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Estimated mercury emissions from coal combustion in the households sector in Poland

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ABSTRACT

Coal consumption secures more than 50% of needs of Polish economy for primary energy carriers and the consumption of hard coal alone amounts 70–80 million Mg annually. Almost 14% of hard coal consumption – up to 11 million Mg per year – fall to households in Poland. Coal combustion in domestic furnaces and boilers is regarded as the main source of emissions into the atmosphere, referred to as the low-stack emission. The matter of the paper is the assessment of the emission of mercury from the households sector as the result of coal combustion. The results of the assessment were collated with GUS data on mercury emission from this sector. A change in the annual emission of mercury from the household sector has been proposed and justified, assuming that the whole low-stack emission of mercury is the result of coal combustion only.

1. Introduction

Low-stack emission poses a problem as various contaminants, usually in large amounts, are released in to the atmosphere in a scattered manner. A large amount of the contaminants released in the process of furnace and boiler usage in households are a result of: the type of fuels used (mainly hard coal), the low efficiency of conversion in these furnaces and boilers and a lack of equipment for reducing the impacts of combustion on the environment. Emissions from the household sector are evaluated through indirect methods due to the huge number and variety of emitters and the resulting measurement difficulties.

Low-stack emission occurs, first of all, as a result of coal utilisation in fuel combustion processes away from industrial processes – mainly in households. Therefore, actions are being taken to eliminate coal as a source of fuel, especially in households (Atmoterm, 2010). Low-stack emission is not only an effect of coal combustion in boilers without protective equipment, but it also results from the market availability of different fuels, including those with bad quality parameters.

Much less is known about the real emission of mercury from furnaces and boilers used in households (Hławiczka, 2008; Hławiczka, Kubica, & Zielonka, 2003; Hlawiczka & Fudala, 2008) than about emissions of other contaminants, e.g. dust, sulphur oxides and others (Kubica, 2010; Sobolewski & Matuszek, 2014), and emissions of mercury from large coal combustion installations, including the knowledge on the methods of mercury emissions reduction (Pavlish et al., 2003; Swaine, 2000; UNEP, 2010; Yudovich & Ketris, 2005). Until recently this resulted in part from a lack of representative data concerning the contents of mercury in combusted coals and in part from the number of emitters and the lack of possibilities to evaluate the work of all the installations or even their groups. Additionally, a lack of legal regulations made the issue of mercury in coal and mercury emissions more cognitive (scientific) than practical, despite the awareness of threats to the environment and human health resulting from the presence of anthropogenic mercury in the environment (Hławiczka, 2008). The issue of mercury emissions became an important topic, especially in Poland, only when actions to develop legal regulations aimed at reducing mercury emissions were taken, such as:

- the European Commission's ongoing work concerning mercury, which resulted in a proposal of standards for mercury emissions from large combustion plants (European Commission, 2013),
- the introduction of mercury emission standards in a number of countries (Canada, USA, China) (Sloss, 2008, 2012),
- work performed for a few years within the framework of the United Nations Environmental Programme (UNEP), resulting in an agreement on the Minamata Convention, which is a global

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convention and while it does not define any standards or other detailed regulations on mercury emission alone, work is being carrying out on executive documents (Minamata Convention, 2013).

Coal combustion is considered to be one of the main anthropogenic sources of mercury emissions on a global scale (UNEP, 2008; UNEP, 2013). In Poland coal consumption makes up an exceptionally high level of economy energy security. In 2013 coal (hard and brown) accounted for approximately 54% of the primary energy carriers' consumption and almost 90% of electricity was produced using coal (Central Statistical Office, 2014a). In the same year approximately 11 million Mg of hard coal was used in households (Central Statistical Office, 2014b).

