

KATARZYNA STALA-SZLUGAJ\*<sup>#</sup>**THE DEMAND FOR HARD COAL FOR HOUSEHOLDS IN POLAND AND THE ANTI-SMOG BILL****ZAPOTRZEBOWANIE NA WĘGIEL KAMIENNY DLA GOSPODARSTW DOMOWYCH W POLSCE  
A USTAWA ANTYSMOGOWA**

Households are the most significant group of consumers in the municipal and household sector in Poland. In 2010-2016, households consumed annually from 8.9 to 10.8 million Mg of coal (77-81% share in this sector).

As of the beginning of 2018, seven voivodships in Poland have already introduced anti-smog resolutions, one has its draft, three are considering introduction of such resolutions. In the face of introducing anti-smog resolutions, the analysis of coal consumption by households was conducted for a situation where anti-smog resolutions will be introduced in all voivodships in Poland.

A forecast of hard coal consumption by Polish households in 2017-2030 was presented in the article. Two scenarios differentiated in terms of calorific value of coal were taken into account: (i) concerned coal with a calorific value of 24 MJ/kg (min. Q for eco-pea coal: grain size 5.0-31.5 mm), (ii) – coals with a calorific value of 26 MJ/kg (Q recommended for use by producers of class 5 boilers).

In the perspective of 2030, the largest decrease in hard coal consumption can be expected (jointly) in the voivodships of Śląskie, Dolnośląskie, Opolskie and Lubuskie. Under the assumptions made, in relation to 2016, it may be reduced by half and fall from 2.8 to the level of 1.4-1.5 million Mg. The smallest decreases in consumption may occur (jointly) in the Małopolskie, Lubelskie, Podkarpackie and Świętokrzyskie voivodships – decrease by 16-22% and fall from 2.6 to approximately 1.9-2.0 million Mg. On a national scale, coal consumption may decrease from the current 10.4 (2016) to around 6.3-6.8 million Mg (a decrease of 30-35%).

Despite the decrease in hard coal consumption in the 2030 perspective, one should expect an increase in demand for high quality coal dedicated to modern boilers (usually pea assortments) as well as qualified coal fuels (mainly eco-pea coal).

**Keywords:** household, hard coal, anti-smog bill, forecast, Poland

Gospodarstwa domowe stanowią najbardziej znaczącą grupę konsumentów w sektorze drobnych odbiorców w Polsce. W latach 2010-2016 gospodarstwa domowe zużywały rocznie od 8,9 do 10,8 mln Mg węgla (77-81% udział w tym sektorze).

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Według stanu na początek 2018 r. siedem województw w Polsce wprowadziło już uchwały anty-smogowe, jedno posiada jej projekt, trzy rozważają ich przyjęcie. W obliczu wprowadzania uchwał anty-smogowych przeprowadzono analizę zużycia węgla przez gospodarstwa domowe w sytuacji, gdy uchwały anty-smogowe będą obowiązywać we wszystkich województwach w Polsce.

W artykule wykonano prognozę zużycia węgla kamiennego przez polskie gospodarstwa domowe w latach 2017-2030. Wzięto pod uwagę dwa scenariusze zróżnicowane pod względem wartości opałowej węgla: (i) dotyczył węgla o wartości opałowej wynoszącej 24 MJ/kg (min. Q dla ekogroszków – węgiel o klasie ziarnowej 5,0-31,5 mm), (ii) – węgiel o wartości opałowej wynoszącej 26 MJ/kg (Q zalecane do stosowania przez producentów kotłów 5 klasy).

W perspektywie 2030 r. największy spadek zużycia węgla kamiennego można spodziewać się (łącznie) w woj. śląskie, dolnośląskie, opolskie i lubuskie. Przy przyjętych założeniach, względem 2016 r. może ono zmniejszyć się o połowę i spaść z 2,8 do poziomu rzędu 1,4-1,5 mln Mg. Najmniejsze spadki zużycia mogą wystąpić (łącznie) w woj.: małopolskim, lubelskim, podkarpackim i świętokrzyskim – może zmniejszyć się o 16-22% i spaść z 2,6 do około 1,9-2,0 mln Mg. W skali kraju zużycie węgla może zmniejszyć się z obecnych 10,4 (2016 r.) do około 6,3-6,8 mln Mg (spadek o 30-35%).

