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ASSESSMENT OF THE AIR POLLUTION TAX AND EMISSION CONCENTRATION LIMITS IN THE CZECH REPUBLIC

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Abstract

This paper assesses the design of the air pollution tax in conjunction with a stringency analysis of the emission concentration limits in the Czech Republic. The analysis draws upon a detailed database containing environmental reporting by industrial stationary sources.

The assessment of the emission concentration limits focuses on analysing the shift of the statutory limits between 2013 and 2017 and the corresponding real-life measured concentration on individual source basis. It provides an assessment of stringency of the air protection instrument and also of the vintage differentiation applied in the form of transitional schemes. The stringency analysis of the emission concentration limits stringency is related to the air pollution tax relief provision.

The air pollution tax was introduced in the Czech Republic in 1967, but its incentivising capacity as a driver for implementing measures in air protection has been questioned throughout its existence. The paper evaluates the major changes of the tax design conceptual amendment in 2012 (in effect since 2013), and assess the tax base, tax rates, administrative costs and especially the tax relief provisions with the recommendations from the OECD and academic literature on setting effective environmental taxes. The paper argues that interconnection of the regulatory instrument – emission concentration limits – with the air pollution tax undermines the incentive for abatement of pollutants and emission reductions.

The impact of the different instruments on emission reduction remains imprecise considering structural changes, such as the fast modernisation of the economy in the 1990s and the clean energy transition. Further work would be needed to provide a fuller assessment of the emission limits and air pollution tax.

The general deficiency of the air pollution tax in the Czech Republic is that the tax rates do not reflect the environmental and social damage costs. By any cost-benefit test, the benefits of the pollution reduction outperform the costs including the abatement costs.

Résumé

Le secteur manufacturier et le secteur de l'énergie représentent environ 32 % du PIB en République tchèque, ce qui la place parmi les membres de l'OCDE les plus industriels. La pollution de l'air est donc une préoccupation majeure dans ce pays, et la recherche d'instruments efficaces pour faire diminuer les concentrations de polluants et enclencher une réduction des émissions figure toujours au premier rang des priorités de l'administration publique, de même que le maintien de la compétitivité de l'industrie. Malgré la restructuration de l'économie et sa modernisation rapide dans les années 90, qui ont entraîné une amélioration sans précédent de la qualité de l'air, l'exposition aux particules en suspension dans l'air a été responsable de près de 8 % des décès prématurés et du recul de l'espérance de vie sans incapacité en 2017, ce qui se traduit par des charges sociales équivalant à 5.5 % du PIB. La gravité des répercussions économiques et sociales de la pollution atmosphérique en République tchèque est supérieure à la moyenne de l'OCDE.

La réglementation concernant la pollution de l'air due aux sources industrielles fixes repose sur des normes techniques complexes applicables au fonctionnement des installations individuellement, et elle prévoit des limites de concentration à l'émission. La taxation de la pollution atmosphérique est un instrument économique de protection de l'environnement que les pays de l'OCDE n'apprécient toujours pas à sa juste valeur, mais elle est pratiquée depuis longtemps en République tchèque. Dans le présent document, l'évaluation des limites d'émission et de la taxe sur la pollution atmosphérique porte sur une période commençant en 2013, date d'entrée en vigueur de la loi sur la protection de l'air.

La taxe sur la pollution atmosphérique et les limites d'émission visent les émissions des sources industrielles fixes, qui ont diminué de 21 % dans le cas des PTS, de 26 % dans celui du SO_2 et de 19 % dans celui des NO_x entre 2013 et 2017. L'incidence des différents instruments sur la réduction des émissions reste indéterminée. Pour procéder à une analyse détaillée de toute la panoplie déployée, il faudrait prendre en compte les autres instruments réglementaires tels que les MTD et plafonds d'émission obligatoires, ainsi que les aides financières en faveur de la diminution des émissions. Les éventuels changements structurels de l'économie devraient être évalués également (encore que la contribution de l'industrie au PIB soit demeurée stable ces dernières décennies).

Les modifications des limites de concentration à l'émission s'appliquent pendant des périodes déterminées et les entreprises savent ainsi que les normes resteront valables deux ou trois ans. Par conséquent, les entreprises ne sont pas incitées en permanence à réduire leurs émissions. L'analyse des niveaux de concentration réglementaires et mesurés dus aux sources industrielles fixes en 2013 et en 2017 montre que les limites stipulées, en moyenne pondérée, ont été abaissées de 23 % dans le cas des PTS, de 11 % dans celui du SO_2 et de 22 % dans celui des NO_x entre les deux dates, mais que les concentrations à l'émission mesurées sont restées au même niveau ou ont continué de baisser. Ainsi, en 2013, les concentrations mesurées moyennes se situaient à 38 % des limites d'émission dans le cas des PTS, à 67 % dans celui du SO_2 et à 64 % dans celui des NO_x, contre 36 %, 56 % et 62 %, respectivement, en 2017.

Des systèmes différenciés en fonction de la date d'entrée sur le marché permettent de maintenir des limites antérieures (moins strictes) et s'appliquaient en 2017 à 19 % de la totalité des PTS, 68 % du SO_2

et 42 % des NO_x émis par les sources industrielles fixes. Ils permettent une modernisation graduelle de l'industrie et, en même temps, protègent la compétitivité des entreprises. Il y a visiblement un hiatus entre l'ambition de la politique de l'environnement et le souci de la compétitivité. Il ressort de l'analyse que la portée actuelle des systèmes différenciés en fonction de la date d'entrée sur le marché devrait être évaluée avec un œil critique dans la perspective d'une éventuelle élimination progressive.

La conception de la taxe sur la pollution atmosphérique a été améliorée depuis 2013 et seuls sont désormais visés les principaux polluants émis par les sources industrielles (PTS, SO_2, NO_x et COVNM), ce qui a fait chuter de 15 % environ à 5 % le rapport entre les coûts administratifs et de mise en conformité, d'une part, et les recettes, d'autre part. Étant donné que 10 % des principaux pollueurs sont à l'origine de la majeure partie des émissions et des recettes, la taxe pourrait, du fait de la conception de son assiette, envoyer un signal prix représentatif des externalités de la pollution atmosphérique due aux secteurs industriels. Néanmoins, les taux d'imposition ne reflètent pas les coûts des dommages environnementaux et sociaux, et jusqu'ici, leur incidence sur la réduction des émissions a été négligeable. Entamée en 2013, une augmentation annuelle progressive du taux des taxes aboutira à une hausse de 350 % en 2021 par rapport à 2016. Cependant, il faudrait qu'elle se poursuive à un rythme beaucoup plus soutenu par la suite pour tirer tout le parti possible de cet instrument fiscal.

Abstraction faite de la réelle amélioration de la conception de la taxe depuis 2013, il existe des mécanismes complexes d'exonération qui ont une incidence notable sur la performance de cet instrument. Ainsi, en 2017, 17 % des émissions de PTS, 12 % des émissions de SO_2 et 21 % des émissions de NO_x ont été totalement exonérées. D'après la présente évaluation, le principe d'une minoration des taux en fonction de la rigueur des limites de concentration à l'émission comparée aux concentrations annuelles mesurées n'est pas indiqué. L'analyse de la rigueur des limites de concentration à l'émission révèle que les concentrations mesurées se sont établies à 30-60 % des limites réglementaires (moyenne pondérée des émissions). L'allégement fiscal est aussi influencé par la portée des systèmes différenciés de limitation des émissions en fonction de la date d'entrée sur le marché. L'interaction des limites rigoureuses de concentration à l'émission et de la taxe sur la pollution atmosphérique ne constituant pas une formule efficace, il est proposé de lier l'allégement de la taxe uniquement à la réduction des émissions obtenues par chaque installation individuellement.

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Executive summary

Manufacturing and energy sectors account for about 32% of the GDP in the Czech Republic, which puts the country among the most industrial ones of the OECD members. Air pollution is therefore of major concern in the country and effective instruments for abatement of pollutants and triggering emission reductions are still high priority for the public and state administration, as well as keeping the competitiveness of the industry. Despite the structural change and fast modernisation of the economy in the 1990s, which resulted in unprecedented improvement of air quality, the exposure to ambient particulate matter was responsible for almost 8% of premature deaths and loss of disability-adjusted life years in 2017, which results in welfare costs equal to 5.5% of the GDP. The extent of the economic and social impact of air pollution in the Czech Republic is above the OECD average level.