In the authors' opinion, methods for evaluating mercury emissions into the atmosphere based on available indexes do not show the real values of emissions. Most probably the "available" indexes are still based on insufficient data concerning both emission measurements and mercury contents in coals, especially the coals used in the household sector. These are most frequently specific sorts (coal size grades) of coal, incomparable with those used mainly in combustion processes in the energy production and transformation sector, which is the area where there is currently the largest amount of data concerning mercury content. Furthermore, data concerning mercury content in coal used in households in Poland (ranging from 140 μg/kg to 1780 μg/kg) are disseminated internationally in the context of health risks (WHO IAQ Guidelines, 2014). This article delivers quite different values originated from the authors' own studies covering all hard steam coal size grades produced in Poland.

The aim of the analysis in this article was to assess the emission of mercury resulting from coal combustion in the household sector. Due to the lack of statistical data on the structure (in terms of coal size grades and quality) of the coal combusted in households, the element of the assessment was the variant evaluation of this structure. The basis for the assessment was the results of the determination of mercury content in all coal size grades produced in Poland ("Hg Base" Project). The assessment results were compared with data provided by the Central Statistical Office (GUS) and developed by the National Centre for Emission Balance and Management (KOBiZE). A change in the annual value of mercury emissions from households was proposed and justified, based on the assumption that low-stack mercury emission is the result of coal combustion only.

Due to quality requirements imposed by commercial coal recipients, raw coals are usually cleaned and subjected to fractionation according to the size of grains (coal size grades). The list of currently produced coal size grades is quite lengthy [PN-82/G-97001, 1982]. Examples of limit values of coal grain size in the most popular coal size grades on the market are presented in Table 1. It can be seen that the size distribution of the coal offered on the market is quite broad, but the selection of fuel for a particular household depends on the construction of the boiler (furnace) used. Traditionally, the types of coal dedicated for small furnaces and boilers in households mainly include so-called 'coarse' coal size grades (especially nut coals and cobbles) and medium coal size grades (pea coal). Recently, small boilers which allow the relatively effective combustion of smalls and the finest grades of coal have been constructed (Kubica, 2010; Sobolewski & Matuszek, 2014). The production of so-called "qualified fuels" for recipients from the household sector has also begun (Korzeniowski, Kurczabiński, & Łój, 2012).

Table 1
Limit values of the size of coal grains in selected coal size grades according to PN-G-97001.

Name of coal size grade	Upper size of grain, mm	Lower size of grain, mm
Cobbles	200	63
Nut coal	80	25
Pea coal	31.5	8
Smalls I	31.5	0
Smalls II	20–10	0
The finest coal	1	0

Apart from coal fuel grains size, a key issue in the coal trade are its quality parameters, the most important of which include:

- calorific value [kJ/kg],
- ash content [%],
- moisture content [%],
- sulphur content [%],

Other parameters, such as: volatile matter, content of chlorine, mercury etc., which are equally important from the point of view of coal combustion and its environmental effects, are usually not of interest to recipients from the household sector. Coal quality parameters can be improved in coal cleaning processes. There is a wide choice of processes, and their application depends on the size of the cleaned grains of raw coal. Coal cleaning is performed in preparation plants, which are located on the premises of each hard coal mine in Poland. Improving the quality of coal fuel is understood to consist of the removal of contaminants from raw coal which after its combustion turn into ash as well as other contaminants that are harmful from the point of view of coal combustion processes and its environmental effects. When contaminants (which are usually incombustible) are removed from raw coal, the cleaned coal is characterized by a higher calorific value, i.e. a higher concentration of energy in a unit of coal fuel mass than raw coal. The quality of raw coal (calorific value, ash content, sulphur content) is very changeable in practice. The quality of cleaned products, when analysed in particular collieries, is practically stable. However, due to the different characteristics of coal in particular mining areas, there are differences between same size coal grades produced by different collieries.

