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The generation of energy fractions from municipal waste based on the analysis of planning documents

ABSTRACT: The amount of potential generation of the energy fraction in the municipal waste was analysed based on the generation index for this fraction (Kłojzy-Karczmarczyk and Staszczak 2017) and based on the generation and morphological composition of municipal waste in the analysed national waste management plans. Those morphological fractions, which are characterised by a high calorific value, frequently above 12 MJ/kg (waste plastic, waste paper and cardboard, waste textiles and clothes, waste wood, multi-material waste), were considered the energy fractions. The estimated weighted average of the energy fraction in the total stream of municipal waste generated on a national scale is 29.8% (an index of energy fraction). The generation of the energy fraction based on the figures forecast in the planning documents in the years 2014–2019 ranged between 3.3 and 4.0 million Mg. Instead, the mass of the energy fraction generated under actual conditions ranged between 3.2 and 4.0 million Mg. The analysis has shown definitely smaller real generation with respect to the forecast figures for the years 2014–2016. A reverse trend has been observed in consecutive years. Considering the morphological composition, the obtained values of the potential generation are close to the figures provided based on the adopted generation index. In the years 2014–2015, the averaged mass of energy fraction in the total stream of municipal waste amounted

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to 3.3 million Mg per year, while its averaged mass in the stream of unsorted waste was 2.9 million Mg. In the years 2016–2022, the averaged mass of energy fraction in the total stream of municipal waste amounted to 3.8 million Mg per year, while in the stream of unsorted waste this value reached approx. 2.9 million Mg.

KEYWORDS: municipal waste, waste generation, energy fraction, unmanaged fraction, mass estimate

Introduction

The estimation of the potential generation of municipal waste by the residents of municipalities, voivodeships, or on a scale of the entire country is based on the values of the waste generation index, broken down into individual morphological fractions and areas differing in the nature of development sometimes. The value of this parameter, used in the planning documents, has changed over the years, hence the value of the estimated potential generation of municipal waste mass in individual areas (e.g., Kłojzy-Karczmarczyk and Makoudi 2017). The planning documents related to waste management mainly include the waste management plans prepared under the Act of 15 December 2012 on Waste (Journal of Laws of 2013, item 21), on the national and voivodeship level. The required scope of those documents and the set targets and tasks comply with the state's ecological policy, and they are updated and reported at several-year intervals.

The amount of potentially generated municipal waste and individual morphological fractions presented in the planning documents is generally based on the analysis of the current situation in the base year, the characteristics of each edition of the plan, and the forecast changes. Based on the morphology adopted in the consecutive editions of the waste management plans as well as on the actual figures and forecast changes, the amount of potentially generated total municipal waste and the generated amount of individual waste fraction is estimated for each of voivodeships and on a scale of all of Poland. Those amounts are verified at various administration levels in the reports on the performance of waste management plans in relation to the actual values.

The paper aims to learn the amount of energy fraction generation in the total volume of municipal waste generated in Poland and the amount of this fraction generation in the unsorted municipal waste that is collected as mixed waste. The analysis was performed based on the provisions of waste management plans on the national level over the years (KPGO 2006, 2010, 2014, 2022, 2028). The unsorted municipal waste is the waste generated in households and the waste originating from other waste generators, which, due to its nature and composition, is similar to the household waste, which is a residue after the separation of selectively gathered and collected waste. This waste, as a residue, is briefly referred to as mixed or residual waste (in accordance with the EU).

1. The adopted methodology for analysis of waste generation

The potential of the energy fraction in the stream of municipal waste was separated, taking into account the calorific value of individual waste types. Those morphological fractions, which are characterized by a high calorific value, frequently above 12 MJ/kg, were considered the energy fractions (e.g., Kłojzy-Karczmarczyk and Staszczak 2017; Czop et al. 2018; Primus and Rosik-Dulewska 2018; Wielgosiński 2020; Kłojzy-Karczmarczyk and Makoudi 2023):

- ◆ waste plastic,
- ◆ waste paper and cardboard,
- ◆ waste textiles and clothes,
- ◆ waste wood,
- ◆ multi-material waste.

The observed and reported calorific values of the aforementioned morphological fractions are comparable with the calorific values obtained for a wide range of fossil fuels, including hard coals (e.g., Olkusi 2012; Stala-Szlugaj 2011; Grudziński and Stala-Szlugaj 2016).

