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Original Research

Analysis of Data on Emissions on Example of Opolskie Voivodship Within Context of Fees for Use of the Environment

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Abstract

A lack of rational environmental management means that the environment is not able to regenerate itself quickly enough on its own. The environment needs support and responsible behavior from all stakeholders. In order to be able to take measures to eliminate negative environmental impact, financial means are needed.

Our article analyzes fees collected for various substances (i.e. nitrogen oxides, sulphur dioxide, carbon dioxide, carbon monoxide, inorganic acid, their salts and anhydrides, ammonia, methane) emitted into the air in Poland over one year in Opolskie Voivodship, pointing to those for which the funds collected are the largest. For chosen substances there has been an attempt to determine whether the unit fee for the emission of a given substance corresponds to the costs of elimination of adverse effects on the environment caused by the substance and, consequently, whether the fee should be raised or not.

Keywords: emissions, economic use of the environment, fees for use of the environment

Introduction

Various aspects of human activity have led to the fact that the condition of the environment in many places is far from satisfactory. The negative impact of man on the environment is mostly connected with the use of its resources and with its pollution, i.e., of the air. Prevention of deterioration of the quality of the environment by limiting pollution, as well as by creating conditions for its inactivation or decomposition, constitute the two basic directions of activity connected with protection and renewal, aimed at regaining and maintaining the satisfactory condition of the environment.

Noticeably, over the last 20 years there has been a significant limitation of emissions of most substances that pollute the environment. According to data collected by the European Environment Agency [1] in 1990-2009 (on average in all 27 present EU member states), the most dynamic decrease in emissions was observed in the case of sulphur oxides (by over 80%). Other significant declines in emissions included carbon monoxide (by over 62%), policyclic aromatic hydrocarbons (by almost 61%), and non-methane volatile organic compounds (by almost 55%). A smaller decrease was noted in the case of nitrogen oxides (by slightly over 44%), mostly due to a relatively smaller decline in emissions from road transport, which has always had the greatest contribution to NO_x emissions. Smaller emission declines were also observed in the case of particulate pollution (by 27% for the PM10 fraction and by almost 34% for PM2.5), which at present, along with ozone, is the greatest problem connected with air quality in many parts of Europe [2]. In Poland in the same period, declines in pollution emissions could also be observed, though they were not as considerable as in the EU. In the case of sulphur oxides and carbon monoxide, the decline in emissions was significant (slightly over 73% and almost 67% respectively), in the case of other substances, however,

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the emissions were limited to a much smaller extent. In the case of nitrogen oxides, the decline in emissions amounted to 36%, in the case of non-methane volatile organic compounds slightly over 36%, and for policyclic aromatic hydrocarbons it fell only by 17%. Definitely insignificant was also the limitation of particulate emissions – in the case of PM10 by almost 12% and for PM2.5 by almost 15%. A significant limitation of emissions, both in all EU member states and in Poland, was observed in the case of heavy metals listed according to the LRTAP Convention [3]. In 1990-2009 in the EU, emissions of mercury decreased by over 67%, the emissions of cadmium fell by 70%, while in the case of lead there was a decline of over 91%, mainly due to limitations of emissions from road transport (due to introduction of the obligation to use lead-free petrol). In Poland the emissions of mercury fell in the same period by a little over 56%, of cadmium by over 58%, and of lead by almost 66%.

Taking into consideration the significant (in some cases) limitation of emissions in recent years, and the resulting visible improvement in air quality, it can be seen that solving problems connected with maintaining the appropriate condition of the environment is going in the right direction. It needs to be noticed that the level of, e.g., total gaseous mercury is in Poland relatively low in comparison with many countries, especially non-European ones [4, 5]. The results of the study on heavy metals concentrations in soils, carried out in the city of Gdańsk, also do not indicate exceeding the legally allowable concentrations of mercury. However in some locations the content of this heavy metal excludes the investigated soils from the cultivation of plants intended for consumption by children and in some other location generally from the cultivation of plants intended for human consumption [6]. Nevertheless, as mentioned before, not all problems in this area have been solved yet and a relatively insignificant limitation of emissions of particulate pollution, and in Poland also of PAH, shows that the limitation of emissions of these substances should be a priority at present. This is especially important not only in the context of improvement of the quality of the environment, but in the context of human health. Numerous studies conducted in the world, but also research carried out in Poland, prove that there is increased risk of occurrence of serious diseases of the respiratory system among people who live in urban areas with high levels of some air pollutants (characteristic for road traffic, as well as for some other economy sectors such as industry or the generation and distribution of energy) in comparison with inhabitants of areas with relatively lower concentrations of these substances (rural areas) [7, 8].