Pomimo spadku zużycia węgla kamiennego w perspektywie 2030 należy spodziewać się wzrostu zapotrzebowania na węgiel o wysokiej jakości dedykowany nowoczesnym kotłom (najczęściej j. o sortymencie groszek), jak również na kwalifikowane paliwa węglowe (głównie ekogroszek).

**Słowa kluczowe:** gospodarstwa domowe, węgiel kamienny, ustawa anty-smogowa, prognoza, Polska

## 1. Introduction

The availability of domestic hard coal deposits being the basis of Poland's energy security causes hard coal to be used in many branches of industry. Among others, this mineral forms the basis of both Polish power system (Grudziński, 2012; Olkusi, 2012; Lorenz et al., 2013; Kamiński & Saługa, 2014; Gawlik et al., 2016; Szczerbowski & Ceran, 2017, Stala-Szlugaj & Grudziński, 2017), and heating system (URE-Energetyka..., 2017).

Hard coal is also used for heating purposes by households. The popularity of this fuel in households is also influenced by the relatively low heating costs compared to other energy carriers. According to (GUS – Zużycie energii..., 2017) in 2015, 49% of households in Poland used heating devices for solid fuels, mainly hard coal.

However, hard coal combustion is associated with the emission of pollutants resulting from the chemical composition of coal, and thus from its parameters and the resulting waste (Klojzy-Karczmarczyk et al., 2016a), as well as the combustion conditions. Emission of pollutants into the environment undoubtedly affects the human health risk (Kicińska, 2017; Kerimray et al., 2017). Bearing in mind the negative impact on human health and the environment, as at the beginning of 2018, seven provinces in Poland have already introduced anti-smog resolutions. These resolutions, inter alia, introduce bans and restrictions on the use of certain solid fuels.

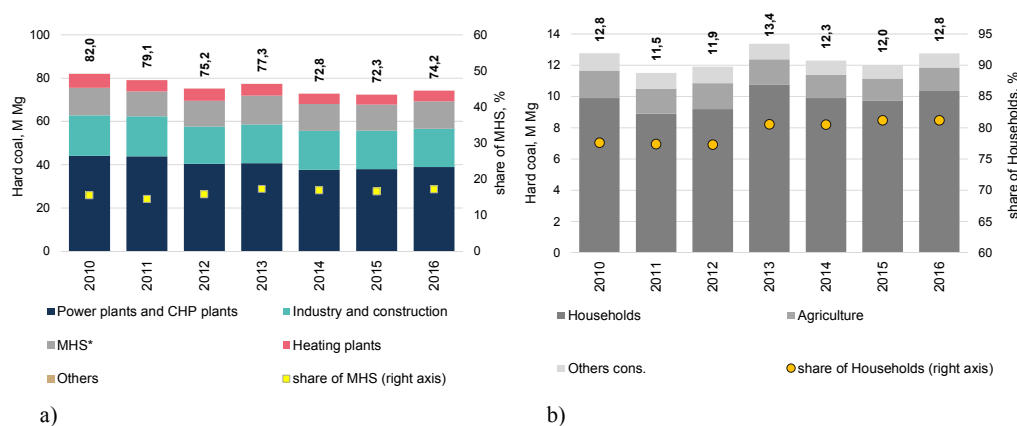
The purpose of the article is to present a forecast of households' hard coal consumption in Poland, taking into account the impact of anti-smog resolutions, as well as indication of coal assortments, for which demand will increase in the coming years.

## 2. Hard coal consumption in households

According to the methodology adopted by the national statistics (GUS – Zużycie energii..., 2017), households, in addition to agriculture and other recipients, belong to the municipal and household sector. In 2010-2016, this sector, following the power plants and heat and power plants

as well as industry and construction, was the third hard coal consumer in Poland (Fig. 1a). The coal consumption in this sector accounted for 15-17% (11.5-13.4 million Mg/year) of domestic coal consumption. It should be noted that households actually burn steam coal. However, often in the CSO statistics (GUS statistics), the consumption of coal in households is reported as hard coal consumption, although in fact it refers to steam coal. In contrast, coking coal is consumed by the coking and metallurgical industry.