The following elements were considered in the analysis of the potential generation of energy fractions in the stream of municipal waste:

- ◆ the current situation and forecasts of municipal waste generation in the individual editions of the national waste management plan,
- ◆ the reports on the national waste management plan performance and the actual values of waste generation,
- ◆ the share of morphological fractions, considered the energy fractions, in the forecast stream and the actual amounts of the generated municipal waste.

The amount of potential generation of the energy fraction was analyzed using two separate procedures (schemes):

1. Based on the index of potential generation of the energy fraction in the stream of municipal waste.

2. Based on the morphological composition of municipal waste in the analyzed years.

In scheme 1 of the analysis, the amount of potential generation of the energy fraction was estimated based on the index of this fraction generation broken down into the areas of different development nature. These indices were determined in the paper by Kłojzy-Karczmarczyk and Staszczak (2017). The paper considered applying the value averaged for the whole country, considering the weight for areas of different development nature and population. The calculated weighted average of the energy fraction for the whole country is 29.8%. After the application of this value, the mass of energy fraction was estimated in the forecast masses of the potential generated municipal waste in individual years, as well as the mass of energy fraction in the mass of the waste generated and presented in the reports. As a result, the mass of the unmanaged (unused) energy fraction was estimated according to the forecasting and reporting data. An assumption

was made that this mass reflects the amount of the generated energy fraction less than the mass of selectively collected waste intended for recycling and reuse and the mass of waste incinerated in individual years of the analysis.

In scheme 2 of the analysis, the amount of potential generation of the energy fraction was determined based on the morphological composition of municipal waste, reported in the consecutive editions of the national waste management plan. The share of individual fractions, considered the energy fractions, was taken into account in the year, which was the basis for preparing the current situation, namely, the year was considered the base year for the next planned editions.

The forecasting of the mass of municipal waste generation in individual planning documents is based on the results of the current situation analysis and considers the forecasts for population changes and the changes in the values of the generation index based on the growth pace of the waste generation. The basic assumptions made to prepare forecasts of municipal waste generation, according to the methodology adopted in the considered documents, are specified in Table 1.

TABLE 1. Assumptions made for the preparation of the subsequent editions of the national waste management plan and the source of information

TABELA 1. Założenia przyjęte do sporządzenia kolejnych edycji krajowego planu gospodarki odpadami i źródło informacji

Source of information	Base year for the preparation of the current situation and the data on the morphological composition	Adopted growth pace of waste generation referred to the base year
National waste management plan for the years 2003–2006 (KPGO 2006)	Morphological composition: based on the quantitative and qualitative studies conducted between 1995 and 2000 (Sieja 2006). Current status for 2000	Growth pace not higher than 3% per year
National waste management plan for the years 2007–2010 (KPGO 2010)	Morphological composition based on the studies conducted between 2000 and 2005 Current status for 2004	Growth pace on average 1% per year
National waste management plan for the years 2011–2014 (KPGO 2014)	Morphological composition based on the study from 2008 (Jędrzak 2010). Current status for 2008	Growth pace from 1.2 to 1.6% per year
National waste management plan for the years 2016–2022 (KPGO 2022)	Morphological composition based on the study from 2008 (Jędrzak 2010). Current status for 2014	Growth pace on average 0.7% per year
National waste management plan for the years 2023–2028 (KPGO 2028)	Morphological composition based on the study from 2021 (IOŚ-PIB Report 2022). Current status for 2020	In the years 2020–2024 the growth is 3% per year. In the years 2025–2029 the growth is forecasted at 0.7% per year.

Source: KPGO 2006, 2010, 2014, 2022 and 2028.

2. The energy fraction in the municipal waste based on the generation index

The forecast amount of the generation stream for municipal waste was determined based on the current situation for the base year, the population, and a unit generation index. For the purpose of preparing the forecast of waste generation, a demographic forecast was adopted, determined by Statistics Poland (GUS, <https://stat.gov.pl/>), and the assumed percentage changes of generation indices for the municipal waste, reported in the consecutive editions of the waste management plans (KPGO 2006, 2010, 2014, 2022, 2028). The correctness of the forecast values was verified by providing the actual figures in the reports on the performance of waste management plans in individual years (Reports for: 2007–2008, 2009–2010, 2011–2013, 2014–2016 and 2017–2019). Figure 1 provides a comparison of the forecast generation values and the actual collection figures.