Economic Use of the Environment

The best method of environmental protection is prevention of its degradation. In order for the protection to be effective, the process must be of complex character, including various areas of human activity taking into account their interactions with nature. Prevention of degradation is an activity that needs significant financial resources. These funds are, however, considerably lower than the costs connected with improvement of the condition of the environment degraded as a result of human activity.

For this purpose, countries have been introducing various types of taxes, charges, and fees for use of the environment. Also in Poland there exists a mechanism of fees for entities that have a negative impact on the environment. Apart from incurring fees for economic use of the environment, they also are obliged to provide data on the use of the environment.

In Poland the obligation of collecting data connected with use of the environment and fees due lies on the entrepreneur who uses the environment in any way. In accordance with Art. 3 p. 20 of the polish Environmental Protection Act (EPA) [9], the following are subject to fees:

- Entrepreneurs and persons engaged in production activities in agriculture in agricultural crops, farming or animal husbandry, horticulture, vegetable growing, forestry and inland fisheries, and medical professionals in individual practice or individual specialist practice;
- Individuals who are not entrepreneurs and who use the environment insofar as it requires special permission, e.g.:
  - in agriculture – underground water consumption for irrigation of land and crops with sprinkler
  - consumption of groundwater or surface water for the household or agricultural purposes in an amount greater than 5m^3/d
  - introduction of wastewater from the household or farm to water or soil in an amount greater than 5 m^3/d
- Organisational units that are not entrepreneurs as foreseen by the Act on Freedom of Economic Activity (offices, municipal facilities, schools, associations, foundations, etc.)

Many reporting obligations in the field of environmental protection are laid down in the EPA, which also points to many other legal acts that outline model reports on providing information on the use of the environment and calculation of fees due. The EPA is the source of, i.e., the Regulation of the Minister of the Environment of 27 February 2014 on model lists containing information and data on the use of the environment and the amount of fees due [10]. The document coming from here will be called the report.

This determines the contents of the report on the economic use of the environment in the area of

- Emission of gases or dust into the air
- Consumption of water
- Emission of wastewater into water or soil
- Storage of waste

Each entity using the environment (as foreseen by EPA) has to submit once a year a report to the marshal's office (MO) and the Voivodship Inspectorate for Environmental Protection (VIEP). The report has to include information on the amount of the fee for use of the environment and data on emissions on the basis of which the fee was calculated.

An exception is only water discharged from sites rearing fish other than salmonids and other aquatic organisms as long as production exceeds 1,500 kg from 1ha of usable area of the pond; then reports have to be submitted by the end of the month, after the financial period lasting from 1 May to 30 April of the following year, to the appropriate marshal's office.

The report includes a general summary with the amount of fees divided by types of the use of the environment (gases or dust into the air, consumption of water, wastewater into water or soil, storage of waste) and additional tables depending on the scope of the use of the environment by the entity in these categories.

Fees

To take measures to remove the negative impact on the environment and to prevent degradation, money is needed. Eurostat and the OECD have developed a definition of environmental taxes so that comparative studies are possible between different countries, for example, on the structure of environmental taxes, etc. The definition of an environmental tax is as follows [11]: "A tax whose tax base is a physical unit (or a proxy of it) of something that has a proven, specific negative impact on the environment."

These fees (taxes) vary between countries and so do billing rules over time as a result of legal changes. A general division of environmental "taxes" is as follows [12]:

- Energy taxes
- Transport taxes
- Pollution taxes
- Resource taxes

A great number of changes in the principles and methods of charging for emissions took place in the 1990s. Several countries in Europe moved beyond individual environmental taxes and undertook Environmental Tax Reforms (ETR) during the 1990s [13]. An overview of the effects of the introduction of ETR can be found in the reports [14, 15]. A short description of the principles of the systems of environmental charges in different European countries can be found on webpages of Confédération Européenne Fiscale [16].

In Europe and the world, one of the most common fees is associated with emissions, particularly of CO_2. Changes associated with billing for emissions are linked with changes in industries whose share in emissions is the greatest. For this reason, a lot of attention is paid to energy. An example of the changes in this industry in Nordic countries can be found in [17].