The instruments for regulating air pollution from industrial stationary sources consist of complex technical requirements on the operation of individual installations, which include emission concentration limits. The air pollution tax is still an underrated economic instrument for environmental protection among the OECD countries, although in the case of the Czech Republic it has a long history. The assessment of the emission limits and air pollution tax in this paper focuses on the period since 2013, when the current Air Protection Act entered into force.

The air pollution tax and emission limits affect the emissions from industrial stationary sources, which decreased by 21% for TSP, 26% for SO_2 and 19% for NO_x emissions between 2013 and 2017. The impact of the different instruments on emission reduction remain unclear. The detailed analysis of the whole policy mix comprising other regulatory instruments, such as mandatory BATs and emission ceilings and furthermore financial subsidies for emission abatement, would need to be taken into account. The possible structural changes in the economy would have to be assessed as well, (even though the contribution of the industry to GDP has remained stable throughout the last decades). The impact of the different instruments on emission reduction remain imprecise considering structural changes, such as the fast modernisation of the economy in the 1990s and the clean energy transition. Further work would be needed to provide a fuller assessment of the emission limits and air pollution tax.

The emission concentration limits change for certain periods of time and thus signal the businesses the upcoming environmental standard a couple of years ahead. They therefore may not be able to incentivise the continual pressure for emission abatement. The analysis of the statutory and measured concentration levels from industrial stationary sources in 2013 and 2017 shows that stipulated emission limits in emission weighted averages were tightened by 23% for TSP, 11% for SO_2 and 22% for NO_x emissions between 2013 and 2017, but the measured emission concentrations remained at the same level or decreased further. As a result, average measured concentrations were 38% of the emission limits for TSP, 67% for SO_2 and 64% for NO_x in 2013, whereas in 2017, they were 36% the respective emission limits for TSP, 56% for SO_2 and 62% for NO_x.

The vintage-differentiated schemes allow keeping the previous (more lenient) limits and applied to 19% of total TSP, 68% of SO_2 and 42% of NO_x emissions from industrial stationary sources in 2017. These schemes provide for gradual modernisation of the industry and at the same time protect the competitiveness of the firms. There is an apparent trade-off between the ambition of the environmental policy and the competitiveness concerns. The results of the analysis indicate that the current extent of the vintage-differentiated schemes should be evaluated critically with a possible phase-out.

The air pollution tax design has improved since 2013 by focusing only on emissions of the main pollutants (TSPs, SO_2, NO_x and NMVOCs) from industrial sources, which has led to a significant improvement in the administrative and compliance costs to revenues ratio, from about 15% to 5%. Because 10% of the largest polluters are responsible for most of the emissions and revenues, the tax base design retains its potential to provide a price signal reflecting the air pollution externalities for the industrial sectors. However, the tax rates do not reflect the environmental and social damage costs and their impacts on emission reduction were historically rather negligible. Since 2013, a gradual annual increase in tax rates will result in a 350% increase by the year 2021 compared with the level in 2016. Nevertheless, the tax rates would need to be substantially further increased in order to reap the full potential of the tax instrument.

Except for an apparent improvement in the tax design since 2013, there are also complex relief provisions, which substantially affect the tax performance. In 2017, in effect 17% of TSP emissions, 12% of SO_2 emissions and 21% of NO_x emissions were relieved completely from the tax payment. The present assessment argues that the system of tax rates reductions based on the stringency of emission concentration limits compared to the annual measured concentration does not constitute a suitable design. The stringency analysis of the emission concentration limits reveal that the measured emission (European Commission, 2013[1]) concentrations were 30-60% of their statutory emission limits (emission weighted average). The tax relief is also affected by the magnitude of the vintage-differentiation schemes in emission limits. The interaction of the emission concentration limits stringency with the air pollution tax does not provide for an effective design, therefore the suggestion is to link the tax leniency only to the individual installation's progress in abatement of emissions.

By any cost-benefit test, the benefits of the more stringent instrument outperform the costs including the comparison of the tax rates with the average abatement costs. The total additional compliance costs of the air protection policy reform in the European Union (European Commission, 2013[1]) were estimated below 1% of GDP in the case of the Czech Republic and for all of the NO_x, SO_2 and PM pollutants, while premature deaths and DALYs lost caused by the exposure only to $PM_{2.5}$ are equivalent of 5.5% of GDP. Moreover, as is argued in the paper by Dechezleprêtre et al. (2019[2]), more stringent air quality regulations could be warranted based solely on economic grounds. This is because the large economic benefits from pollution reduction are greater than previously thought and compared with relatively small abatement costs: for example, reducing emissions of fine particulates by 25% across Europe would cost EUR 1.2 billion annually according to the European Commission, but the economic benefits from such emissions reductions would be at least two orders of magnitude greater. Consequently, such a reduction in pollution would easily pass a cost-benefit test, even ignoring the large benefits in terms of avoided mortality.

1 ASSESSMENT OF THE AIR POLLUTION TAX AND EMISSION CONCENTRATION LIMITS IN THE CZECH REPUBLIC

Introduction

Air pollution from the transport sector has been the subject of considerable research, whereas air pollution from stationary sources has received less attention. This paper provides an ex-post evaluation of two policy instruments for air protection from stationary sources in the Czech Republic, using administrative data sources. These regulatory requirements constitute elaborate technical requirements that differ in relation to types of combustion or industrial processes; however, the aim of this study is assessment of the emission reduction instruments – emission concentration limits and the air pollution tax.

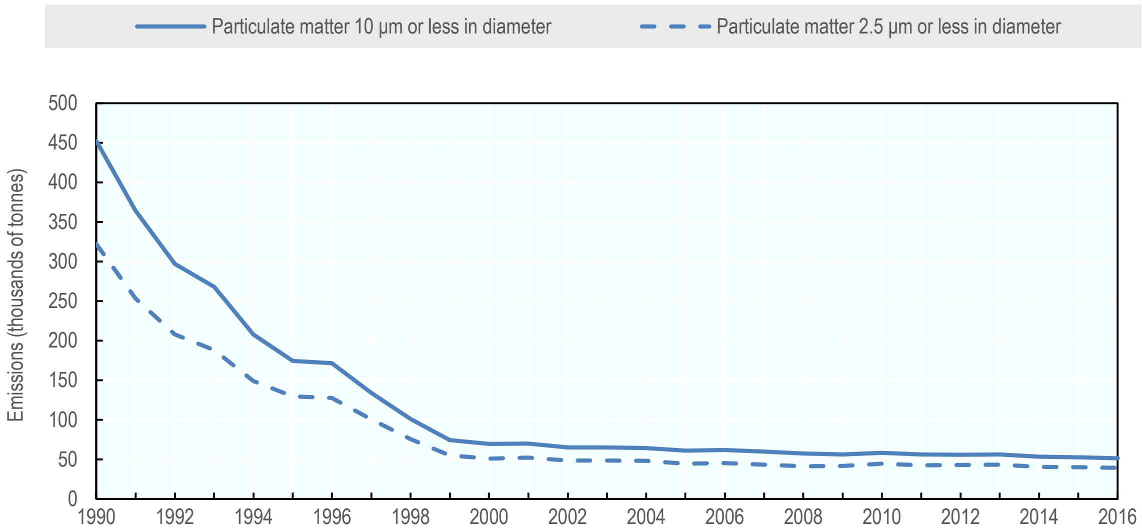
The consequences of air pollution are well documented in many studies and publications on damage incurred predominantly by exposure to fine particulate matter ($PM_{2.5}$), ozone and nitrogen dioxides. The World Health Organization states that ambient air pollution represents the biggest environmental risk to health (WHO, 2016[3]). NO_x (nitrogen oxides) pollutants worsen respiratory conditions and lead to eutrophication (oversupply of nutrient nitrogen with a harmful impact on ecosystems). NO_x and SO_2 (sulphur dioxide) contribute to acidification of soil and water bodies. Air pollution damage also includes corrosion and detrimental effects on the built environment and on cultural heritage according to the European Environment Agency (EEA, 2019[4]). The impact of air pollutants on climate change may be diverse (in contrast with the effects of greenhouse gases), and so using an integrated approach to air protection and climate policies may lead to increased efficiency of such policies.