Analyzing the hard coal consumption in individual statistical groups of the municipal and household sector (Fig. 1b), it can be noticed that households constitute the most significant group of consumers. In 2010-2016, households consumed annually from 8.9 to 10.8 million Mg of coal, and their share in the consumption of coal in the municipal and household sector changed in the range of 77-81%. In terms of statistics, a household is understood as a group of people living together and supporting one another, regardless of whether they live alone or with other people.



\* The municipal and household sector

Fig. 1. Hard coal consumption in Poland (a) and in households (b) in 2010-2016  
 Source: own work based on (GUS – Zużycie paliw..., 201-2017)

Research conducted by the national statistics (GUS – Zużycie energii..., 2017) shows that the average household in Poland for heating 1 square meter of residential space with hard coal has spent about 21 PLN/year (average annual exchange rate in 2015 according to NBP data (<http://www.nbp.pl>) amounted to PLN 3.8/USD). In the case of heating with natural gas – for each 1 m<sup>2</sup>, these expenses were higher by 5 PLN and amounted to around 26 PLN/year. The average age of the central heating boiler for solid fuels was just over 11 years, and for the dual-function boiler – 9 years. The average statistical household in the city spent 1,900 PLN for the purchase of hard coal, and its consumption amounted to 2.7 Mg. In the case of households located in the countryside, these expenses amounted to 2,100 PLN, and consumption was at the level of 2.9 Mg.

The hard coal consumption in any given apartment is associated with many factors. It depends not only on the area of the heated apartment. It is also influenced by: calorific value of coal, age of the boiler, condition of chimney systems, coal combustion technique, as well as the age of the residential building and the degree of its thermal insulation. The use of various construction materials over decades, construction techniques, insulation of external walls, foundations and

flat roofs, window and door joinery – all contribute to the diversity of the final energy demand of a residential building (Fig. 2a).

Results from the 2011 National Population and Housing Census (GUS-NSP2011 Mieszkania 2013) show that buildings constructed in the years 1945-2011 had the largest share (24% share in total residential buildings). The analysis conducted by the author (Stala-Szlugaj, 2017) indicates that the largest number of flats heated with coal is located in rural areas. The average residential area in Poland heated with individual central heating boiler for solid fuels in the countryside is approximately 102 m<sup>2</sup> (data by GUS-NSP2011 Mieszkania 2013), and heated with ovens – around 64 m<sup>2</sup>.

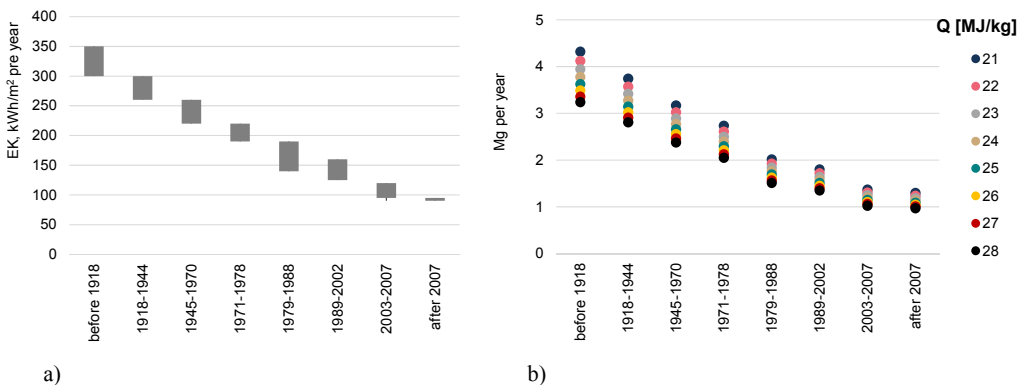


Fig. 2. Demand for final energy of the building (a) and annual consumption of hard coal (b)  
 Source: (a) own work based on (Uchwała RM – Krajowy Plan..., 2015), (b) own calculations

The graph in Fig. 2b shows the simulation of how the annual hard coal consumption changes depending on: coal heating value and the age of a residential building. The simulation assumes that the single-family building will be located in the countryside, its heating area will be 102 m<sup>2</sup>, and the coal will be burnt in a modern, low-emission, class 5 boiler according to PN-EN 303-5:2012, with an efficiency of 85%. The methodology used to determine the energy performance certificates of a building was used for calculations. In the calculations for (Uchwała RM – Krajowy Plan..., 2015) it was assumed that approximately 70% of final energy EK is used for heating in Poland.