In Poland the obligation of reporting data on the use of the environment and fees due lies on the entity using the environment once a year. Fees due are paid into the account of the marshal's office as appropriate for the place of the use of the environment. Collected funds are divided by the office, i.a., among the National Fund for Environmental Protection and Water Management and the Voivodship Fund of Environmental Protection and Water Management, and used to finance environmental protection by these units.

Each entity using the environment calculates the fees for using the environment independently on the basis of annual unit fees and calculation formulas published in separate executive regulations. Exemption from fees is possible in two cases [9]:

- If the fee for all components of the environment (gas and dust, water consumption, wastewater into water and soil, storage of waste) does not exceed 800 PLN for a year (this does not exempt from the obligation to submit a report).
- In the case of conducting rescue operations – for example, charges are not borne for the consumption of water used for fire fighting or for fuel consumption by means of transport used in rescue operations.

Each of the reported components mentioned in section 2 comprises a few parts. In the case of reporting data on air, these include:

- Combustion of fuel in combustion engines
- Combustion for energy generation purposes
- Reloading of fuels
- Animal husbandry
- Emission of other substances into the air

Among the above-mentioned sub-components, the largest share of funds is collected for "emission of other substances into the air". This category (formally called "Volume of emissions from a given installation or activity") also provides the most useful data for further analysis. Users of the environment complete the section "Volume of emissions from a given installation or activity" and they must specify both the parameters of the installation and also choose one or more positions among 67 groups of gases or particulates subject to fees, provide the name of the substance, and then, using unit fees (given annually in the Announcement of the Minister of the Environment), calculate the fee due. The unit fees (for 2013) range from 0.00028 PLN/kg (e.g. for carbon dioxide) to 364.47 PLN/kg (e.g. for arsenic) [18].

The present article analyses fees obtained for emissions of some substances into the environment. Data for one calendar year in a chosen voivodship were used, pointing, i.e., to those positions that bring the largest funds. For chosen substances there is an attempt to determine if the unit fee for emissions of a given substance corresponds to the costs of removal of negative environmental impact caused by the substance and, consequently, whether the fee should be changed or not. Generally, fees for use of the environment, including air pollution, should be determined so as to minimize the volume of emissions from installations but also, to some extent, compensate for their negative impact on the environment. The mechanism should therefore encourage actions on the part of the environment user to limit emissions.

Analysis of Emissions Data from Reports

The present chapter provides an analysis of data from the Opolskie Voivodship for 2010. Opolskie, as for types of entities using the environment, does not stand out on

the national scale (it may be considered typical), therefore it can be expected that the analyzed data also correspond to data typical for Poland. Secondly, most voivodships do not have software tools that allow for analyzing the data from emissions. Opolskie is one of the very few voivodships that has these software tools.

Good quality of data from Opolskie is also proven by the Supreme Audit Office report [19]. Out of 9 offices audited, the only one with positive evaluation was the Opolskie Marshal's Office. Despite the lack of formalized regulations on cooperation with public administrative units, the office has been systematically soliciting information on entities obliged to incur fees. The report appreciates the introduction of information on registered units reported in databases of the Opolskie Voivodship Office, Voivodship Inspectorate for Environmental Protection, Voivodship Veterinary Inspectorate and the Statistical Office. Data were complemented with information obtained during visits to commune offices made by MO representatives.

In submitted reports, there were 58 out of 67 possible groups of substances in total. Fig. 1 presents the share in total income from the substances for which the share was at least 3%.

The above histogram shows that fees for the 6 presented substances constitute over 88% of total income. Income from emissions of substances from other 52 groups represent only 12% of the total amount. A large share of fees for nitrogen oxide and ammonia results from the functioning of chemical (nitrogen) plants in the Opolskie Voivodship.

As can be seen from the data collected by the National Centre for Emissions Management, the above pattern (i.e. income for emissions of nitrogen oxides, sulphur dioxide, carbon dioxide, and carbon monoxide amounting to circa 80% of total income) is visible in the whole country [20].

Fig. 2 presents a weight share of emissions of substance groups in total emissions of all substances except for carbon dioxide, which represents over 99% of the volume of emitted substances.