The market economic costs of air pollution are derived from the direct impact on additional health spending, reduced labour productivity, absenteeism at work, and loss of crop and forest yields. Non-market economic impact includes increased mortality and morbidity, degradation of air and water quality affecting the health of ecosystems, and climate change. The traditional approach to estimating economic costs builds upon non-market health impact assessment (such as avoided premature deaths). Dechezleprêtre et al. (2019[2]) estimated that air pollution also has substantial direct impact on productivity, which should not be neglected. For example, an increase in air pollution caused a substantial reduction in economic activity (decreased cognitive and physical ability, see Zivin and Neidell (2018[5])) to the extent that a 1 μg/m^3 decrease in $PM_{2.5}$ concentration boosted gross domestic product (GDP) by 0.8% that same year.

The economy of the Czech Republic is an industrial one – the added value of the manufacturing and energy sectors accounts for about 32% of the GDP, putting the country in third place among OECD countries. Air pollution is therefore of major concern in the country, where the outdoor concentrations of particulate matters breach the stipulated limits. In 2016, concentrations above the PM_{10} daily limit value occurred in three rural background stations, and for $PM_{2.5}$, two rural background stations registered concentrations above the annual limit value (CHMI, 2017[6]). The mean exposure to $PM_{2.5}$ remains above the OECD and European Union averages of 12.5 and 13.1 μg/m^3, as high as 16.2 μg/m^3 in 2017, despite the tremendous progress made in air quality since the 1990s. The extent of the economic and social impact of air pollution in the Czech Republic is thus also above the average level. Exposure to ambient particulate matter was responsible for almost 8% of premature deaths and disability-adjusted life years (DALYs) in 2017.[1] Welfare costs of premature deaths from exposure to environmental risks were equal to 5.5% of the GDP equivalent in 2017. This estimate represents the cost of premature mortalities only, and was calculated using estimates of the value of a statistical life (VSL) and the number of premature deaths attributable. Thus, the estimate excludes any morbidity impact (labour productivity losses, treatment costs and willingness-to-pay to avoid pain and suffering from illness). It also excludes impact other than that on human health (e.g. on built structures, agricultural productivity and ecosystem health). The social cost of the exposure to these environmental risks is thus greater. The VSL also captures non-market values that are unrelated to spending; therefore, it is not an integral part of the calculation of the GDP. Consequently, comparing the costs with the GDP serves as an illustration.[2]

The extent of the level of exposure to air pollution and resulting negative impact in the Czech Republic is comparable with that of other former centrally planned economies in Europe. The Czech economy has undergone a major structural change since the early 1990s, and the industrial sectors have been vastly modernised as in other such economies. This has contributed to a steep reduction of air pollutant emissions (see Figure 1.1 and Figure 1.2).

Figure 1.1. Total human-made emissions of particulate matter in the Czech Republic

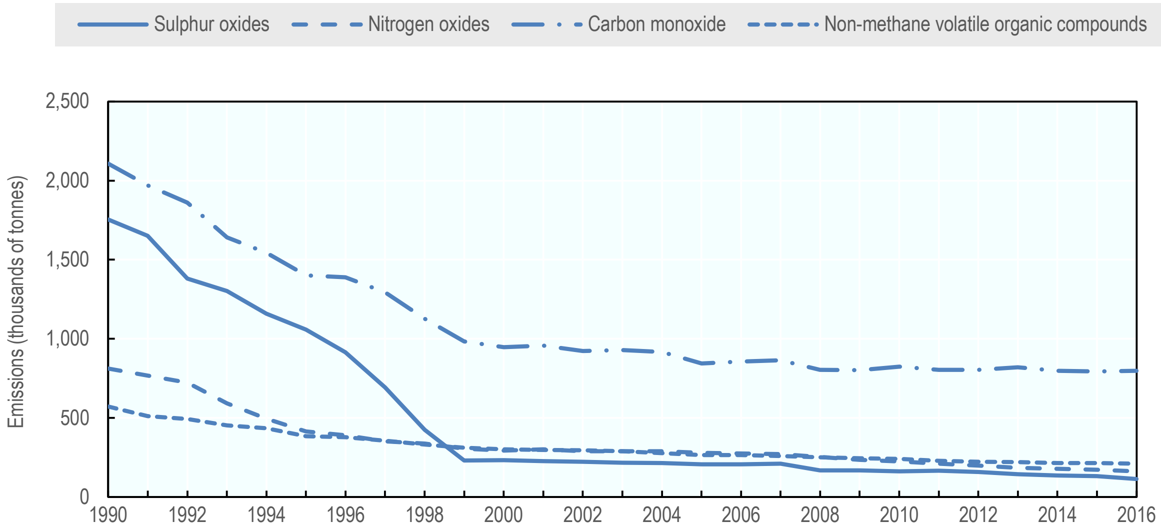


Source: OECD.Stat.

[1] DALYs are calculated as the number of years lost due to exposure to environmental risks, expressed in absolute value, per 1 000 inhabitants, and as a percentage of total attributable DALYs. DALYs are defined as the sum of years of potential life lost due to premature mortality and the years of productive life lost due to disability. Total attributable DALYs include DALYs due to environmental and occupational risks, behavioural risks and metabolic risks.

[2] The statistics used draw on OECD.Stat, http://dotstat.oecd.org/?lang=en.

Figure 1.2. Total human-made emissions of other pollutants in the Czech Republic



Source: OECD.Stat.

Conversion of emissions into exposure depends on a variety of factors, which are time and space specific. Pollutants stemming from human-made and natural sources undergo chemical transformations and reactions to sunlight, and are then dispersed in a certain area depending on weather conditions. The resulting exposure, together with its impact on people and the environment, is also affected by topography. Therefore, reducing emissions in a specific area or from specific sources does not automatically result in lower exposure. Furthermore, some pollutants may be transported in the atmosphere over large distances and may affect exposure levels elsewhere.

Annex A shows the overall contributions of emission sources of different air pollutants in absolute and relative terms, in time series. Stationary sources of air pollution contribute greatly to SO_2 emissions (around 80% of the total SO_2 emissions), but they have been reduced by more than 40% in absolute terms over the past 10 years. An impressive reduction in the emissions of total suspended particles (TSPs)[3] has also taken place in the industrial sector, in which emissions were half in absolute terms in 2017 compared with those in 2008. However, unlike the case of stationary sources, there has been no substantial improvement in the reduction of residential emissions, and residences caused 75% of TSP emissions in 2017. Stationary and mobile sources are important sources of NO_x emissions, but both sectors managed to reduce their emissions substantially (by 41% for stationary sources and by 33% for mobile sources from 2008 to 2017).

The aim of this ex-post appraisal is to evaluate the design of the air pollution tax and the emission limits as the main policy instruments for air protection in the Czech Republic. Chapter 2 provides an assessment of the emission limits with a focus on their statutory stringency compared with the measured emission concentrations at different points of time. Furthermore, the extent of the vintage-differentiated regulation applied for emission limits is assessed in order to interpret the shift in stringency correctly. The stringency analysis is conducted with the aim of discussing the appropriateness of the relief provisions of the air

[3] Airborne particulate matter contains a complex mixture of organic and inorganic substances, covering a wide range of diameters, from less than 0.1 µm and up to 100 µm. TSPs is the fraction sampled with high-volume samplers, with approximate particle diameters in the range 50-100 µm. PM_{10} particles are inhalable particles, with a diameter of less than 10 µm, and which enter through the nose during breathing. $PM_{2.5}$ are fine particles, with a diameter less than 2.5 µm, and which penetrate the lungs (EEA, 2016[28]).

pollution tax. Chapter 3 contains an assessment of the air pollution tax design. The aim is to assess recent changes in the tax design; the assessment focuses on the tax base, stringency in the sense of tax rates in relation to the level of the externality, tax relief provisions and administrative costs. Chapter 4 provides conclusions and suggestions in relation to these two policy instruments in the Czech Republic, in order to reap their full potential in industrial air emission reduction.