All raw coal with a grain size over 20 mm, from which coarse and medium coal size grades can be obtained, are fully cleaned. Smalls, accounting for more than 60% of raw of mine coal mass, are only partially cleaned, and in many mines they are sold "as raw coals". This means that the possibility of improving raw coal quality through cleaning is not fully utilised. A clear and repeatable tendency for each mine to change the quality of coal between size grades is observable. The highest quality, i.e. the lowest content of ash and the highest calorific value, is observed in the case of coarse and medium size coal grades. Smalls have worse quality and the finest coal the worst (also smalls and the finest coals fully cleaned). Data illustrating this tendency for the average production of coal companies can be found in literature (Łój & Kurczabiński, 2011; Paprotny, Wróbel, & Sitko, 2011).

Price is an important factor which influences the recipients of coal. The price of cleaned coarse and medium coal size grades (cobbles, nut coals, pea coals) can be as much as twice as high as that of smalls and nearly three times higher than of the finest coal (Katowicki Holding Węglowy S.A., 2015; Kompania Węglowa, 2015; Tauron Wydobycie, 2015). An important issue is the fact that after recalculating the price of particular size grades per unit of energy, e.g. 1 GJ (1 GJ), different prices for 1 GJ of energy for particular coal size grades are obtained. The highest price of 1 GJ is obtained for the highest quality coals (coarse and medium coal size grades) and the lowest for the worst quality smalls and the finest coal. This means that the higher the "concentration" of energy in a unit of

Table 2
Prices (*ex* mine, exclusive of excise duty, when coal is collected by truck) of selected coal size grades and prices of 1 GJ of energy contained in these coal size grades for three collieries belonging to Kompania Węglowa (2015).

Grade	Coal mine A		Coal mine B		Coal mine C	
	Price PLN/Mg	Price, PLN/GJ	Price, PLN/Mg	Price, PLN/GJ	Price, PLN/Mg	Price, PLN/GJ
Cob coal	509	16.4	509	17.6	517	19.9
Nut coal	461	14.9	461	15.9	473	18.2
Pea coal	434	14.0	434	15.0	–	–
Coal dust II					259.81	10.8
Raw sludge	181.53	9.6	–	–	43	3.9
Cleaned sludge (flotation concentrate)	–	–	221	11.6		

coal mass, the higher the price of 1 GJ of energy. By way of example, Table 2 presents prices (in the year 2015) of selected coal size grades and the prices of 1 GJ of energy contained in these coal size grades for three collieries from Kompania Węglowa S.A., offering, among others, the finest quality of coal.

Data (Kubica, 2010; Kurczabiński, 2003; Sobolewski & Matuszek, 2014) indicates that, currently, the combustion of even these highest quality coals (nut coal and pea coal) ensures the lowest cost of obtaining a unit of heat in households. Therefore, combustion of the finest coal, due to its price, must be even more attractive in terms of price, if we look at it only from the point of view of the cost involved in the obtaining of fuel. It is no wonder that the recipients frequently decide to buy this fuel. Selection of a fuel for a household is a long-term decision due to the period of usage and depreciation of the boiler adjusted to the fuel (coal size grade).

In households 10.77 million Mg of hard coal was used in 2013 which accounts for 13.9% of the total hard coal consumption in the Polish economy and 11.02 million Mg in 2012. In recent years the lowest consumption of hard coal in households was reported in 2009 – approximately 9 million Mg (Central Statistical Office, 2011; Central Statistical Office, 2014a; Central Statistical Office, 2014b). In household energy consumption in Poland, the usage of coal represents 29% of all the energy needs of this sector, which is a unique phenomenon in the European Union. This is in contrast to other countries, where coal is used in households, i.e. Bulgaria and Ireland, where the share of coal in the securing of household energy needs is only 7–8% (Central Statistical Office, 2014b; SEAI, 2013).