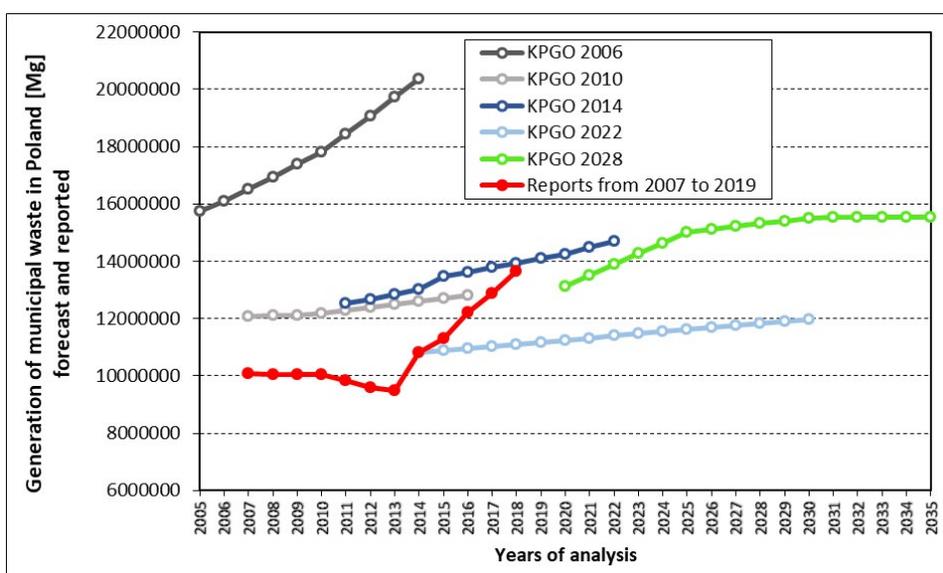


Fig. 1. Generation of municipal waste forecast according to the plans and the actual figures according to the reports on plans implementation (based on KPGO 2006, 2010, 2014, 2022, 2028 and Reports for: 2007–2008, 2009–2010, 2011–2013, 2014–2016, 2017–2019)

Rys. 1. Wytwarzanie odpadów komunalnych prognozowane według planów oraz rzeczywiste według sprawozdań z realizacji planów

In general, till 2013, the values forecast in the planning documents for the municipal waste generation were much higher than those of collected waste. Since 2013, these values have gradually equalised, which was undoubtedly related to the change in the municipal waste management system in Poland. Pursuant to relevant legal provisions, municipalities became the waste owners.

As a result, the collection of municipal waste from the residents and the ensuring of its proper processing became a task of the municipality. Such a waste management system is maintained and up to date, subject to permanent updating. The data reported since 2017 show higher collection values than municipal waste generation values, as forecasted in the appropriate planning documents. Instead, since 2019, waste management has been reported via the Database of Products and Packaging and of Waste Management (BDO, <https://bdo.mos.gov.pl/>) to which access is restricted, hence the analysis is short of the actual data since 2019 and of comparative possibilities.

The reported values of the energy fraction generation are proportional to the values of municipal waste generation. The indices reported in a 2017 paper (Klojzy-Karczmarczyk and Staszczak 2017) were used to estimate the share of energy fraction in municipal waste for all of Poland. The highest percentage of energy fractions in the waste stream is observed in the waste generated by residents of big cities, and it is 39%, slightly smaller in the waste generated by residents of small towns, around 29%, and the lowest in the waste generated by residents of rural areas, which amounts to 22%. To estimate the percentage of energy fraction in the municipal waste for all of Poland, the reported values and their weighted average were used, taking into account the number of residents of a big city, a small town, and a rural area in the total population. The weighted average of the energy fraction in the total stream of municipal waste generated on a national scale calculated in this way is 29.8%. This value was considered an index of energy fraction generation in the total stream of municipal waste and used in Tables 2 and 3 (difference in the energy fraction generation is the forecast figures minus the reported figures).

The potentially generated mass of energy fraction waste was reduced by the masses, which were incinerated and selectively collected, recycled, and prepared for reuse. Such a procedure allowed for estimating the mass of the energy fraction waste, which has not been managed and continues to feed the stream of municipal waste collected in a mixed way (unsorted municipal waste).