2 Emission limits

The emission concentration limits are a command-and-control instrument, which sets the allowed concentration of pollutants in emissions from stationary sources. A lower concentration of polluting substances in the emissions from a given source helps dispersion of pollutants and hence lowers their harmful effects. The emission concentration limits are binding thresholds of permitted concentration for polluting substances per cubic metre of fume. They are stipulated as part of permit conditions for installations and differ according to the rated thermal input, type of activity, type of fuel and other aspects. Emission (concentration) limits should not be confused with emission ceilings, which indicate the total allowed emission levels per time unit (usually a total annual amount). Emission ceilings may be set per plant, area or entire country. The following assessment concentrates on the emission concentration limits, their shift in recent years and comparison with the measured concentrations in order to assess the stringency of the instrument. The aim of the assessment is to add more context of the relief provision in the air pollution tax, which is based on the stringency of the emission limits (see chapter 3). By not assessing also the emission ceilings, the interpretation of the environmental impacts is rather limited.

In general, the minimum requirements for emission limits in the European Union are given by Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) for large installations (Industrial Emissions Directive; IED) (European Union, 2010[7]) and by Directive 2015/2193 on the limitation of emissions of certain pollutants into the air from medium combustion plants (MCP Directive) (European Union, 2015[8]). In principle, the IED regulates installations above 50 MW of rated thermal input in listed industrial activities and the MCP Directive regulates permit conditions, including emission limits, for combustion plants with rated thermal inputs from 1 to 50 MW.

Permit conditions for industrial processes should be set on the basis of the best available techniques (BATs) to meet output standards for a particular industrial process. BAT is defined in the IED as "the most effective and advanced stage in the development of activities and their methods of operation". This indicates the practical suitability of particular techniques and provides the basis for emission limit values and other permit conditions. BATs are designed to prevent and reduce emissions and harmful impact on the environment. They include the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned. BATs should be available, meaning that they are developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions. Availability assessment takes into consideration the costs and effectiveness in achieving a high general level of protection of the environment.[4]

The European Union provides for an exchange of information among the European Commission, member states, the industries concerned and non-governmental organisations promoting environmental protection, which is necessary to draw up, review and update the BATs. The mandatory BAT conclusions take the form of reference documents, so-called "BREFs", which, upon adoption, require member states to take them into account when determining the specific emission limits for installations under the scope of the IED.

The following analysis focuses on the level of stringency of the emission limits by comparing the limits in operation permits with measured and reported concentrations. In the Czech Republic, the installation

[4] IED, Art. 3, para. 10.

permits are administered by regional authorities, and the permitted emission limits may be differentiated on an individual basis. Emission limits thus also play a role as a regulatory instrument in reduction of regional pollution, as the limits may be imposed more strictly than the statutory minimum threshold. The concentration of pollutants in the fumes of given stationary sources is measured by automated monitoring systems or by periodical measurement, which is specified in the IED and its implementation into Czech law, namely Act No. 201/2012 Coll. (Air Protection Act) (Czech Republic, 2012[9]) and Ministerial Decree No. 415/2012 Coll. (Czech Republic, 2012[10])

Analysis of the measured emission concentrations draws upon the administrative data, which are administered by the Czech Hydrometeorological Institute (as the reporting centre). Two aspects of the analysis have to be taken into account to avoid over-interpreting the results. First, the dataset used includes a sample of stationary sources which are obliged to air pollution tax, for which TSP, SO_2 and NO_x pollutants are compared for the years 2013 and 2017.[5] The dataset represents about 60% of total tax obliged TSP emissions in 2013 and 2017, 80% in 2013 and 90% in 2017 of SO_2 emissions and 80% of NO_x emissions in 2013 and in 2017. The difference between the total tax obliged emissions and emissions included in the dataset is caused by exclusion of the sources with simplified reporting per plant, which does not allow disaggregation of the data for individual sources. The data may as a simplification be understood as industrial stationary sources as they do not comprise residential stationary sources (and mobile sources).

Second, the regulatory requirements stipulate detailed conditions when the measured concentration of an individual source meets the statutory emission limits. In practice, the concentration of pollutants at a given time point may differ depending on the type and quality of fuel used, abatement technologies and other technical aspects of an installation. However, the concentration is also affected by the installation's output capacity in operation. The analysis is based on the reported annual concentrations of individual sources and does not examine fluctuations in the concentration levels in other than annual time period. The aim of the assessment is to add more context of the relief provision in the air pollution tax, which is based on the stringency of the emission limits on annual basis.

Figure 2.1 shows the shift in the level of TSP emission limits in 2013 and 2017 on the vertical axis. The horizontal axis represents the magnitude of the environmental impact in percentages of total emissions in the given year, to capture the landscape of more than 1 500 individual sources of TSP emissions in the dataset. The sources are in order from the ones with the highest (most-lenient) emission limits to those with the most-stringent limits; the length of the horizontal dimension represents the share of emissions in total emissions in the given year of the group of sources with the same emission limit. The emission limits became stricter for over 60% of emissions in 2017 compared with the limits in 2013. However, the sources with the most-lenient (highest) limits, over 100 mg/m^3, remained unaffected and represented approximately 30% of total emissions. Annex B shows the graphs also for SO_2 and NO_x emissions.

Figure 2.2 visualises the emission limits and measured concentrations along with the environmental magnitude in the form of total emissions in 2013. The vertical axis represents the level of emission limits and measured annual concentrations. The horizontal axis represents the emissions in tonnes of TSPs for each source in the dataset (not the share of the total, as in Figure 2.1). The sources are in order from the ones with the most-lenient (highest) emission limits; within each group of the sources with the same emission limits, the sources are sorted from the ones with the highest measured concentration to those with the lowest levels. The measured concentrations are near the levels of the emission limits for most of the emissions. Figure 2.2 illustrates groups of the sources with the same limit and the stringency of the limits in and among groups. Most of the TSP emissions in 2013 were emitted by the sources that did not, in practice, exceed 50% of their stipulated emission limits. However, the dataset does not provide data for

[5] Air pollution tax obliged sources are listed in Annex 2 of the Air Protection Act. They include the energy sector (combustion sources above 0.3 MW of rated thermal input) and industrial processes of energy products, manufacturing of iron, steel, plastics and chemicals.

mandatory BATs and emission ceilings, therefore the analysis does not contain the overall stringency of all of the policy instruments. Annex C shows the graphs of measured concentrations and emission (concentration) limits of TSP, SO_2 and NO_x from stationary sources in 2013 and 2017.