Currently there is no statistical data on the structure of coal size grades used in households. In one study (Atmoterm, 2010) an attempt was made to evaluate the coal size grade structure of locally combusted coals in the region of Cracow, based on information obtained from nearby coal yards. The presented data raises doubts due to the fact that the equal masses of consumption of medium (ecological pea coal, pea coal) and coarse coal size grades (nut coal, cobbles) are considered. Probably even the import of coal does not eliminate the unavoidable differences in the volume of production and accessibility in the market of both coal size grade groups in Polish mines. Additionally, the consumption of the finest coal is not mentioned. Therefore a new approach to assess the quantity and quality structure of coal size grades combusted in households was undertaken.

2. Material and methods

Work carried out can be split into two parts:

- assessment of the quantity and quality structure of the coal size grades combusted in households,
- sampling, and mercury content and ash determination for coal size grades of hard steam coal produced in Polish collieries.

Both areas, mentioned above, will make it possible to calculate the load of mercury in coal combusted in the household sector in Poland and the potential emissions of mercury in this sector.

The quantity and quality structure of the coal size grades combusted in households was proposed based on the following assumptions:

- the masses of medium and coarse coal size grades and the finest coals produced in Polish collieries in 2014 were taken as a basis mass data,
- two variants of the finest coal share in the fuel used in households have been considered; the first resulting from the total production of this coal size grade in Polish collieries, and the second – based on the assumption that households buy the finest coal only of "good quality", i.e. with ash below 20% (air dried),
- it has been assumed that hard coal consumption in households ranges between 9.2 and 10.77 million Mg annually (data for 2012 and 2013),
- it has been assumed that the complement amount of coal fuel, as the amount of medium, coarse coal size grades and the finest coal produced doesn't cover annual consumption of coal in households (9.0–11,02 million Mg), will be filled up with smalls.

The above assumptions are simplified, as they do not take into consideration the following facts:

- not all coarse, medium coal size grades and finest coals are consumed by individual recipients from the household sector,
- coal, including medium and coarse coal size grades, is both exported and imported.

The evaluation is based on annual data on the production of hard coal in Poland, including coarse coal size grades, medium coal size grades and the finest coal, and reflects real production capabilities. Both the yield of particular coal size grades and their mutual mass relations (especially medium and coarse size grades) cannot be arbitrarily shaped, but are characterized by a stable share in collieries' production.

Analysis of mercury content was carried out for all coal size grades of hard steam coal produced in Polish collieries, excluding those that produce almost exclusively coking coal or components of size grades like smalls in cases where steam coal blends were produced, based on raw coal, clean coal, middlings, etc. The gross samples of all coal size grades and components were collected from increments taken from between one to two weeks, depending on local conditions. The increments were taken at the same time, with those sampled in routine sampling operations in all collieries under consideration. Sampling has conformed to the requirements of the following standards:

- Hard coal and brown coal. Methods of sampling and laboratory sample preparation PN-90/G-04502

- Hard coal and coke – Mechanical sampling – Part 2: Coal – Sampling from moving streams PN-ISO 13909-2
- Hard coal and coke – Mechanical sampling – Part 3: Coal – Sampling from stationary lots PN-ISO 13909-3
- Hard coal and coke – Mechanical sampling – Part 4: Coal – Preparation of test samples PN-ISO 13909-4
- Hard coal and coke – Manual sampling PN-ISO 18283.

Ash and mercury content were determined using the following standard and procedure:

- Solid fuels. Determination of ash by gravimetric method PN-80/G-04512 and PN 80/G-04512Az1
- the certified internal procedure, elaborated in Główny Instytut Górnictwa No. SC-1.PB.23 applying the Cold-Vapor Atomic Absorption Spectrometry, using the analyzer MA-2000 of Nippon Instrument Corporation. It is a fully automated measurement system for the determination of mercury content in solid materials, gases and liquids through sample combustion or evaporation.

The results of the determination of mercury content in coal, used to calculate the load of mercury in coal and emissions, are given in μg/kg (as received). The results of the determination of ash in coal, used to compare the quality of coal size grades, are given in % by mass for air dried basis.