With the change in the age of the building, the annual demand for coal changed. The largest demand was found for buildings constructed in technology from before 1945, amounting to about 3-4 Mg/year. In buildings built after 2002 – with the adopted calculation assumptions – it may fall even below 2 Mg/year. In relation to the oldest buildings, the consumption in newer buildings may even drop twice. The improvement of the calorific value of coal by 1 MJ/kg reduces the demand for coal by 4%.

### 3. Anti-smog resolution

In mid-November 2015, the amendment to the Act – Environmental Protection Law (Ustawa Prawo..., 2015), known as the so-called anti-smog law entered into force. In accordance with

Article 96 of this Act, in order to prevent a negative impact on human health or the environment, the regional council may introduce a resolution containing restrictions or bans on the operation of installations in which fuels are burned.

The mentioned resolution has to define (Ustawa Prawo..., 2015):

- the boundaries of the area where orders and bans will be introduced,
- types of entities and installations concerned,
- technical parameters or solutions, or emission parameters in which fuels are burnt, admitted for use in a given area.

As of the beginning of 2018, seven voivodships in Poland took advantage of the opportunity provided by this amendment and introduced anti-smog resolutions on the territory of the entire voivodship (Tab. 1). One province has a draft resolution and is awaiting approval. It should be noted that anti-smog resolutions are also in force for four cities: Kraków, Wrocław, Poznań and Kalisz as well as for five health resorts in the Dolny Śląsk voivodship. However, the Lubelskie, Świętokrzyskie and Lubuskie voivodships are also considering introduction of anti-smog resolutions in their area.

Due to the hard coal consumption, the resolutions valid for the entire area of a given voivodship will have the greatest impact, which is why they were given more attention. In these seven provinces, households collectively burn 65% of the coal consumed in all households in Poland.

TABLE 1

List of voivodships covered by anti-smog resolutions, as at the beginning of 2018

Ordinal number	Voivodship	Date of:		
		duty	replacement of the oldest boilers	application of new 5th class boilers
1	Małopolskie	2017-07-01	2022-12-31	2027-01-01
2	Śląskie	2017-09-01	2021-12-31	2028-01-01
3	Opolskie	2017-11-01	2023-12-31	2030-01-01
4	Wielkopolskie	2018-05-01	2023-12-31	2026-01-01
5	Łódzkie	2018-05-01	2023-12-31	2030-01-01
6	Mazowieckie	2018-07-01	2022-12-31	2028-01-01
7	Dolnośląskie	2018-07-01	2024-06-30	2028-01-01
Proposal				
8	Podkarpackie	2018-05-01	2021-12-31	2028-01-01

Source: own work based on (<https://powietrze.malopolska.pl/antysmogowa/>, <https://powietrze.slaskie.pl/content/uchwala-sejmiku-nr-v3612017>, <http://bip.opolskie.pl/wp-content/uploads/2017/09/367-uch-antysmogowa-1.pdf>, <http://www.wfosgw.poznan.pl/sejmik-województwa-wielkopolskiego-przyjal-uchwaly-antysmogowe/>, <http://powietrze.lodzkie.pl/uchwa%C5%82a-antysmogowa/projekt-uchwa%C5%82y-antysmogowej>, <https://www.mazovia.pl/dla-mediow/informacje-prasowe/art,3954,mazowsze-ma-uchwale-antysmogowa.html>, <https://www.wroclaw.pl/srodowisko/sejmik-przyjal-uchwaly-antysmogowe>, <http://www.bip.podkarpackie.pl/index.php/informacja-o-srodowisku/ochrona-powietrza/3719-antysmogowa464332556>)

In all anti-smog resolutions currently in force, it is prohibited to use fuels such as lignite, silts, flotoconcentrates, some coal fines (the share of grains 0-3 mm cannot exceed 15%) and wet biomass (total moisture in as received basis is to be lower than 20%). Among others, the resolu-

tions also specify: permissible solid fuels, dates of introduction of class 5 boilers into buildings, replacement of old boilers with class 5 boilers.