TABLE 2. Forecasts and the actual figures of the energy fraction generation in the municipal waste for all of Poland in the years 2014–2016 using the generation index

TABELA 2. Prognozy i wartości rzeczywiste wytwarzania frakcji energetycznej w odpadach komunalnych w skali Polski w latach 2014–2016, przy zastosowaniu wskaźnika wytwarzania

Specification	2014	2015	2016	
Energy fraction acc. to the generation forecast [Mg]*	3,884,430	4,009,888	4,057,449	
Energy fraction acc. to the report [Mg]**	3,221,499	3,367,191	3,642,454	
Difference in the energy fraction generation [Mg]	662,931	642,697	414,995	
Municipal waste prepared for reuse and recycled	1,015,000	1,041,000	1,213,400	
Incinerated municipal waste [Mg]	4,600	3,600	4,500	
Unmanaged energy fraction [Mg]	forecast	2,864,830	2,965,288	2,839,549
	reported	2,201,899	2,322,591	2,424,554
Percentage of unused energy fraction [%]	68.4–73.8	69.0–73.9	66.6–70.0	

* Forecast figures provided acc. to KPGO 2014.

** Reported figures provided acc. to Report for 2014–2016.

TABLE 3. Forecasts and the actual figures of the energy fraction generation in the municipal waste for all of Poland in the years 2017–2019 using the generation index

TABELA 3. Prognozy i wartości rzeczywiste wytwarzania frakcji energetycznej w odpadach komunalnych w skali Polski w latach 2017–2019, przy zastosowaniu wskaźnika wytwarzania

Specification	2017	2018	2019
Energy fraction acc. to the generation forecast [Mg]*	3,285,593	3,307,508	3,329,424
Energy fraction acc. to the report [Mg]**	3,834,992	4,066,299	n.o.
Difference in the energy fraction generation [Mg]	–549,399	–758,791	n.o.
Municipal waste prepared for reuse and recycled	1,325,810	1,750,700	n.o.
Incinerated municipal waste [Mg]	7,080	14,300	n.o.
Unmanaged energy fraction [Mg]	forecast	1,952,703	1,542,508
	reported	2,502,102	2,301,299
Percentage of unused energy fraction [%]	59.4–65.2	46.6–56.6	n.o.

* Forecast figures provided acc. to KPGO 2022.

** Reported figures provided acc. to Report for 2017–2019.

n.a. – not applicable.

The performed analysis has shown that the estimated generation of the energy fraction based on the figures forecast in the planning documents in the years 2014–2016 ranged between 3.9 and 4.0 million Mg. Instead, the mass of the energy fraction generated under actual conditions and determined with the index application ranged between 3.2 and 3.6 Mg. The analysis has shown definitely smaller real generation with respect to the forecast figures and the difference between these values is 0.4–0.6 million Mg. Based on the forecast figures, the estimated mass of energy fraction has shown 20–12% higher values than those estimated based on the actual generation (collection) figures for municipal waste. Considering the forecast values of municipal waste generation, the unused energy fraction exceeds 70% of the total generated energy fraction. Referring to the generated (collected) mass of the energy fraction waste, calculated based on the actual data with the index application, the percentage of unused energy fraction in 2014 was 68.4 and 66.6% in 2016.

The estimated generation of the energy fraction in municipal waste, which results from the forecast figures in the planning documents for 2017–2019, fluctuates around 3.3 million Mg, with a small increase. While the mass of energy fraction calculated based on the applied index and the actual reported data is around 3.8–4.0 million Mg. So, the difference between these values is approx. 0.5–0.8 million Mg. However, in this case, since 2017, higher values of the potential generation of the energy fraction have been observed, which have been estimated based on the actual generation (collection) figures (Fig. 2). The estimation of the generated mass of the energy fraction based on the forecast figures has shown 14–18% lower values as compared with the values estimated based on the actual generation (collection) figures for municipal waste. Considering the forecast values of municipal waste generation, the unused energy fraction is 47–59% of the total generated energy fraction. Referring to the generated (collected) mass of the

energy fraction waste, calculated based on the actual data with the index application, the percentage of unused energy fraction is higher; in 2017 it was 65.2% and 56.6% in 2018.