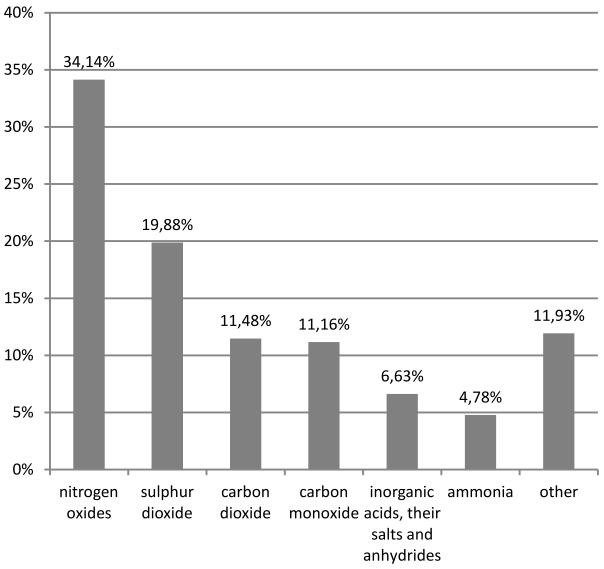

Fig. 1. Share in total income from some groups of substances (for groups with share of over 3%).

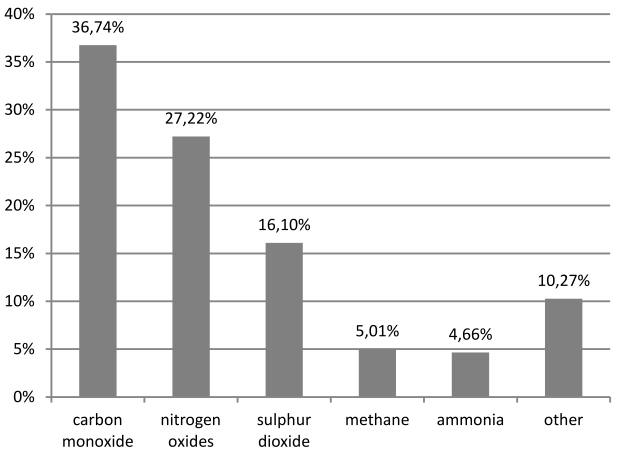

Fig. 2. Weight share of emissions of substance groups in total emissions of all substances except for carbon dioxide.

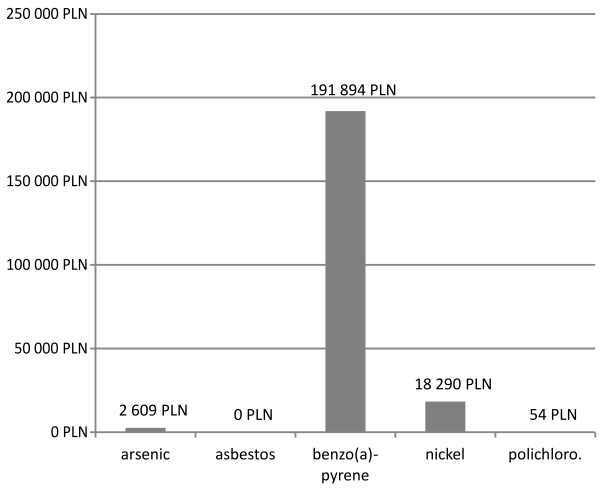

Fig. 3. Level of income from emissions of substance groups for which the largest fee has been determined.

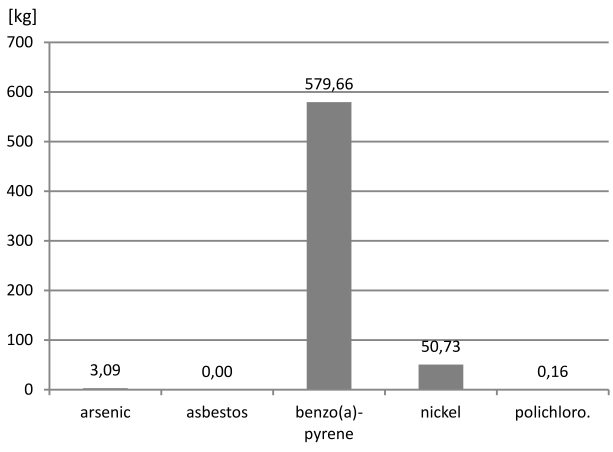

Fig. 4. Volume of emitted substances (in [kg]) from emissions of substance groups for which the largest fee has been determined.

