Problems of low emission in Poland in sectoral terms

M Dzikuć1 A Piwowar2 and M Dzikuć1

1 Faculty of Economics and Management, University of Zielona Góra, Poland
2 Faculty of Engineering and Economics, Wrocław University of Economics, Poland
E-mail: m.dzikuc@wez.uz.zgora.pl

Abstract. The problem of low emission in Poland has been unresolved for many years. One should be aware that when planning activities to reduce low emission, it is necessary to determine in which sectors of the national economy the problem is the most serious. In this way, it will be possible to intensify activities in areas that contribute the most to the emission of pollutants entering the air. For the purposes of analyses undertaken in this publication, low emission should be defined as pollution, which enters the air at a height not exceeding 40 meters from the ground level. The aim of the article was to identify problems related to the creation of low emission in Poland in sectoral terms.

1. Introduction

In Poland every year, due to bad air quality, there are about 45 thousand of premature deaths. Pollutants that get into the air are so small that they penetrate into the human body and cause and accelerate heart disease, lung diseases and contribute to more frequent asthma problems [1]. Air quality in Poland is significantly different from the standards adopted in most European Union (EU) countries. For several years, the law in Poland has been changing and regulations are being introduced, aimed at reducing low emission [2]. On the other hand, these solutions have not so far resulted in the reduction of emissions of harmful substances into the air. Low emission is an important topic of public debates and scientific papers in many regions and countries around the world. The issues of low emission are undertaken by researchers in the field of technical and medical sciences as well as social [3, 4]. From the point of view of social and medical sciences, it is often stressed that long-term exposure to air pollution can be very harmful to health [5, 6]. As the experience of richer European Union countries shows, the problem of poor air quality can be significantly reduced. There are a number of regions in the European Union that have a similar the length of the heating season, population density, altitude and show a number of other similarities to the regions in Poland [7]. The aim of the article was to identify problems related to the creation of low emission in Poland in sectoral terms.

2. The problem of low emissions in Poland

Although Poland has been facing the problem of low emission for many years, the issue of too much pollution in the air has not been resolved [8]. This is confirmed by the data presented by the European Environment Agency, according to which air in Poland is one of the most polluted, including PM10 dust. Many years of negligence regarding the failure to take action in Poland to improve the air quality led to the situation in which in 2015 the European Commission filed a lawsuit to the European Court of Justice in Luxembourg against Poland for failure to comply with EU air quality legislation. For too high concentrations of pollutants in the air, Poland may have to pay a penalty calculated in billions of euros [9].
According to the European Environment Agency (EEA), air quality in Poland is one of the worst in the European Union. On October 29, 2018, the European Environment Agency (EEA) published the report “Air Quality in Europe –2018”. The report prepared by the EEA presents data on air pollution in 2016 about 2.5 thousand of cities from 41 European countries, including all EU countries. The report includes air pollution that particularly adversely affects human health and the environment, including suspended particulates PM10 and PM2.5 benzo(a)pyrene - B(a)P, nitrogen oxides [10-12]. It should be emphasized that according to the WHO, the average annual concentration of B(a)P should not exceed 1 ng/m³. Meanwhile, there are cities in Poland where the concentration is over a dozen nanograms per cubic meter. According to the EEA, as many as 19 out of the 20 most polluted cities in the EU by B(a)P are in Poland (Fig. 1). PM2.5 and PM10 suspended dust are also a serious problem, because as many as 6 out of 10 cities in the EU most polluted with PM2.5 dust are in Poland. In the case of PM10 dust, however, of the 50 most polluted cities in the EU, as many as 27 are in Poland. A number of reasons for not solving the low emission problem in Poland can be distinguished, despite the presence of this country in the European Union structures such as the above-mentioned negligence of the Polish authorities or the fact that a significant part of society achieves relatively low incomes [13]. However, the problem is also the fact that the legal instruments used so far have been ineffective and do not sufficiently reduce the impact of polluted air on the environment [9, 14].

Fig. 1 Concentrations of B(a)P, 2016 [15]

3. Sectoral approach to the low emission problem in Poland
Low emission is not evenly distributed between economic sectors. When analysing the share of particular sectors in the emission of pollutants into the air, it should be noted that low emission should be assigned overlapping emission sources from tables 1-5;:

- combustion processes outside the industry,
- road transport,
- other vehicles and machines,
• waste management,
• agriculture.

Other emission sources listed in tables 1-5 should be also included, however, it would be difficult to estimate what part of the pollution from other sectors is low emission. Therefore, the focus was on those sectors, which are classified as low emission, because most of the pollution from the above sectors is created at an altitude of 40 m above ground level.