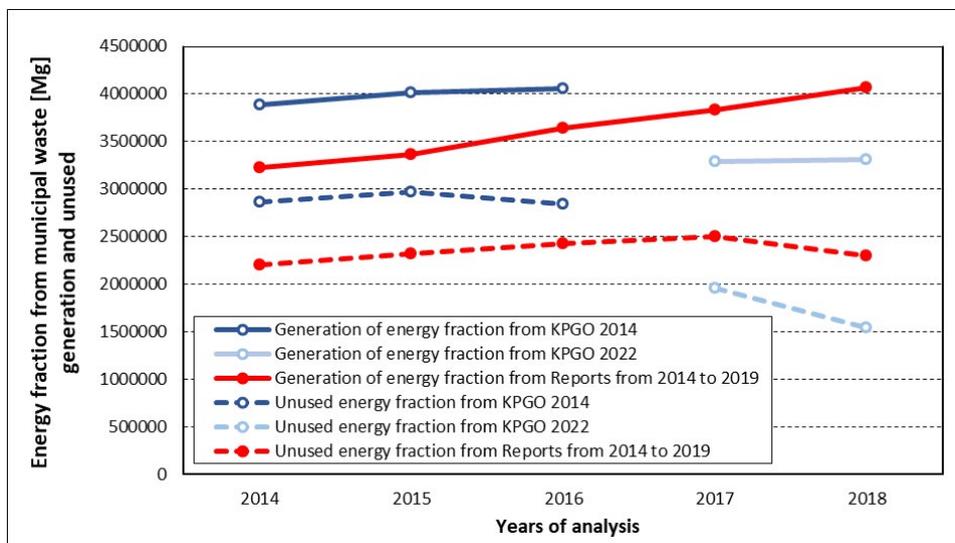


Fig. 2. Energy fraction separated from the stream of municipal waste based on the generation forecasts and the actual figures (based on KPGO 2014, 2022 and Reports for 2014–2016 and 2017–2019)

Rys. 2. Frakcja energetyczna wydzielona ze strumienia odpadów komunalnych w oparciu o prognozy wytwarzania i wartości rzeczywiste

3. The energy fraction in municipal waste based on the waste composition

The analysis of the morphological composition of municipal waste presented in the national waste management plans (KPGO 2006, KPGO 2010, KPGO 2014, KPGO 2022 and KPGO 2028) shows that a summary share of the energy fractions changes depending on the share, or on the mass of a specific waste fraction adopted in this plan (Table 1). The estimation method for the energy fraction share differed for individual years of the analysis due to the dissimilarity of the way data was presented in the consecutive editions of the waste management plan. The shares of energy fraction, estimated in the analyzed planning documents, in recent years, show a downward trend in the total mass of generated municipal waste (Fig. 3). Such a picture is undoubtedly related to changes in the economic conditions and the application of raw materials in the field of packaging, and changes in the ecological awareness and residents' behavior.

At the same time, with a decreasing percentage of the energy fraction in the total stream of generated municipal waste, the mass of generated waste of this fraction was growing till 2021,

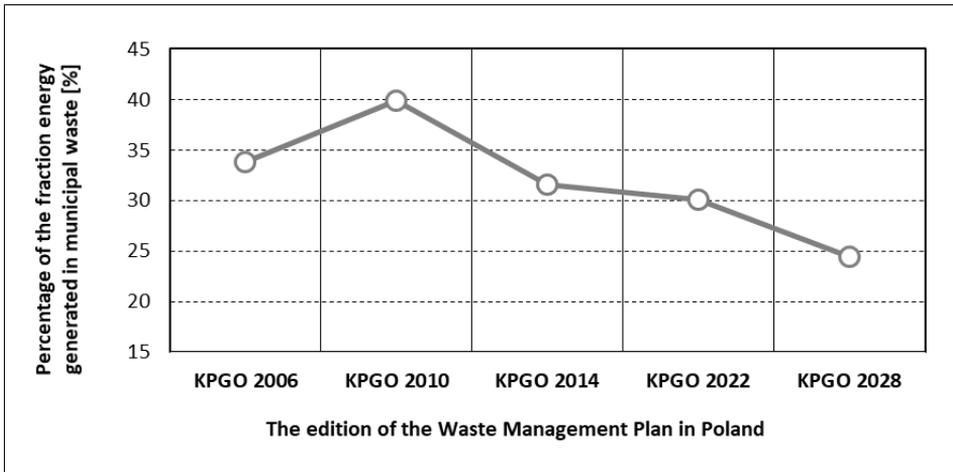


Fig. 3. Percentage of the energy fraction in the stream of generated municipal waste based on the analyzed planning documents (based on KPGO 2006, 2010, 2014, 2022 and 2028)