Figure 2.1. Emission limits for TSPs as a share of total annual emissions

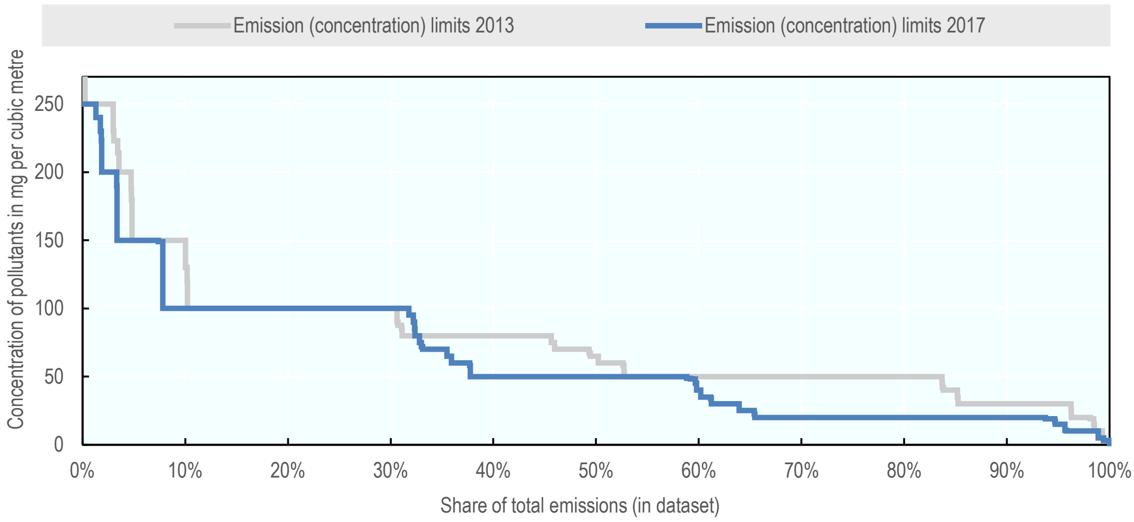
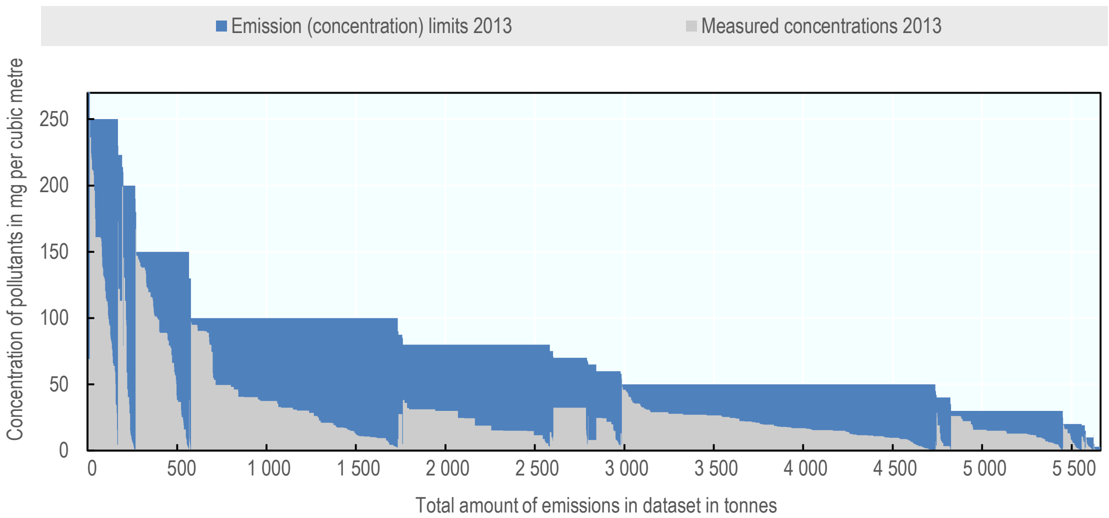


Figure 2.2. Emission limits and measured concentrations per total emissions



It should be noted that the total amount of emissions in the dataset decreased by 23% for TSP and by 16% for SO_2 and NO_x when comparing the results from 2013 and 2017. The total TSP and NO_x emissions (according to the emission balance report) from industrial sources also decreased by 20% in the same period. Those of SO_2 decreased slightly more, by 26%.

Figure 2.1 and the graphs in Annex B represent the share of emissions of the total in the given year (i.e. 100% in 2013 represents the total of 5 662 tonnes of TSP emissions, whereas 100% in 2017 represents 4 365 tonnes of TSPs). Figure 2.2 and the graphs in Annex C represent the amount of emissions in tonnes.

Furthermore, the statutory emission limits are affected by vintage-differentiation. There are four transitional schemes under the IED:

- The Transitional national plan, which allows keeping emission limits of selected pollutants on the 2015 level throughout the period 2016-20 for combustion plants above 50 MW of rated thermal input that were granted their first operation permit before 2002.[6]
- Limited lifetime derogation – installations in this scheme will be decommissioned by 2023 at latest and benefit from less stringent mission limits until the end of their operation. They are restricted by regulation with regard to the remaining total amount of working hours allowed.[7]
- Small isolated systems may be exempt from the obligatory emission limit values until the end of 2019.[8]
- District heating plants with rated thermal input from 50 to 200 MW put into operation before 2003 may be in a special emission limits scheme from 2016 to 2022, on the condition that they provide at least 50% of their heat production for thermal energy supply systems.[9]

The Czech Republic has implemented the transitional schemes, except that for small isolated systems. Only one plant was granted the limited lifetime derogation; therefore, the prevailing transitional schemes were the Transitional national plan and district heating plants. In effect, 19% of TSP emissions, 68% of SO_2 emissions and 42% of NO_x emissions in 2017 originated from the sources that benefit from the less stringent emission limits.[10] Most emissions, which kept the same emission limits in 2017 as in 2013 and which are shown in Annex B and Annex C, are therefore from the sources included in the vintage-differentiated schemes.[11]

Vintage differentiation is a reflection of transition policy and aims at smoothing the induced adjustment costs for established businesses. Coysh et al. (2019[11]) discuss the consequences of vintage-differentiated regulations. Such regulations provides an incentive for prolonged exit of environmentally ineffective installations and increases the burdens associated with permitting new installations, as it sets higher entry barriers for new competitors. This prevents shift of the plant stock towards more-efficient and more-productive facilities by favouring older plants (Coysh et al., 2019[11]). However, with regard to market entry and exit, market dynamics, ownership and firm structure also matter – i.e. plants that tend to export and plants that produce multiple products are more likely to survive (Bernard and Jensen, 2007[12]). Vintage differentiation also affects the incentives for modernisation (i.e. installation of newer abatement technologies) in established plants (Heutel, 2011[13]). The policy may even establish a direct disincentive to invest in new capital equipment once the plant falls out of the grandfathered scheme (Bushnell and Wolfram, 2012[14]). The described effects result in higher overall costs of achieving the pollution reduction targets. See Kaplow (2003[15]) for further discussion of a conceptual framework for assessing transitional schemes.

The stringency of the emission limits is assessed as the leniency of the real-life measured concentration annual average compared with the statutory emission limits by individual source. The assessment of the shifts using per source basis indicators does not capture the magnitude of the impact because the cohort comprises diverging polluting sources by rated thermal input or technological processes and emission

[6] IED, Art. 32; Air Protection Act, Art. 37.

[7] IED, Art. 33; Air Protection Act, Art. 38.

[8] IED, Art. 34.

[9] IED, Art. 35; Air Protection Act, Art. 39.

[10] Compared with the total emissions from industrial sources.

[11] The vintage-differentiated schemes cover 71% of TSP, 100% of SO_2 and 90% of NO_x emissions from the sources retaining the same emission limits in the analysed dataset.

amount. Therefore, the emission weighted and rated thermal input weighted averages are used in analysis of the emission limits stringency, to capture the magnitude of the effects.

Table 2.1 shows a comparison of the emission limits and measured concentrations in 2013 and 2017. Emission wise, the averages of TSP and NO_x emission limits were about 20% stricter in 2017 than in 2013, whereas the SO_2 emission limits were lower by 11%. The measured annual concentrations registered a steeper progress of 28% decrease of TSP concentrations, 23% of SO_2 and 27% of NO_x concentrations in the given time period. In conclusion, comparison of the leniency space for measured concentrations with the statutory emission limits reveals that the concentration of all three types of pollutants reached lower levels of their limits in 2017 than in 2013.

Table 2.1. Stringency of the emission limits and measured concentrations

	Emission limits for concentration of pollutants			Measured annual concentration of pollutants			Measured concentration as a percentage of emission limits	
	2013 (mg/m^3)	2017 (mg/m^3)	Decrease in 2017 compared with 2013 (%)	2013 (mg/m^3)	2017 (mg/m^3)	Decrease in 2017 compared with 2013 (%)	2013 (%)	2017 (%)
TSP emission weighted average	80	61	23	30	21	28	38	36
SO_2 emission weighted average	1 225	1 094	11	816	624	23	67	56
NO_x emission weighted average	606	473	22	389	284	27	64	62

Source: Own calculations based upon the reported data administered by the Czech Hydrometeorological Institute.

Analysis of the empirical data shows that the operators managed to adapt effectively to stricter emission limits. It remains unclear to what extent the emission limits are a driver of this trend, even though there is progress in emission reduction from industrial sources. The assessment does not include mandatory BATs and emission ceilings, therefore the analysis does not contain the overall stringency of all of the policy instruments. Emission limits are a regulatory instrument for permitting operation of the installations and stipulate market entry conditions. They are also an instrument for environmental protection with effects on already established installations, as they adjust the allowed level of emission concentrations on the basis of current technological development.