As a result, the demand for fuels dedicated to modern boilers should increase over the next 5-6 years. However, in the perspective of 10-11 years, only low-emission, high-efficiency class 5 boilers may be used in households. Most often, these boilers are adapted to the combustion of qualified coal fuels (eg. eco-pea coal) or pea coal assortment. The conducted analysis of offers from producers of class 5 boilers shows that for a given boiler to comply with the applicable emission standards, it should usually burn coal with a calorific value of 26 MJ/kg.

## 4. Hard coal supply for households

Currently, the supply of coal to Polish households is largely provided by domestic producers (Fig. 3a). In 2012-2017, the share of steam coal sales addressed to other domestic consumers (including households) implemented by Authorized Resellers varied from 64 to 88%. The remaining part was supplemented by the sale of imported coal (33-58%).

Analyzing the sales of coal according to the assortment groups, it is noticed that in 65-74% it consists of: coarse, medium and fine assortments (Fig. 3b). Considering the draft regulation of the Minister of Energy regarding quality requirements for solid fuels (Projekt – Wymagania jakościowe...2017) in the case of coarse assortments, the minimum calorific value is to be 22 MJ/kg (Fig. 4). For eco-pea coal, for which class 5 boilers are most often intended, it is to be at least 24 MJ/kg.

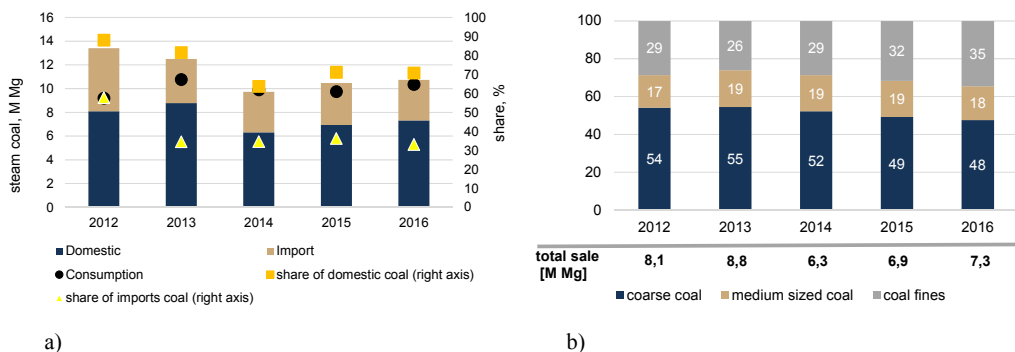
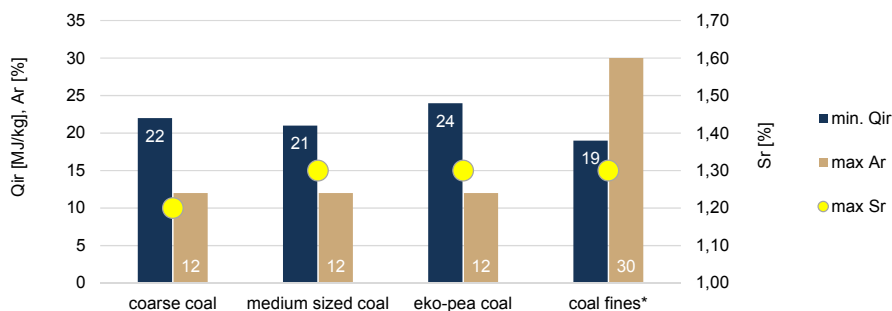


Fig. 3. National supply of steam coal for households (a) specifying sales by coal assortment (b)  
 Source: own work based on (GUS – Zużycie paliw..., 2011-2017; ARP – Ceny..., 2013-2017; ARP – Import..., 2013-2017)

## 5. The forecast of hard coal consumption in households in Poland

In the face of introducing anti-smog resolutions regarding the entire areas of voivodships, the question was asked: how will coal consumption look like in a situation where anti-smog resolutions will apply in all voivodships in Poland.