Rys. 3. Udział frakcji energetycznej w strumieniu wytwarzanych odpadów komunalnych na podstawie analizowanych dokumentów planistycznych

but in recent years, it has been diminishing again (Table 4, Fig. 5). In the years 2014–2015 (when KPGO 2014 was in force), the mass of potentially generated energy fraction, estimated in the total stream of municipal waste, was 3.2–3.4 million Mg. While its estimated mass in the stream of unsorted waste was 2.8–2.8 million Mg. In the years 2016–2022 (when KPGO 2022 was in force), the estimated mass of the energy fraction in the total stream of municipal waste ranged from 3.5 million Mg in 2015 to 4.0 million Mg in 2022, where the highest value was estimated for 2021, around 4.1 million Mg. In the same period, the estimated mass of the energy fraction in the stream of unsorted waste was between 3.0 million Mg in 2016, with a minor downward trend to 2.8 million Mg in 2022. In 2023 (covered by KPGO 2028), a reduction of the estimated mass of potential generation of the energy fraction in the stream of municipal waste was noticed. At the same time, the mass of this fraction in the stream of unsorted waste was maintained on a level of previous years. It is caused by the application of data, which shows definitely smaller shares of the energy fraction in the stream of generated municipal waste (IOŚ-PIB Report 2022).

The estimated mass of waste fractions considered to be the energy fractions generated and separated in the stream collected in a mixed way that is, unsorted municipal waste, in general, maintains a permanent level with a minor downward trend (Fig. 5). Such observations are related to the intensification of the process of selective collection of raw material fractions and directing the energy fraction to the selectively collected waste (mainly paper and cardboard and plastics). Table 4 presents a specification of the estimated mass of potential generation of the energy fraction waste in the total stream of generated municipal waste and in the stream of unsorted municipal waste (Fig. 4). The difference between these figures allowed for showing the scale of selective collection of the energy fraction generated in individual years.

TABLE 4. Energy fraction in the unsorted (mixed) and generated municipal waste.
The values are estimated for the area of Poland

TABELA 4. Frakcja energetyczna w niesegregowanych oraz w wytwarzanych odpadach komunalnych.
Wartości szacowane dla obszaru Polski

Energy fraction	Estimated mass of energy fraction in individual years [‘000 Mg]		
	Years 2014–2015 (KPGO 2014)	Years 2016–2022 (KPGO 2022)	Year 2023 (KPGO 2028)
Energy fraction in the total generated municipal waste*	3,264–3,432	3,507–4,116	3,281
Energy fraction in the unsorted (mixed) municipal waste**	2,857–2,872	3,006–2,780	2,753
Estimated mass of the energy fraction, collected selectively	407–559	501–1259	528

The total mass of generated municipal waste and the mass of waste collected as mixed was taken in accordance with Statistics Poland data (<https://stat.gov.pl/>).

* Shares of the fraction applied in accordance with the data provided in Fig. 3 with respect to the years when a specific plan was in force.

** The share of the fraction adopted is 34.5%, according to the data from the IOŚ-PIB Report 2022.

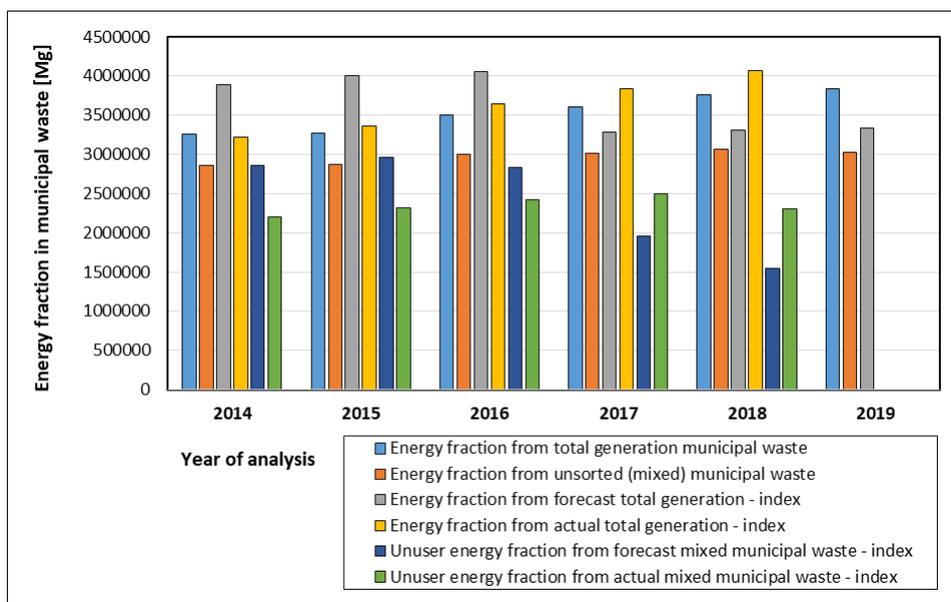


Fig. 4. Comparison of the obtained values of the estimated energy fraction in the stream of municipal waste in accordance with the adopted methodology, using two separate estimation schemes