3. Results and discussion

3.1. Quantity and quality structure of the coal size grades combusted in households

Taking into consideration information on the production of different coal size fractions and the structure of this production in 2014, four variants of the coal size grades share in the quantity of hard coal consumed in households were outlined – Table 3. The number of variants results from assuming two values, the highest and lowest, of the total consumption of coal in households for the last few years (9.0 and 11.02 million Mg) and two values of the finest coal consumption: only "good quality" (ca 830 000 Mg) and the total amount of the finest coal produced (ca 1 114 000 Mg).

The presence of exported coal on the market as well as the sale of coarse and medium coal size grades to other recipients should not considerably change the aforementioned shares with regard to individual recipients. The aim of this work is to evaluate mercury load in coal combusted in households, and the content of mercury in imported coal is not known. To avoid underestimating the mercury load in the discussed coals, it has been assumed that the quality parameters of smalls used to fill up the domestic consumption of coal in households will be average for the whole population (not only limited to clean coal). This will probably result in the overestimating of mercury load in smalls, as it is clean smalls that are usually combusted in households, especially in those where boilers dedicated to the combustion of smalls are used.

Data contained in Table 3 indicates that the production of coarse coal size grades is more than twice as high as that of medium coal size grades; it should also be mentioned that this tendency has been observed for many years and it results from the size distribution of raw of mine coal.

Smalls are typical fuels dedicated to the sector of energy production and transformation as well as for direct consumption in industry. This is a commercial product which has a maximum grain size of 31.5 mm, 20 mm or 6 mm (fuel for fluidised boilers). Approximately 40% of this size grade production volume is raw, uncleaned coal (Dubiński, Pyka, & Wierzchowski, 2011).

The finest coals are specific products of mines (Lorenz & Ozga-Blaschke, 2005). These are the finest grains of mined rock which have had contact with water in the production process (most frequently as a result of cleaning carried out in a water separation medium) performed in coal preparation plants. They may, but do not have to, be subjected to cleaning processes dedicated for the finest grains, such as foam flotation, spirals, hydrocyclones and others. As mentioned before, quality parameters of the finest coal are the worst compared to other coal size grades, but their basic "problem" is their high content of moisture (most frequently over 20% total moisture). It could be claimed that if properly dewatered, they can be completely "hidden" in smalls. This is the most advisable way to manage them. It should be mentioned that processes of dewatering the finest grains are expensive and the result of dewatering must be good enough so that the transportability of a coal product with the addition of the dewatered finest coal is not worsened. Such limitations are absent in the case of individual recipients. The "cutting" of "plastic" the finest coal material is even beneficial for individual recipients, whereas in the conditions of large power plants the "plastic" properties of the finest coal cause transportability problems or even downtimes in coaling systems. This is one of the reasons why the finest coals are offered to individual recipients and, as mentioned before, an additional advantage is their attractive price.

3.2. Ash and mercury content in different coal size grades

Table 4 contains the values of selected statistics characterizing the contents of ash in basic coal size grade groups, and Figs. 1–4 illustrate the quantitative distributions of the production of particular grades according to mercury content.

Our own studies have shown, that weighted mean values of mercury content (as-received) in particular coal size grade groups in 2014 are as follows:

- coarse size grades ca 64 μg/kg,
- medium size grades ca 87 μg/kg,
- the finest coal ca 81 μg/kg,
- smalls ca 113 μg/kg.

The contents of ash in coarse and medium coal size grades are similar. The average values in both cases reach approximately 5–6% and the variability of these coal size grades' whole production is similar and not very high. Minimal values are ca 2–3%, maximal –

Table 3
Masses and percentage shares of particular coal size grade groups used in households (authors' own calculations).