\* for combustion in installations without flue gas desulphurisation with a nominal heat output of not less than 1.0 MW

Fig. 4. Quality requirements of selected coal assortments according to the draft regulation  
 Source: own work based on (Projekt – Wymagania jakościowe..., 2017)

While preparing a projection of coal consumption by households, the methodology presented by the author in the publication (Stala-Szlugaj, 2017), was applied, however some updates were introduced. For each province – based on the available data (GUS – BDL, 2018) the number of single-family houses located in the countryside and in the city and houses heated with coal was updated. As a starting point for the forecast for each province in the country, hard coal consumption from 2016 was adopted (see: GUS – Zużycie paliw..., 2011-2017). the number of single-family houses located in the countryside and in the city and houses heated with coal was updated. As a starting point for the forecast for each province in the country, hard coal consumption from 2016 was adopted (see: (Stala-Szlugaj, 2017).

In addition, the following assumptions were made in the calculations:

- hard coal consumption will be limited only to rural areas; households in cities will be heated by different energy carrier (eg. network heat, natural gas, renewable energy sources),
- the coal will be burned only in low-emission class 5 boilers with an efficiency of 85%,
- the final energy demand of the building for a given construction period was taken as the minimum value presented in Fig. 2a,
- the forecast will be made in the perspective of the year 2030.

Considering the consumption of coal in households, two scenarios differentiated in terms of calorific value of coal were taken into account:

- the scenario Sc\_H\_24MJ concerned coal with a calorific value of 24 MJ/kg – according to (Projekt – Wymagania jakościowe...2017 it is the minimum calorific value of qualified fuels of pea coal assortments (eco-pea coals);
- the scenario Sc\_H\_26MJ concerned coal with a calorific value of 26 MJ/kg – coal with this calorific value is most often recommended for use by producers of class 5 boilers.

The results of the calculations are presented graphically in Fig. 5, with the regional division proposed by the author in the publication (Stala-Szlugaj, 2014). Each of the proposed four regions was assigned four voivodships diversified in terms of industry, urban planning and distances from coal mines. The names of provinces included in a given region are placed above each graph. The introduction by the author of the regional division was aimed at showing certain trends that were

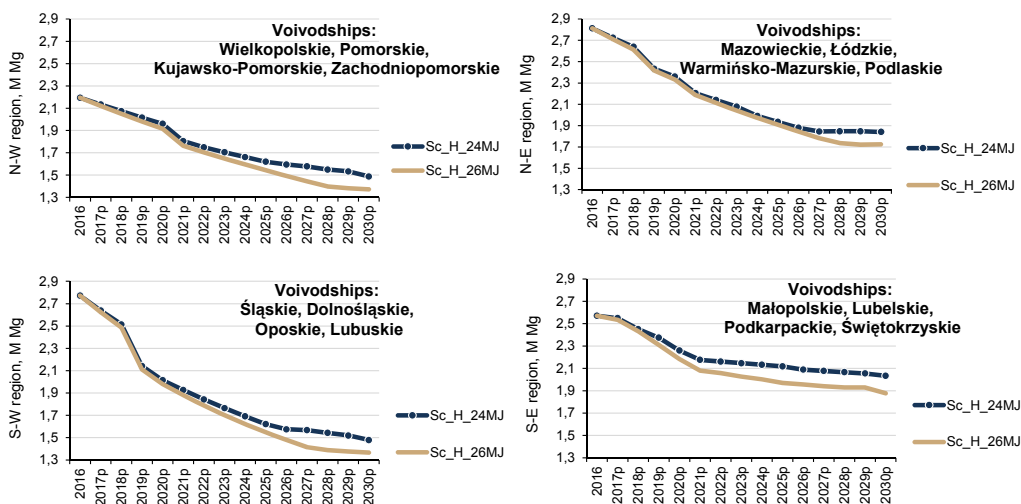


Fig. 5. The forecast of hard coal consumption in Poland in 2017-2030 in regional terms

Source: own calculations

also found in the neighboring provinces. These trends would not be visible if the information is provided only at the level of one voivodship.