Rys. 4. Porównanie uzyskanych wartości szacowanej masy frakcji energetycznej w strumieniu odpadów komunalnych zgodnie z przyjętą metodyką, przy zastosowaniu dwóch oddzielnych schematów szacowania

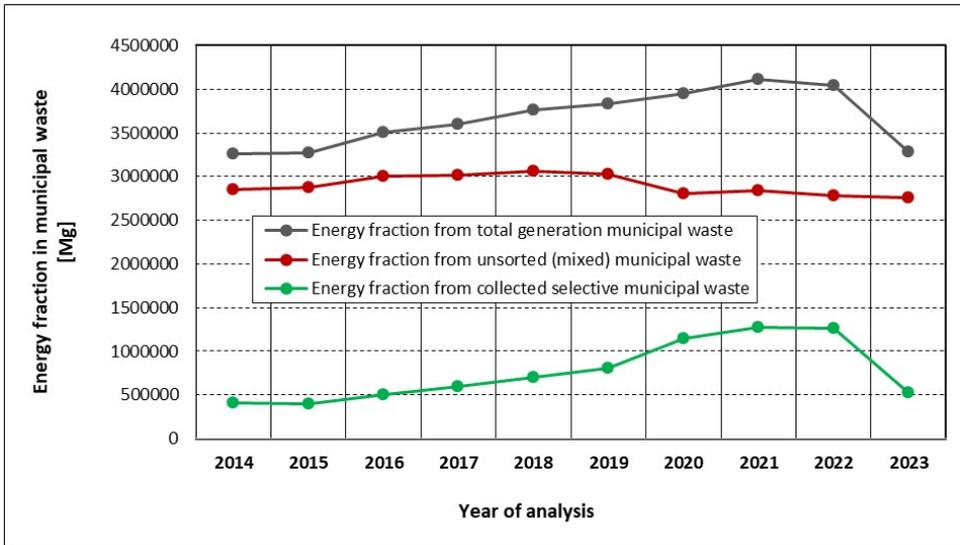


Fig. 5. Estimated mass of the energy fraction in the stream of municipal waste based on the Statistics Poland data (<https://stat.gov.pl/>), applying the morphology of waste adopted in the paper methodology

Rys. 5. Szacowana masa frakcji energetycznej w strumieniu odpadów komunalnych na podstawie danych GUS z zastosowaniem morfologii odpadów przyjętej w metodyce pracy

A separate issue is the specification of the waste code, which may be assigned to individual energy fractions separated from the stream of municipal waste. Detailed considerations are the subject of Modrzejewski (2016) paper, and the determination of affiliation to a specific group and type must comply with the Regulation of the Minister of Climate on the catalog of waste (Dz.U. of 2020, item 10). Considering the above, the energy fractions waste separated from the stream of unsorted municipal waste that is collected as mixed may be generally assigned to group 19 of waste, with code 19 12 12 (*Other waste (including mixed substances and objects) from mechanical treatment of waste, other than specified under 19 12 11*). It also may be the basis for the generation of waste with code 19 12 10 (*Flammable waste (alternative fuel)*). Instead, the energy fractions waste collected selectively may be assigned to group 20 with various waste codes, depending on the type of collected fraction (20 01 01, 20 01 10, 20 01 11, 20 01 38, 20 01 39, 20 01 99).

Summary and conclusions

The planning documents in the field of waste management are mainly waste management plans prepared at the national and voivodeship levels. The potential generation of municipal waste and individual morphological fractions presented in the planning documents is generally based on the analysis of the current situation in the base year, the characteristics of each edition of the plan, and the forecast changes.

The amount of potential generation of the energy fraction in the stream of municipal waste was analyzed based on the generation index for the energy fraction and based on the morphological composition of municipal waste in the analyzed years, consistent with the individual editions of waste management plans. Such procedures allowed for the estimation of the mass of the energy fraction waste, which has not been managed and continues to feed the stream of municipal waste collected in a mixed way (unsorted municipal waste). The analyses performed showed convergence of results with the application of two separate procedures (schemes).