Grade group	Variant 1		Variant 2		Variant 3		Variant 4	
	Millions Mg	%	Millions Mg	%	Millions Mg	%	Millions Mg	%
Coarse coal size grades	5.254	58	5.254	48	5.254	58	5.254	48
Medium coal size grades	2.473	28	2.473	22	2.473	27	2.473	22
The finest coal	0.940	10	0.940	9	1.224	14	1.224	11
Smalls	0.333	4	2.353	21	0.049	1	2.069	19
Total	9.0	100	11.02	100	9.0	100	11.02	

Table 4
Selected statistics of ash contents (in analytical state) in coal used in households according by grade groups according to data for the year 2014 (authors' own study).

Statistics	Coarse size grades A^a, %	Medium size grades A^a, %	Smalls, A^a, %	The finest coal A^a, %
Average value	5.2	5.9	18.9	29.7
Weighted mean value	5.6	5.9	19.5	25.2
Minimal value	2.5	2.9	4.0	5.2
Maximal value	9.9	11.1	49.2	54.8
Interquartile range	7.5	8.2	45.2	49.6
Quartile 1	4.0	4.4	9.2	16.4
Quartile 3	6.8	7.0	26.7	44.9

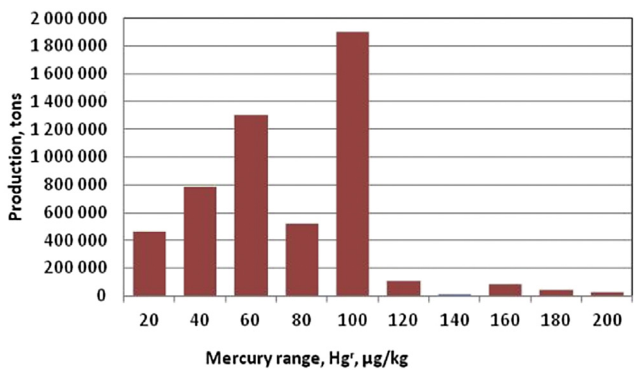

Fig. 1. The distribution of the production of coarse coal size grades in Poland in 2014 by the content of mercury (authors' own study).

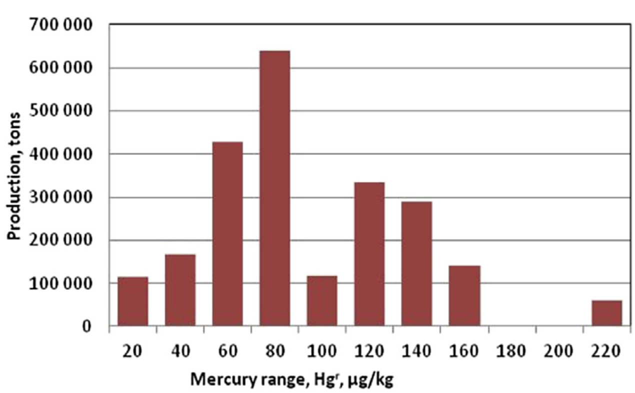

Fig. 2. The distribution of the production of medium coal size grades in Poland in 2014 by the content of mercury (authors' own study).

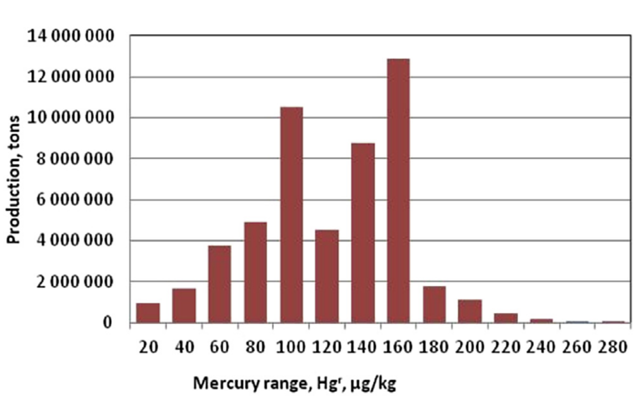

Fig. 3. The distribution of the production of smalls in Poland in 2014 by the content of mercury (authors' own study).

