measurement of the quantities of fuel and energy, and are named as follow: the cubic meter (m³), ton (metric ton, 1 ton = 10³ kg), joule (1 J = 1 N • m, 1 N (Newton) = 1 kg • m • s⁻², s - seconds). These units are included in the International System of Units, designated by the abbreviation "SI" (Système International d'Unités). Apart from the applicable SI units there are also used other units, depending on the country and local traditions reflecting the historical conditions of each country.

1. Prefixes of decimal system and the major abbreviations

Below there are the prefixes and symbols, and more important abbreviations to express decimal multiples and sub-units of measurement commonly used in fuel economy and energy:

Prefixes of decimal system		Major abbreviations			
decy (d)	=10 ⁻¹	dag	dekagram	GW	gigawatt
deka (da)	=10	kg	kilogram	kWh	kilowatt-hour
hekto (h)	=10 ²	t	ton (10 ³ kg)	MWh	megawatthour
kilo (k)	=10 ³	tys. t	thousand tons	GWh	gigawatt-hour
mega (M)	=10 ⁶	km	kilometer (thousand meters)	TWh	terawatt hour
giga (G)	=10 ⁹	tys. km	one thousand km	kJ	10 ³ Joule
tera (T)	=10 ¹²	m³	cubic meter	MJ	10 ⁶ Joule
peta (P)	=10 ¹⁵	dam³	thousand cubic meters	GJ	10 ⁹ Joule
		%	percent	TJ	10 ¹² Joule
		l	liter (10 ⁻³ m ³)	PJ	10 ¹⁵ Joule
		kW	kilowatt	toe	tonne of oil equivalent
		MW	megawatt	Mtoe	million tonnes of oil equivalent

2. Selected units of mass

No.	Name	symbol	
1.	kilogram	kg	-
2.	ton (megagram)	t (Mg)	10 ³ kg
3.	long ton (tona ang.)	lt	1016 kg
4.	short ton (tona USA)	st	907,2 kg

3. Selected units of pressure

No.	Name	symbol	
1.	pascal	Pa	$1 \text{ Pa} = 1 \text{ N} \cdot \text{m}^{-2}$
2.	physical atmosphere	atm	101325 Pa
3.	tor (1 mm Hg)	Tr	133,3 Pa
4.	bar	bar	10^5 Pa

4. Selected units of energy

No.	Name	symbol	
1.	joule	J	$1 \text{ J} = 1 \text{ N} \cdot \text{m}$
2.	calorie	cal	4,1868 J
3.	ton of conventional fuel	tpu	$29,3076 \cdot 10^9 \text{ J}$
4.	tonne of oil equivalent	toe	$41,868 \cdot 10^9 \text{ J}$
5.	kilowatt-hour	kWh	$3,6 \cdot 10^6 \text{ J}$
6.	British unit of heat	Btu	1055 J

Ton of equivalent fuel (tpu) is the equivalent of one ton of coal with a calorific value equivalent to seven thousand kilocalories per kilogram (7000 kcal / kg).

Tonne of oil equivalent (toe) is equivalent to one metric ton of crude oil with a calorific value equivalent to ten thousand kilocalories per kilogram (10000 kcal / kg).

British thermal unit (Brytyjska jednostka ciepła) is the energy needed to heat one pound of water by 10 degrees Fahrenheit.

5. Selected units of power

No.	Name	symbol	
1.	watt	W	$1 \text{ W} = 1 \text{ J} \cdot \text{s}^{-1}$
2.	megawatt	MW	10^6 W

Degrees of Kelvin (K) and also degrees Celsius ($^{\circ}\text{C}$) are used for measuring of differences of the temperature, wherein the unit of temperature rise is the same on the both of scales:

$$1^{\circ}\text{C} = 1 \text{ K}$$

and for the determination of temperature:

$$T = t_c + 273,15$$

where: T - thermodynamic temperature in K,
 t_c - temperature in degrees of Celsius.