3 The air pollution tax

Economic instruments may be able to provide incentives for polluters to choose the most cost-effective abatement mechanisms and encourage the greatest abatement effort. They also provide an ongoing incentive for innovation in pollution control, which is also recognised by the large body of literature available on this matter (see Jaffe, Newell and Stavins (2000[16]) and Popp, Newell and Jaffe (2009[17]) for a literature review). Johnstone et al. (2010[18]) studied the characteristics of the market-based instruments and what effect these characteristics have on innovation. They found that the stimulating effect of environmental policies on technological progress is stronger for more-stringent, more-predictable and more-flexible environmental policies. Conversely, regulatory policies which stipulate that the polluters must use particular technologies or maintain emissions below a specified limit may achieve compliance, but do not encourage polluters to make further effort in emission reductions.

Uniform environmental tax also achieves a cost-effective distribution of abatement – all polluters face the same pollution tax rates (in principle, when no exemptions are applied). Economic instruments are most useful when there are numerous polluters encompassing a wide range of activities (such as industrial processes in the case of air pollution from stationary sources). Variability in the character of the polluting behaviour causes different marginal costs of abatement, which regulatory policy instruments usually cannot address fully. In these cases, the costs of regulation are large, and the efficiency benefits of the economic instruments are likely to be greater. Economic instruments incentivise each polluter to abate in the cheapest way.

Tax instruments also have their limitations. For example, a uniform pollution tax that is not proportional to the damage associated with the polluting activity would likely result in an inefficiency when the pollution damage varies broadly with the source of emissions. In these cases, source-by-source regulation may achieve a more-efficient outcome. The consequences of the tax may also be adverse to the aimed environmental protection in cases that lead to illegal behaviour to avoid high tax costs (especially when the polluting activity cannot be controlled properly, e.g. illegal dumping of waste; in other cases, the high tax burden may provide an incentive for corruption or falsification of the reported emission amounts, etc.). Environmentally adjusted input taxes, such as energy excise taxes, may also be regressive, which causes distributional social consequences that are generally perceived as an undesirable impact of the policy. However, environmental taxes raise revenues, which can be deployed to attain distributional and other policy objectives. An environmental tax cannot guarantee a particular environmental impact – the response to the tax may be less, or more, than expected. An emission trading scheme may be a better policy instrument when achieving a particular emission reduction goal is the policy objective. In addition, taxing the business sector always causes concerns about international competitiveness as the taxes increase the costs of domestic production, to which foreign producers are not subjected. It is also necessary to strike a balance between the costs and benefits of using environmental taxes; the direct costs of the emission measurement may not be justified in cases when the costs of pollution are low. (Theoretical remarks draw on Fullerton, Leicester and Smith (2008[19]).

In broad terms, air pollution from stationary sources fulfils the prerequisites for an effective application of the tax instrument based on the amount of emissions. In principle, it also fits the objective of the air protection policy of lowering the air pollution and its negative social impact. A practical condition needs to be met – the emission measurement should not be too burdensome for tax payers. However, in the case of the Czech Republic, measuring the emissions is historically well established and is also demanded by the established regulatory requirements of the European Union acquis.

The air pollution tax was introduced in the Czech Republic in 1967, but its incentivising capacity as a driver for implementing measures in air protection has been questioned throughout its existence. Before the protests against the totalitarian regime in Prague in 1989, the state of severe air pollution caused protests against the Communist Party in an industrial city, Teplice, where the pollutant concentration exceeded ten times the statutory limit. The tax was revised in the 1990s after the transition to democracy (the so-called "Velvet Revolution"), retaining its general fiscal, revenue-raising role.

The tax base by the year 2000 covered all stationary sources except for small sources up to 5 kW of heat power, unless used for business purposes. Sources above 0.2 MW of heat power paid the tax according to the measured level of pollutant emissions and the applicable tax rates, with the possibility of up to 60% tax relief if abatement measures were undertaken. At the same time, the tax rates were increased by 50% if the emission limits were exceeded in the facility. The remaining small sources were taxed based on the assumed emission levels according to the size of the source and the type and amount of fuel used.[12] The tax covered a wide array of pollutants, including TSPs, SO_2, NO_x, volatile organic compounds and carbon monoxide (CO), but also benzo(a)pyrene, asbestos and heavy metals.

A new comprehensive Air Protection Act, which entered into force in 2003, retained the original design with some adjustments. Notable changes included abolishing the increase in tax rates for polluters that exceeded their emission limits and setting stricter eligibility criteria for tax relief, with a condition that the abatement measures result in at least a 15% emission decrease. In addition, agricultural emissions of ammonia and methane were exempt from the tax.[13]

Since 2013, the new *Air Protection Act* simplified the tax design and abandoned taxing small sources with the aim of improving administrative and environmental efficiency. The revised regulation levies the tax on the sources operating in explicitly selected industrial and combustion processes. The tax shortlisted the pollutants to TSPs, SO_2, NO_x and non-methane volatile organic compounds (NMVOCs) on condition that the source has an obligation to measure and monitor emissions of these pollutants. The measuring obligation is generally bound with the source-specific emission (concentration) limit or other regulatory obligations.

The tax-liable entity is the plant, which may comprise one or more stationary sources in the listed combustion and technological processes.[14] Partial tax amounts are calculated per individual stationary source by multiplying the amount of taxed emissions and the tax rates differentiated for each pollutant. The payable tax is then the total of all the partial tax amounts of all sources operated by the given plant. The tax is payable only if the total annual amount of tax due is higher than CZK 50 000 for each plant (ca. EUR 1 950 calculated with the 2018 average exchange rate of CZK 25.65 per EUR).

The tax relief conditions entail further particularities in comparison with the previous legislation since 2013. The tax is not payable (for the individual source and pollutant emitted by the given source) if the operator carries out emission-decreasing measures that produce at least a 30% decrease in the TSP emissions, a 55% decrease in the SO_2 or NO_x emissions or a 30% decrease in the NMVOCs emissions, compared with the emissions in 2010. The tax relief is conditional only on achieving the mentioned emission reduction thresholds for an individual source, without demanding, for example, financial investment or installation of a particular technology. Since 2017, calculation of the tax includes a leniency provision according to the

[12] Act No. 309/1991 Coll.; Act No. 389/1991 Coll.

[13] Act No. 86/2002 Coll.

[14] The tax obliged sources are listed in Annex 2 of the *Air Protection Act*. They include the energy sector (combustion sources above 0.3 MW of rated thermal input) and industrial processes of energy products, manufacturing of iron, steel, plastics and chemicals.

level of measured concentrations compared to BAT[15] thresholds, or emission limits where the BAT is not set. In effect, the payable tax amount for emissions of the given pollutant from an individual source is then proportionately lowered or completely relieved, as shown in Table 3.1.

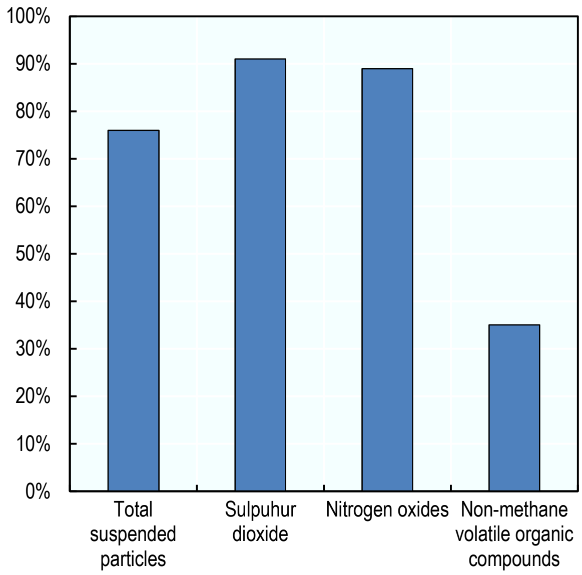
The relief provisions affect substantially the tax revenues from tax-eligible polluters: in 2017, 17% of TSP, 12% of SO_2 and 21% of NO_x revenues were relieved in total (by all of the relief provisions altogether).