When analysing PM2.5 and PM10 particulate matter emission to air in Poland, it should be emphasized that the impact of emission related to individual heating of buildings has the largest share, significantly ahead of processes including combustion in the energy production and transformation sector as well as combustion processes in industry and processes production (Table 1 and 2). Although emissions from industry have been limited in recent years, air quality still does not meet the standards adopted in the EU [16]. The emission of PM2.5 and PM10 suspended dust, whose source was the industry, was limited because the industry now has to meet a stringent set of standards and regulations limiting the amount of emission to the atmosphere [17]. It should be emphasized that in 2016 the level of particulate matter emission in Poland increased compared to 2015. The increase in coal and wood consumption in households contributed to this. A very dangerous substance contained in suspended dust is benzo(a)pyrene. The data from recent years indicate that the target level of benzo(a)pyrene (1 ng/m³) is exceeded in most regions in Poland, which means that most of them are classified as class C, which necessitates the development of air protection programs for this area [18].

When analysing low-emission components, carbon monoxide should be taken into account, which is released into the air, among others, by burning fuels outside the industry and road transport [20-21]. The scale of this phenomenon increased in 2016 compared to 2015. The increase in CO emission was mainly due to the low emission, the increased share of which is explained by the higher consumption of hard coal and wood in households (Tab. 3). It should be emphasized that a significant reduction in CO emissions between 2015 and 2016 in the agriculture sector was due to the much smaller surface area of fires taking place on agricultural land [22].

| Emission source                                      | Emission of PM2.5 [Mg] |
|-----------------------------------------------------|------------------------|
|                                                      | 2015       | 2016       |
| Combustion processes in the energy production and transformation of energy | 11 906.7   | 12 711.7   |
| Combustion processes outside the industry (mainly heating buildings) | 65 994.8   | 70 184.2   |
| Combustion processes in the industry                 | 28 605.8   | 28 519.6   |
| Production processes                                 | 6 581.4    | 6 544.6    |
| Extraction and distribution of fossil fuels          | 679.1      | 655.2      |
| The use of solvents and other products               | 1 065.0    | 1 373.6    |
| Road transport                                       | 9 156.5    | 10 646.9   |
| Other vehicles and machines                          | 9 101.2    | 9 621.3    |
| Waste management                                     | 1 785.1    | 1 875.0    |
| Agriculture                                          | 3 467.9    | 3 374.9    |
| Total                                               | 138 343.5  | 145 507.0  |
Table 2 Emission of PM10 fraction in Poland in sectors of the economy (2015-2016) [19]

| Emission source                              | Emission of PM10 [Mg] | 2015    | 2016    |
|----------------------------------------------|-----------------------|---------|---------|
| Combustion processes in the energy production and transformation of energy | 18 819.1              | 19 892.1|
| Combustion processes outside the industry (mainly heating buildings) | 110 409.00            | 117 406.40|
| Combustion processes in the industry         | 31 056.20             | 30 774.80|
| Production processes                         | 17 719.00             | 17 643.00|
| Extraction and distribution of fossil fuels  | 6 790.70              | 6 551.50|
| The use of solvents and other products       | 1 065.00              | 1 373.60|
| Road transport                               | 11 063.90             | 12 825.40|
| Other vehicles and machines                  | 9 101.20              | 9 621.30|
| Waste management                             | 7 178.10              | 7 323.20|
| Agriculture                                  | 35 452.30             | 35 753.90|
| **Total**                                    | **248 654.50**        | **259 165.20**|

Table 3 Emission of carbon monoxide in Poland in sectors of the economy (2015-2016) [19]