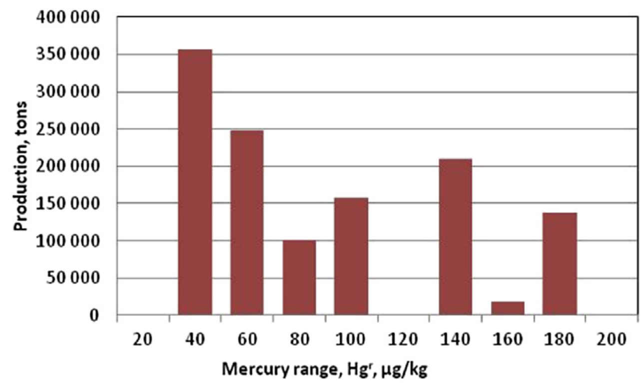

Fig. 4. The distribution of the production of the finest coal in Poland in 2014 by the content of mercury (authors' own study).

up to 11%. In both cases 50% of the results range from 4 to 7%. As previously mentioned, these are solely fully cleaned coals.

Contents of mercury are slightly different in these coal size grade groups. The content of mercury is notably at its lowest in coarse coal size grades – the weighted mean value is ca 64 µg/kg. The vast majority of the production of these coal size grades is characterized by mercury content below 100 µg/kg. The amount of mercury content in the largest part of production of this coal size grade, 1.9 million Mg, ranges from 80 to 100 µg/kg. In the case of medium coal size grades the weighted mean value of mercury content reaches approximately 87 µg/kg, and in the largest part of production of this coal size grade – ca 0.65 million Mg – the content of mercury ranges from 60 to 80 µg/kg. Characteristically, for both coal size grades, the content of mercury in these cleaned products may reach 220 µg/kg. However, this only applies to very small production volumes.

On the other hand, the finest coal and smalls are characterised by completely different quality. In these coal size grade groups the average content of ash is notably higher than in coarse and medium coal size grades and the ranges of ash content are much wider. The average content of ash in the finest coal is ca 30%, but the weighted mean value is lower, reaching ca 25%. This means that the finest coal lots with a lower content of ash prevail in terms of mass. The minimal value is ca 5% and the maximal one ca 55%. 50% of the results are within a wide range of values: from ca 16 to ca 45%. In the case of smalls both average values are similar, reaching ca 19%. The minimal value is ca 4% and the maximal one ca 49%. 50% of the results are within a wide range of values, from ca 9 to ca 27%.

Both in the case of the finest coals and smalls, coal which has a high content of mercury (over 100 µg/kg) is produced in relatively large quantities. Also relatively large amounts of the finest coals and smalls with mercury content reaching up to 180 µg/kg have been identified. Due to the prevalence of these finest coals production with mercury content reaching up to 40 µg/kg, being approximately 350 000 Mg, the weighted mean value of mercury content in the finest coals on an as-received basis is relatively small,

Table 5
Estimates of mercury load in coal size grade groups used in households per year (authors' own calculations).

Size grade group	Mercury loads per year, kg			
	Variant 1	Variant 2	Variant 3	Variant 4
Coarse size grades	336	336	336	336
Medium size grades	215	215	215	215
The finest coal	76	76	99	99
Smalls	38	267	6	235
Total	665	894	656	885

reaching merely ca 81 μg/kg. The weighted mean value of mercury content in smalls is notably higher – ca 113 μg/kg, but, as mentioned before, this results from the fact that the cleaned coal was analysed with raw coal. This fact also explains the high variability of mercury content in smalls.