Comparing Fig. 1 with Fig. 2, it can be seen that the level of income is related to the volume of the emitted substance. The listing of the volume of emitted substances is dominated by emission of carbon dioxide, whereas its share in income is not so overwhelming due to a very low fee for a unit of emission (the fee is a few orders of magnitude lower than for other substances). Noticeably, the weight share of CO_2 in emissions amounts to circa 99%.

For the sake of comparison, note the level of income and the volume of emitted substances for which the largest fee has been determined. This is presented in Figs. 3 and 4 respectively.

The highest fees are determined for the following groups of substances: arsenic, asbestos, benzo(a)pyrene, nickel, polichloro dibenzo-p-dioxins, and polichloro dibenzofurans – 329.06 PLN/kg for 2010 [21]. Most probably this is due to their particularly negative impact on the natural and social environment, resulting from the presence of these substances in the air.

As can be seen from the above histograms, the volume of emissions of benzo(a)pyrene is especially high in comparison with other substances for which the largest fees have been determined. Since it is a compound with an adverse impact on the environment, it has been regarded by the World Health Organisation (WHO), as well as by the US Environmental Protection Agency (US EPA), as one of the most important toxic pollutants potentially hazardous for human health [22, 23]. Among policyclic aromatic hydrocarbons regarded as carcinogenic, benzo(a) pyrene especially promotes development of cancer. For this reason, special attention must be paid to limiting its emissions and thus its concentration in the air. It should, therefore, seem that, taking into account the volume of emissions, the fee for emissions in the case of benzo(a) pyrene is not adequate to the level of its emissions into the air. Exposure to PAHs (as well as some other air pollutants) can lead to increased risk of several respiratory diseases (including lung cancer, asthma, COPD, or pneumonia), as well as low birth weight and cardiovascular events [24]. It was also demonstrated that exposure to polycyclic aromatic hydrocarbons (originating from diesel exhaust particles or wood smoke particles) has been associated with inflammatory responses. The proinflammatory effects of the fractioned methanol extracts of both kinds of particles were characterized by exposure of bronchial epithelial lung cells [25]. As mentioned in the Polish study [26], the origin, concentrations, and health effects of PAHs are associated with particulate matter and most often with particles diameter not greater than 2.5 and 10 μm ($PM_{2.5}$ and PM_{10}). High concentrations of PAHs, especially in the southern part of Poland, are linked with the importance of negative health effects. High values of health hazard coefficients at the urban traffic and urban background station in the city of Katowice indicated a serious problem with air quality and therefore also the potential negative impact on the state of health of city residents. A Ghanaian study indicated in turn that children living in the Tamale Metropolis have a higher risk of cancer associates with inhalation of different PAHs (benzo[a]anthracene, benzo[a] pyrene, benzo[k]fluoranthene, and chrysene) [27]. A study conducted in Taiwan on two groups of steel plant workers (nonsmoking coke oven workers as a highly exposed group and administrative workers as a control group) exposed to PAHs demonstrated statistically significant lower quality of morphology as well as DNA addition compounds in the group of coke oven workers. There were, however, no statistically significant differences in sperm concentrations, vitality, and DNA fragmentation between the groups [28].

The possibility of increasing the fee should be considered, in order to encourage installation owners to limit emissions, though two facts need to be taken into account in this context. Firstly, in 1990-2009 the industry saw the greatest decrease in emissions from all sectors of the economy (a fall by 68%), which partly resulted from smaller activity of the sector, but also was due to investments toward limitation of emissions. Secondly, which seems a much more significant phenomenon, in Poland the key source of PAH emissions (including benzo(a)pyrene) is the municipal and household sector, the emissions from which are not known exactly (it is estimated that their share in total PAH emissions amounts

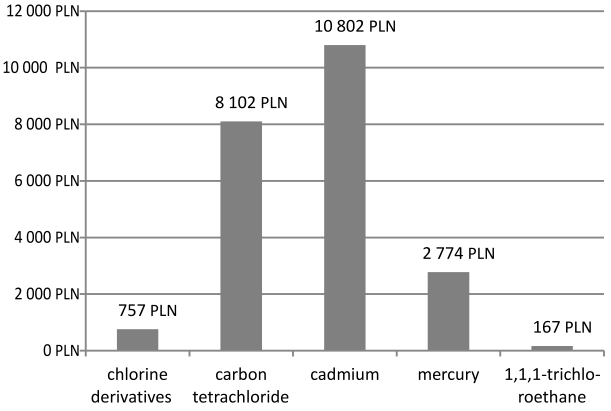

Fig. 5. Income from emissions of substance groups for which the determined fees amount to ca. half of the maximum fee.