| Emission source                              | Emission of carbon monoxide [Mg] | 2015    | 2016    |
|----------------------------------------------|-----------------------------------|---------|---------|
| Combustion processes in the energy production and transformation of energy | 47 285.0              | 49 773.8|
| Combustion processes outside the industry (mainly heating buildings) | 1 444 729.8           | 1 535 254.7|
| Combustion processes in the industry         | 265 775.2              | 265 180.7|
| Production processes                         | 47 393.2               | 45 850.1|
| Extraction and distribution of fossil fuels  | -                    | -       |
| The use of solvents and other products       | 4.8                   | 6.2     |
| Road transport                               | 462 368.6             | 502 358.9|
| Other vehicles and machines                  | 80 688.5              | 85 133.9|
| Waste management                             | 20 451.5              | 21 590.0|
| Agriculture                                  | 1 736.2               | 482.9   |
| **Total**                                    | **2 370 432.8**       | **2 505 631.2**|
Sulphur dioxide is another harmful substance that is a low-emission component. The amount of sulphur dioxide emitted into the atmosphere has been significantly reduced in the industrial sector in recent years by the increasing amount of flue gas desulfurization installations [23]. The data of the Institute for Environmental Protection indicate a several-fold decrease in the level of sulphur dioxide emission from the early nineties of the twentieth century until 2016. In 2016, SO$_2$ emissions were lower by approximately 17% compared to 2015. The decrease in SO$_2$ emissions in Poland had a significant impact on emission from the industrial sector, which resulted from operators adapting from January 1, 2016 to the requirements of implementation of Directive 2010/75/EU on industrial emissions in the scope of stricter emission standards for SO$_2$, NO$_x$ and total dust. On the other hand, the increase in SO$_2$ emissions in 2016 compared to 2015 in the sector of Combustion processes outside the industry resulted from the increased consumption of hard coal (Tab. 4).

Another contamination that cannot be neglected during the analysis of low-emission components in Poland is nitric oxide. However, in the case of this pollution, the highest proportion of NO$_x$ comes from road transport, not from heating buildings as in most other harmful substances that make up low emission. The emission of nitrogen oxides increased in 2016 by over 3% in relation to 2015. The increase in emission in transport had the biggest impact on the growth in NO$_x$ emissions in Poland. At the same time there was a decrease in emissions from the professional power industry [24], which was similar to SO$_2$ from the implementation of stricter emission standards (Tab. 5). It should be noted that the increased content of nitrogen oxides in Poland is particularly visible near roads and larger towns with high traffic volumes [25].

**Table 4** Emission of sulfur dioxide in Poland in sectors of the economy (2015-2016) [19]

| Emission source                                      | Emission of sulfur dioxide [Mg] |
|------------------------------------------------------|---------------------------------|
|                                                      | 2015                            | 2016                           |
| Combustion processes in the energy production and transformation of energy | 370 191.3                      | 261 170.1                      |
| Combustion processes outside the industry (mainly heating buildings) | 164 925.5                      | 173 419.1                      |
| Combustion processes in the industry                | 149 343.1                      | 129 602.2                      |
| Production processes                                 | 15 026.4                       | 14 936.2                       |
| Extraction and distribution of fossil fuels          | -                              | -                              |
| The use of solvents and other products               | -                              | -                              |
| Road transport                                       | 0.3                            | 0.4                            |
| Other vehicles and machines                          | 261.4                          | 288.9                          |
| Waste management                                     | 2 083.5                        | 2 103.4                        |
| Agriculture                                           | -                              | -                              |
| **Total**                                            | **701 831.5**                  | **581 520.3**                  |
Table 5 Emission of nitrogen oxides in Poland in sectors of the economy (2015-2016) [19]

| Emission source                                           | Emission of nitrogen oxides [Mg] |
|-----------------------------------------------------------|----------------------------------|
|                                                           | 2015                             | 2016                             |
| Combustion processes in the energy production and transformation of energy | 198 934.6                        | 179 478.8                        |
| Combustion processes outside the industry (mainly heating buildings) | 90 189.2                         | 96 630.1                         |
| Combustion processes in the industry                      | 73 740.4                         | 70 825.3                         |
| Production processes                                      | 24 623.5                         | 24 900.7                         |
| Extraction and distribution of fossil fuels               | -                                | -                                |
| The use of solvents and other products                    | 0.14                             | 0.18                             |
| Road transport                                            | 200 028.0                        | 231 150.7                        |
| Other vehicles and machines                               | 71 896.5                         | 75 934.5                         |
| Waste management                                          | 3 057.9                          | 3 591.3                          |
| Agriculture                                               | 42 354.0                         | 43 919.7                         |
| Total                                                     | 704 824.24                       | 726 431.28                       |

4. Perspectives of low emission reduction in Poland

The data presented in this article indicate that low emission is one of the most serious threats related to air quality in Poland. The main reason for the formation of poor air quality are the emissions of pollutants from the household boilers, in which low quality coal is often burnt. Moreover, the combustion of coal takes place in an inefficient way, because the boilers used for this purpose burn coal at low temperatures, which releases more harmful substances to the air.