The calculated weighted average of the energy fraction percentage in the total stream of municipal waste generated for the entire Poland is 29.8%, which was considered the index of fraction generation. The performed analysis, with the use of the provided value, has shown that the estimated generation of the energy fraction based on the figures forecast in the planning documents in the years 2014–2019 ranged between 3.3 and 4.0 million Mg. Instead, the mass of the energy fraction generated under actual conditions ranged between 3.2 and 4.0 million Mg. The analysis has shown a definitely smaller real generation with respect to the forecast figures for the years 2014–2016. A reverse trend has been observed in consecutive years.

In accordance with the applied morphological composition, the amount of potential generation of the energy fraction waste, referred to as a specific year, changes in individual editions of plans. In the years 2014–2015 (KPGO 2014), the averaged mass of energy fraction in the total stream of municipal waste amounted to 3.3 million Mg per year, while its averaged mass in the stream of unsorted waste was 2.9 million Mg. Such a value is close to the average value, obtained in the estimation process for the unmanaged energy fraction based on the forecast values of municipal waste generation and the generation index for this fraction. In the years 2016–2022 (KPGO 2022), the averaged mass of energy fraction in the total stream of municipal waste amounted to 3.8 million Mg per year, while in the stream of unsorted waste, this value reached approx. 2.9 million Mg. In this case, the obtained values are closer to the average values of the data obtained based on the actual data obtained from the reports. In 2023 (KPGO 2028), a reduction of the estimated mass of potential generation of the energy fraction in the stream of municipal waste was noticed. At the same time, the mass of this fraction in the stream of unsorted waste was maintained at a level similar to that of previous years.

The forecasting of waste generation with the separation of the energy fraction is a difficult and complicated task. This process and the values obtained depend on many factors, including the applied estimation methodology and the predicted and current economic changes. The

energy fraction waste, separated from the stream of municipal waste, is an important element of the circular economy system, and it should be perceived in such a way by society and businessmen.

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The Authors have no conflicts of interest to declare.

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Wytwarzanie frakcji energetycznej z odpadów komunalnych w oparciu o analizę dokumentów planistycznych

Streszczenie

Wielkość potencjalnego wytwarzania frakcji energetycznej w strumieniu odpadów komunalnych analizowano na podstawie wskaźnika wytwarzania (Kłojzy-Karczmarczyk i Staszczak 2017) oraz na podstawie wytwarzania i składu morfologicznego odpadów komunalnych podawanego w planach gospodarki odpadami na poziomie krajowym. Za frakcje energetyczne uznano te frakcje morfologiczne, które charakteryzują się wysoką wartością opałową, często powyżej 12 MJ/kg (odpady z tworzyw sztucznych, odpady papieru i tektury, odpady tekstyliów i odzieży, odpady drewna, odpady wielomateriałowe). Szacowana średnia ważona udziału frakcji energetycznej w całym strumieniu wytwarzanych odpadów komunalnych w skali kraju wynosi 29,8% (wskaźnik wytwarzania frakcji energetycznej). Wytwarzanie frakcji energetycznej w oparciu o wielkości prognozowane w dokumentach planistycznych w latach 2014–2019 waha się w granicach 3,3–4,0 mln Mg. Natomiast masa frakcji energetycznej wytworzona w warunkach rzeczywistych waha się w granicach 3,2–4,0 mln Mg. Analiza wykazała zdecydowanie mniejsze wytwarzanie rzeczywiste w odniesieniu do wielkości prognozowanych w latach 2014–2016. W kolejnych latach obserwowany jest trend odwrotny. Biorąc pod uwagę skład morfologiczny, uzyskane wielkości potencjalnego wytwarzania są zbliżone do podawanych w oparciu o przyjęty wskaźnik wytwarzania. W latach 2014–2015 uśredniona masa frakcji energetycznej w całym strumieniu odpadów komunalnych wynosi rocznie 3,3 mln Mg, natomiast jej uśredniona masa w strumieniu odpadów niesegregowanych wynosi 2,9 mln Mg. W latach 2016–2022 uśredniona masa frakcji energetycznej w całym strumieniu odpadów komunalnych wynosi rocznie 3,8 mln Mg, natomiast w strumieniu odpadów niesegregowanych wielkość ta osiąga wartość około 2,9 mln Mg.

SŁOWA KLUCZOWE: odpady komunalne, frakcja energetyczna, wytwarzanie odpadów, frakcja niezagospodarowana, szacowanie masy