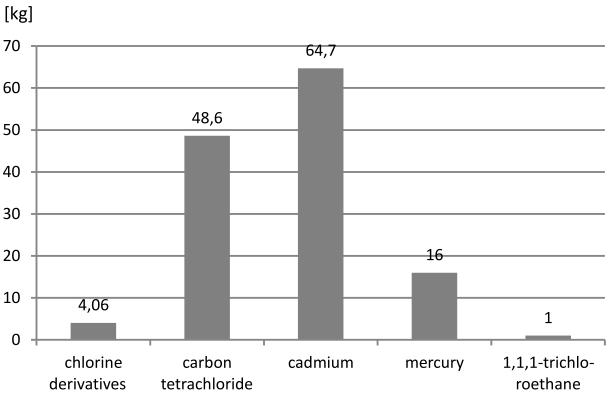

Fig. 6. Volume of emitted substances (in [kg]) from emissions of substance groups for which the determined fees amount to ca. half of the maximum fees.

to almost 88% at present). This sector is actually not controlled at all and does not incur fees for pollution of air with these substances. Therefore, the environmental effect, resulting from increasing the fee for emissions of the pollutant, would actually be negligible.

Another analyzed group of substances is the one for which the determined fees amount to about half of the maximum fee. These include, i.e., the following groups of substances: chlorine derivatives of hydrocarbons, carbon tetrachloride, cadmium, mercury, and 1,1,1-trichloroethane – ca. 165 PLN/kg (for 2010) [21]. The income for the emissions of these substances is presented in Fig. 5 and the volume of emitted substances in Fig. 6.

As in the case of benzo(a)pyrene, one might consider increasing the fee for emissions of cadmium, which is a particularly toxic heavy metal. Nevertheless, also in the case of this pollutant the main source of emissions is not connected with sectors controlled and listed in terms of emissions. The basic source of cadmium emissions is also the municipal and household sector, whose share in the total balance of emissions is estimated at the level of ca. 67%, though in comparison with 1990, until 2009 there was an almost 67% decrease in the emissions of cadmium from this sector. Another important source (with the share at the level of 17%) is the sector of industrial energy consumption, which in the same period limited the emissions of cadmium by over 70%. Thus, also in this case the fee for emissions is apparently at the correct level, and any changes to it may only increase the burden on the economy sectors obliged to incur fees for using the environment and will not bring noticeable positive environmental effects.

For other substances the fees are significantly lower and their share in emissions (except for substances presented in Fig. 2) is negligible.

Conclusions

Actions toward improving of air quality have been taken in many countries for decades. Also in Poland, over the last 20 years, a number of investments have facilitated radical limitation of emissions of some types of pollution to the air. The system of fees for economic use of the environment is connected with these actions, obliging entities operating various types of installations to limit their impact on air quality. Though the present paper outlines the situation of only one voivodship and one calendar year, it seems that if the situation in this voivodship is not totally different from other voivodships it can be stated that the fees are determined at the correct level. In many cases, not only in the case of benzo(a)pyrene and cadmium, on the basis of which the tendencies have been exemplified, sectors that have the reporting obligation on the emissions of pollution to the air are not a significant burden for the environment. A large share in emissions balance (sometimes even a dominating one) is connected with economic sectors not covered by reports. This mostly pertains to the municipal and household sector, but also transport, especially road transport, in which case it is characteristic that emission sources are largely dissipated, and there is no possibility to measure them.

Therefore, in these cases, as has been stressed in the article, increasing fees for emissions of pollutants would mostly contribute to excessive burdening of plants with additional costs connected with fees or with investments they would need to make to limit emissions, while the environmental effects due to the actions would be insignificant or even unnoticeable since generally sectors covered by the reporting obligation have a relatively low share in total emissions of these substances.

Efforts must thus be made to limit emissions from sectors that are the greatest burden for the environment. It is necessary to take appropriate legal, administrative, and fiscal action that would enable a more effective control of emissions in the municipal and household sector, and transportation. This will be especially complicated, particularly with regard to the former sector, mainly due to dissipation of emission sources and, at present, lack of virtually any instruments to charge entities emitting pollution (especially individual households) for damage that their activity does to the local environment.

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