It is difficult to indicate precise calculations on the costs related to poor air quality in Poland. However, it can be assumed that the costs associated with the treatment of people who are ill as a result of inhaling contaminated air can be counted in billions of euros per year. Although the problem of low emission in Poland has been occurring for many years, it was only in 2018 that the government program "Clean Air" was introduced, the aim of which is to significantly reduce this problem. The implementation of this program is to take place by providing financial support (subsidies and loans) for the replacement of old and ineffective household boilers as well as thermo-modernization of single-family houses. The budget of the "Clean Air" program for Polish conditions is huge, amounting to 103 billion PLN (GDP amounted to 1 988.73 billion PLN in 2017). The implementation of the Clean Air program is expected to last until 2029. It should be emphasized that in 2018 the ban on the sale of the most polluted solid fuels to households, which pollute the air, is also introduced in Poland. It is difficult to predict whether and how quickly air quality in Poland will begin to improve, while experts agree that this is a process that will last at least several years. In the opinion of the authors of articles there should be introduced legal regulations requiring the exchange of the most environmentally inefficient boilers for heating buildings in order to achieve a faster result.

The air quality in Poland during the heating season depends to a large extent on the method the buildings are heated. However, road transport also affects air quality in Poland. There are a number of solutions...
that allow to reduce the level of emissions from road transport, such as the ban on entering into the city centres of cars that do not meet current ecological standards [26]. However, in order to significantly reduce the issue of emissions from road transport, it is necessary to reduce the share of the oldest cars that pollute the air the most. It should be emphasized that in Polish conditions road transport makes a significant contribution to the creation of low emission. This is because a large proportion of cars moving on Polish roads are more than 10 years old and do not meet the ecological standards that are currently required for newly produced cars.

One of the important directions that can reduce the emission from road transport is the development of electro mobility. Currently, it is difficult to imagine it in Polish conditions, because it is estimated that the break-even point for an electric car is achieved only after traveling 50,000 km per year. The main obstacle preventing a significant increase in sales of electric cars in Poland is their too high price, which results in high costs of producing batteries, which correspond to even almost half of the total cost of the car [27]. Even if it was possible to significantly reduce the price of electric cars in Poland, their sales would not increase significantly, because there is no infrastructure for charging batteries.

When planning activities to reduce low emission, consideration should be given to the work carried out by local government authorities. At the same time, they should be not only educational activities, but also support for investments limiting low emission and controlling the quality of fuel used for heating buildings [28, 29]. Local authorities in the city of Kraków are an example of local government implementing initiatives to reduce emission. In Kraków, a ban on the sale of low-quality solid fuels (coal and wood) was introduced. However, since 01.09.2019, Kraków will have a complete ban on coal and wood. It should be emphasized that Kraków was the first big city in Poland where it was possible to obtain financial support for boiler replacement and the co-financing amount reached 100% of costs. These activities have proven to be effective and their effects are noticeable, as the number of days with exceedances of air quality standards in recent years has been reduced. In 2015 there were 140 days, in 2016 – 100 days, and in 2017 – 87 days with exceedances of air quality standards.

Currently in Poland, it is possible to indicate more examples of active actions of local governments to reduce low emission. The growing awareness of residents significantly streamlines this process, because measures to reduce low emission can be introduced without social protests, the example of which can be the city of Kraków. However, in Kraków, air quality in recent years has been very bad, and the city has been among the most polluted in the EU.

5. Conclusions

In Poland, exceeded permissible concentrations of harmful substances in the air have been recorded for years. One of the most important sources of pollution is low emission. It should be noted that the most dangerous pollutants for human health and the environment are suspended dust PM10, PM2.5 and B(a)P, which is contained in suspended dust, and these substances determine the poor air quality in Poland, especially in the heating season. Actions to reduce low emission in Poland have not led to a noticeable effect on the national scale. It should be emphasized that the analyses carried out in the article regarding the share of individual sectors in total emission indicate low emission as one of the main sources of pollution. Hence the conclusion that a significant part of measures to reduce total emission should be aimed at reducing low emission.

While analysing the measures implemented so far, aimed at reducing low emission, one can notice a small number of them of a restrictive nature, which clearly imply the use of more environmentally friendly building heating technologies or reduce the use of non-ecological vehicles, especially in city centres. It is necessary to conduct parallel activities supporting financially Polish residents, especially those who do not always have the financial resources necessary to implement eco-friendly solutions in their households. A significant percentage of these households are located in rural areas in Poland, hence the big challenge is to modify rural development policy and create new support instruments for their inhabitants. The problem of low emission in Poland has been unresolved for many years. Therefore, a number of different activities should be undertaken in parallel to limit this phenomenon. Then it will be possible to expect positive effects in a relatively short time.
6. References

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