3.3. *Evaluation of mercury emissions in the household sector*

Table 5 contains estimated values of annual mercury load in coal in particular coal size grade groups used in households. These estimates correspond to the variants from Table 3. Data presented in Table 5 shows that for the analysed variants the mercury load in coal used in the household sector ranges from ca 656–894 kg per year. This value is considerably lower than the reported value of mercury emissions from the households sector, reaching 1076 kg in the year 2012. It should be emphasised, however, that such a comparison of data is not authorised. In the first case we are talking about mercury load in coal and in the other about mercury emissions in to the atmosphere. Due to the available literature data it is known that not all of the mercury load contained in coal gets into the atmosphere. As a result of research (Hławiczka et al., 2003; Hławiczka, 2008) it was found that boilers used in the household sector only emit approximately 52% of gaseous forms of mercury in flue gases in to the atmosphere, therefore, this emission is expressed by the following formula:

$$\text{emission [kg]} = \text{load [kg]} * \eta\ [\%]$$

where $\eta = 52\%$

Based on the above estimate of mercury load in coal used in households, the emission of mercury into the atmosphere can reach:

$$656 - 894\ [\text{kg}] * 0.52 = 341 - 465 [\text{kg}]$$

The estimated value of mercury emissions to the atmosphere from the household sector as a result of coal combustion is notably lower than the value quoted in official reports. The uncertainty of the estimates results from the fact that the coefficient of mercury release from coal to the atmosphere in the processes of its combustion without protective equipment in small boilers has been based on the results of one of the available studies. The estimation does not also take into consideration mercury condensed on ash particles. Nonetheless, the difference between estimated and reported values is too great to be ignored.

4. Conclusions

1. Hard coal is an important primary energy source in the Polish household sector. Coal represents approximately 29% of this sector's energy needs, which is a unique phenomenon in Europe. Direct consumption of coal in households reaches ca 13–14% of the total consumption of coal in Poland. This situation is the effect of past circumstances resulting from the easy accessibility of coal on the market as well as the historical and current prices of alternatives for coal carriers of primary energy.
2. Coal combustion in households is seen as a basic source of so-called "low-stack emission". Ideas concerning the introduction of a complete ban on coal combustion in households have been put forward. In the authors' opinion, we should strive to eliminate coal fuels which are not intended for household use from the market and improve combustion efficiency. In households only fully cleaned coals ought to be used.
3. The weighted mean values of mercury content on an as-received basis in particular size grade groups analysed have been estimated as follows:
   - coarse size grades ca 64 μg/kg,
   - medium size grades ca 87 μg/kg,
   - the finest coal ca 81 μg/kg,
   - smalls ca 113 μg/kg.
4. The total mercury load in coal combusted in households has been estimated as between 656 and 894 kg per year. The above values are much lower than the ones quoted in official reports, which reaches 1076 kg for the year 2012. Taking into account that not all of the available mercury is emitted into the atmosphere even when it is combusted without protective equipment, the mercury emission from households per year should be far less than reports suggest, from 656 to 894 kg per year.
5. The use of coal fuel in households and its choice should be based on a regulated supply, restricted to good quality coals. It seems that these do not have to be only coarse (e.g. nut coal) and medium coal size grades (pea coal). These can also be good quality coal smalls or even the finest coal (e.g. in a form of pellets – in this form the finest coal can be effectively combusted). Research and analytical studies have demonstrated that from the point of view of mercury emissions, the latter can be even more attractive than some of the coarse and medium size grades produced, provided that the remaining basic quality parameters, i.e. ash and sulphur contents are also low.
6. All of the above does not negate the need to eliminate coal as fuel for direct use in households. As long as coal is used, good quality coal (cleaned) of all coal size grades should be offered and first of all poor quality coals, attractive in terms of price, should be eliminated from the market.

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The results of the determination of mercury and ash content in commercial products of Polish hard coal collieries have been obtained in the project funded within the framework of the Applied Research Program of the Polish National Centre for Research and Development, entitled: The elaboration of a data base on mercury content in domestic coal, technological guidelines of further mercury reduction, including the defining of benchmarks for domestic indices of mercury emission" – acronym "Hg Base" ("Baza Hg"), (PBS2/A2/14/2013).

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