In the perspective of 2030, the largest decline in hard coal consumption can be expected in the SW region that groups the following voivodships: Śląskie, Dolnośląskie, Opolskie and Lubuskie. Compared to 2016, in the case of the Sc\_H\_24MJ scenario, consumption may decrease by 48% and fall from 2.8 to 1.5 million Mg, and in the scenario Sc\_H\_26MJ – to 1.4 million Mg (decrease by 43%). The smallest drops can be expected in the SE region that groups the following voivodships: Małopolskie, Lubelskie, Podkarpackie and Świętokrzyskie. According to the scenario Sc\_H\_24MJ, the consumption may decrease by 16% (fall from 2.6 to 2.0 million Mg), and in the scenario Sc\_H\_26MJ – to approximately 1.9 million Mg (a decrease of 22%). Such a relatively low drop in the consumption of coal in households has been caused by a large group of consumers located mainly on farms in the countryside.

By summing up the coal consumption in individual voivodships, a forecast of hard coal consumption in households across the country was obtained (Fig. 6). According to the conducted calculations, in the scenario Sc\_H\_24MJ, the consumption may decrease from 10.4 to 6.8 million Mg (a decrease of 30%), and in the scenario Sc\_H\_26MJ – to approximately 6.3 million Mg (a decrease of 35%).

Despite the decrease in hard coal consumption in the 2030 perspective, one should expect an increase in demand for high quality coal dedicated to modern boilers (usually pea assortment) as well as qualified coal fuels (mainly eco-pea coal).

## 6. Summary

Due to the amendment to the Environmental Protection Act of 2015 (so-called anti-smog bill), regional councils may introduce restrictions or bans concerning operation of fuel combus-



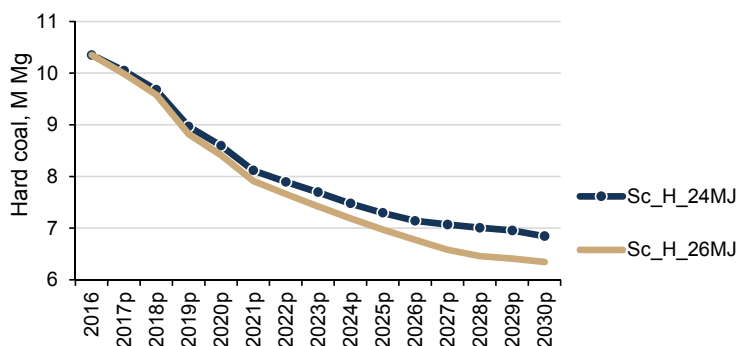


Fig. 6. The forecast of hard coal consumption in Poland in 2017-2030

Source: own calculations

tion installations. These resolutions are intended to prevent a negative impact on human health or the environment. As of the beginning of 2018, seven voivodships in Poland have already taken advantage of the possibility of its introduction. The adopted anti-smog resolutions will affect the domestic supply of coal. The current consumption in these seven provinces accounts for a total of 65% of coal consumed in households across the country.

In the face of the growing number of anti-smog resolutions, a forecast of hard coal consumption in households was prepared, assuming the existence of anti-smog resolutions in all voivodships in Poland. According to the adopted assumptions, in the perspective of 2030, it may fall from 10 (in 2016) to about 6-7 million Mg. The biggest drops can be expected in households from the voivodships: Śląskie, Dolnośląskie, Opolskie and Lubuskie. Compared with 2016, this consumption can be halved and fall to around 1.4-1.5 million Mg.

The mentioned resolutions introduce, among others, the ban on burning coal silts (culms). This ban will cause coal producers to face the problem of their development. One of the ways may be storage, however, it will be associated with environmental fees. Thus, there is a need to look for new ways to use them, one of which is the reclamation of degraded areas (Klojzy-Karczmarczyk et al., 2016b).

Introducing a ban on the combustion of low quality fuels will contribute to reducing the level of air pollution. An important element contributing to the reduction of low-stack emissions will also be the large-scale environmental education (Pawul & Sobczyk, 2011; Sobczyk, 2013).

In addition, the reduction of coal consumption will result in a decrease in the mass of the generated fine fraction waste, which according to research (Klojzy-Karczmarczyk et al., 2015) supplies municipal waste.

Although the prepared forecast shows that in the perspective of 2030 there will be a decrease in hard coal consumption, one should expect an increase in demand for high quality coal dedicated to modern boilers, especially for qualified coal fuels of the eco-pea coal type.

## Acknowledgements

Publication prepared within the statutory research of The Mineral and Energy Economy Research Institute, Polish Academy of Sciences.

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