Table 3.1. Tax leniency design based on emission concentration

Annual measured concentration level compared with emission concentration limit (%)	<50	50-60	>60-70	>70-80	>80-90	>90
Percentage of tax payable (%)	Not payable	20	40	60	80	100

Figure 3.1 shows averages of the shares of the tax obliged emissions (including the sources granted lower tax rates according to the relief provisions) compared with total emissions from industrial sources in the period 2012-17. The tax design provides for a broad tax base and covers most TSP, SO_2 and NO_x emissions from industrial stationary sources, and thus represents good potential for a proper price signal. For NMVOCs, it is questionable whether the tax base provides a coherent price signal for the operators, as only a third of the emissions from stationary sources is taxed. Note that NMVOC emissions are usually not measured directly, and their concentration is estimated depending on the type and amount of compound used and the nature of the activity.

Figure 3.1. Share of tax obliged emissions of total emissions from industrial sources



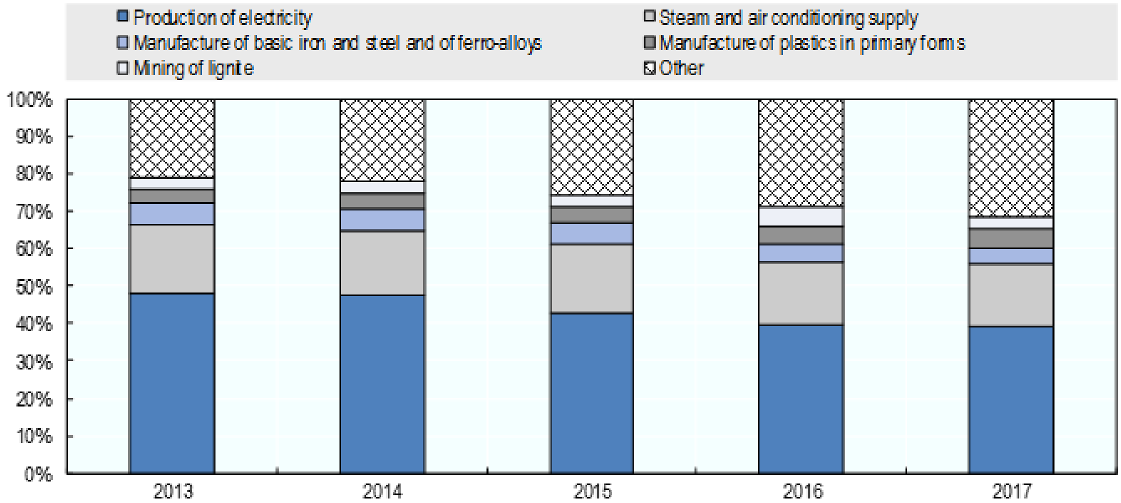
Note: The share shown is of the taxed emissions (notwithstanding the relief provisions) compared to total emissions from industrial stationary sources, averages 2012 to 2017.
Source: Own calculations based upon the reported data administered by the Czech Hydrometeorological Institute.

The 10% largest polluters paid 94% of the tax in 2011 (570 out of total 5 701 operators) when assessing the tax base from the point of view of taxed companies. The tax coverage of operators has become

[15] BATs for emission concentrations specify a span of the concentration for the given combustion or technological process.

considerably less granular since 2013 due to the changed tax design, and the 10% largest polluters raised 70% of the tax revenues in 2017 (46 out of total 446 operators). From the sectorial point of view, the major contribution comes from the energy sector, where electricity production and steam and air conditioning supply account for about 60% of the tax revenues, with a declining trend from 2013 to 2017. Figure 3.2 illustrates the sectorial distribution.

Figure 3.2. Distribution of tax revenues by sector



Source: Own calculations based upon the reported data administered by the Czech Hydrometeorological Institute.

Table 3.2 shows evolution of the tax rates for the major taxed pollutants since 1991. The tax rates remained the same from their introduction in October of the year 1991 to the end of 2012, despite the Air Protection Act entering into force in 2003. The tax rates would have to almost double in real terms and exceed even the rates introduced since 2013, if they were to be adjusted for inflation since 1995. Consequently, only after the tax rates were increased again in 2017 did they exceed the inflation-adjusted value of the tax rates from the 1990s.

Table 3.2. Tax rates and marginal social damage costs and abatement costs (in euros per tonne)

	TSPs	SO_2	NO_x	NMVOCs	CO
1991-2012	117	39	31	78	23
2013-16	164	53	43	105	-
2017	246	82	66	164	-
2018	327	109	86	218	-
2019	409	136	109	273	-
2020	491	164	129	327	-
2021+	573	191	152	382	-
Low VOLY (EEA)	25 897	12 483	6 420	2 075	-
High VSL (EEA)	74 770	36 491	17 663	5 518	-
External costs 2020 (CASES)	23 992	9 574	11 961	141	-
Average damage costs for transport emissions 2016	39 600	11 600	24 800 (city) / 14 800 (rural)	1 100	-

Abatement costs (European Commission, 2013)	2 500 – 5 200	1 400 – 2 600	500 – 7 600	-	-
Damage costs (European Commission, 2013)	14 750 – 41 650	7 600 – 21 200	5 500 – 13 900	-	-

Note: The tax rates and VOLY and VSL estimates are in EUR, exchange rate of CZK 25.65 per EUR (average in 2018) is used.
Source: Value of a life year (VOLY) and VSL estimates are taken from EEA (2014[20]), *Costs of Air Pollution from European Industrial Facilities 2008–2012*, http://dx.doi.org/10.2800/23502. The CASES external costs estimates for the Czech Republic for the year 2020 are taken from (Štreimikienė and Ališauskaitė-Šeškienė, 2016[21]) *Comparative Assessment of External Costs and Pollution Taxes in Baltic states, Czech Republic and Slovakia*. Average damage costs for transport emissions are taken from (van Essen et al., 2019[22]) *Handbook on the external costs of transport, Version 2019*. The abatement and damage costs are taken from the European Commission's Impact Assessment accompanying the documents Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and he Committee of the Regions a Clean Air Programme for Europe; Proposal for a Directive of the European Parliament and of the Council on the limitation of emissions of certain pollutants into the air from medium combustion plants; Proposal for a Directive of the European Parliament and of the Council on the reduction of national emissions of certain atmospheric pollutants and amending Directive 2003/35/EC; Proposal for a Council Decision on the acceptance of the Amendment to the 1999 Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution to Abate Acidification, Eutrophication and Ground-level Ozone (European Commission, 2013[1]).

Tax rates should reflect the marginal social costs imposed by the negative externalities.[16] An EEA report (EEA, 2014[20]) was chosen as the reference study in the case of marginal damage costs caused by emissions from industrial stationary sources in the Czech Republic. Figure 3.2 allows for comparison of the tax rates with the VSL and the value of a life year (VOLY), which correspond to the use of two different approaches for valuing health damage. The VSL is an estimate of damage costs based on how much people are willing to pay for a reduction in their risk of dying from adverse health conditions, whereas the VOLY provides an estimate of damage costs based upon the loss of life expectancy (expressed as potential years of life lost). This measure takes into account the age at which death occurs by giving greater weight to deaths at a younger age and lower weight to deaths at an older age. See, for example, OECD (2012[23]) for a detailed description of the process of estimating the VSL and VOLY, and Alberini (2017[24]) for further discussion of the use and interpretation of the VSL and VOLY.

Health damage represents only part of the total social costs because not all the negative impact of the pollutants is accounted for (i.e. crop and building material damage, the negative impact on ecosystem services, etc. is not included in the VSL or VOLY estimates). Furthermore, the tax rate for emissions of TSPs is compared with the PM_{10} marginal damage cost used in the VSL and VOLY estimates. Particulate matters ($PM_{2.5}$ and PM_{10}) are a subset of the TSPs; therefore, the actual marginal health damage cost of the TSPs is higher. This implies that the reference marginal damage costs are likely to be underestimated when compared with the complete marginal social costs.

The CASES project assessed with the ExternE methodology broader external damages from air pollution, concretely on human health (fatal and nonfatal effects) and effects on crops and materials. External costs are highly site-dependent, so the CASES project applied impact pathway assessment in which environmental benefits and costs are estimated by following the pathway from source emissions via quality changes of air, soil and water to physical impacts, before being expressed in monetary benefits and costs. Table 3.2 shows estimations of the values for the Czech Republic in 2020, which were derived from the original 2010 estimates (Štreimikienė and Ališauskaitė-Šeškienė, 2016[21]). For the sake of illustration with more recent external costs valuation, the average damage costs (all effects: health effects, crop loss, biodiversity loss, material damage) for transport emissions in 2016 in the Czech Republic are also mentioned (van Essen et al., 2019[22]).

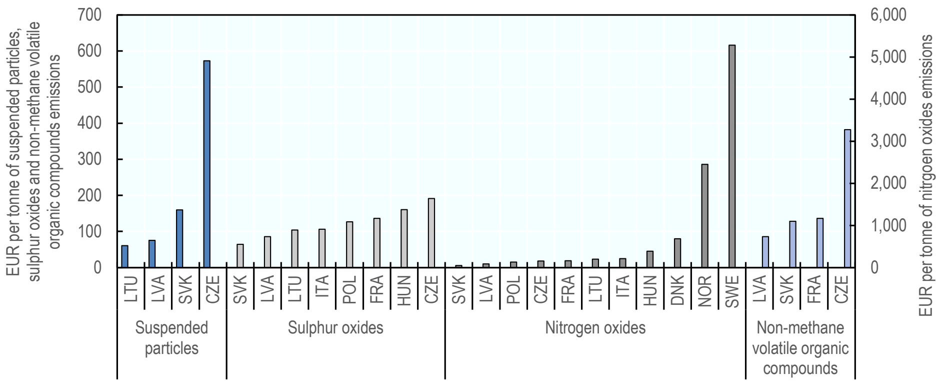
In 2013, the European Commission proposed a comprehensive reform of the European Union's air protection with impact assessment of several policy options. A comparison of the Czech air pollution tax

[16] Alternatively, tax rates can be set as a function of policy targets on abatement, which may lead to prices higher or lower than estimated damages.

with the estimates of abatement costs per tonne of pollutant (European Commission, 2013[1]) reveals that the tax rates are also below the abatement costs, which reduces the incentive capacity of the air pollution tax. The average abatement cost was calculated as the compliance cost of more stringent policy options divided by the associated emission reduction for each pollutant. The total direct cost of policy options is then the annualised investments required in different sectors to install pollution abatement equipment, as well as operation and maintenance of that investment. These costs were compared to the baseline costs deriving from implementation of the former pollution control legislation. Direct additional compliance costs for different options of the policy stringency and resulting level of emission decrease are calculated from 0.00% GDP to 0.95% for the Czech Republic (European Commission, 2013[1]).

The tax rates are being gradually increased in the Czech Republic from 2017 to 2021; however, the resulting levels would have to be considerably higher to reach at least the lower (VOLY) reference values. In practice, the potential of air pollution tax is not fully achieved throughout OECD countries. Such an economic instrument in air protection has not been introduced in many countries. The ones that have managed to do so have not been successful in setting tax rates reflecting the marginal damage caused by the emissions. Figure 3.3 shows a comparison of tax rates, and is based on the OECD Database on Policy Instruments for the Environment (PINE). In practice, the only tax rate that approaches the lower estimate of the marginal social damage costs is the Swedish NO_x pollution tax, which is combined with a refund system. Most countries do not have any tax addressing air pollutants.

Figure 3.3. Tax rates in selected countries



Notes: Exchange rate of CZK 25.65 per EUR (average in 2018), tax rates used for the Czech Republic are applicable as of 2021. In the case of Norway, there is a temporary tax exemption for undertakings covered by an environmental agreement with the state on the implementation of measures to reduce emissions of NO_x in accordance with a predetermined environmental target.
Source: https://pinedatabase.oecd.org.

Stakeholders have questioned the cost-effectiveness of the tax, especially the former tax design that encompassed a series of pollutants and the tax payment obligation threshold that was set low. The total compliance and tax administration costs were estimated in 2011 as part of the regulatory impact assessment of the current Air Protection Act. The regulatory obligations are set in the operation permits, such as the type of emission monitoring (automated continuous, one-off measuring, calculations and emission estimation based on fuel consumption). Therefore, the costs of monitoring cannot be attributable only to the tax because it is stipulated by the other regulatory obligations, which include emission limits and environmental data reporting. Automated monitoring is mandatory above a 50 MW rated thermal input according to the IED; the Czech Air Protection Act does not enhance this obligation to smaller sources.

In the current legislative environment, the tax liability is based on activities that the operators would have conducted regardless of the tax. Table 3.3 captures the revenues and estimates of administration and compliance costs. The tax administration costs are derived from the original regulatory impact assessment of the air protection regulation, and the compliance costs are adjusted only to the tax-related obligation with the assumption that the activity directly attributable to the tax constitutes filling in the tax self-declaration. The burden per entity may represent a few hours to a maximum of 2-3 days of work in some cases, when the tax payer intends to claim additional tax relief available from 2017. For a general overview, one working day (8 hours) is estimated as the average workload.

Given the number of eligible entities was almost 13 times higher until 2012, and at the same time tax revenues remained around EUR 10 million after amending the tax design from 2013 (higher tax obligation threshold, limiting the tax only to major pollutants and increased tax rates), the tax was disproportionately burdensome before that year, as the total costs constituted around 16% of the revenues. A tax efficiency ratio of 5% since 2013 still represents a cost-inefficient tax; however, the ratio of the tax revenues to administrative and compliance costs may not be a decisive indicator for environmentally related taxes because revenues will decline if taxes are environmentally effective (OECD, 2001[25]). The tax rates increase annually by 20-50% during the period 2017-21, and the operators pay the tax if the total amount of tax obligation exceeds EUR 1 950 per production facility plant. Therefore, more operators will become tax payers (see the increase of entities from 2016 to 2017 in Table 3.3), hence compliance costs and revenues will increase. Consequently, the compliance and administration costs to revenues ratio will probably remain at 5%.

Table 3.3. Tax revenues, administration costs and compliance costs

	2011	2012	2013	2014	2015	2016	2017
Tax revenues (thousands of EUR)	10 964	8 815	12 353	11 818	11 083	9 599	12 172
Tax administration costs (thousands of EUR)	738	715	541	538	537	533	521
Number of tax payers	5 701	5 318	324	337	343	340	444
Total compliance costs (thousands of EUR)	836	798	46	48	49	49	66
Tax administration and compliance costs as a share of tax revenues (%)	14	17	5	5	5	6	5

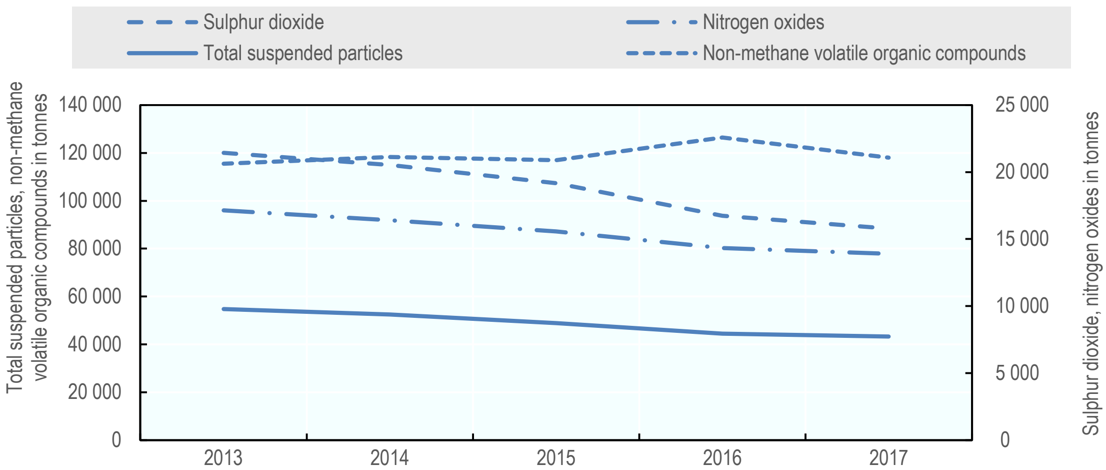
Note: Money values are inflation adjusted to 2018 constant prices; exchange rate of CZK 25.65 per EUR (average in 2018).
Source: Own calculations based upon the reported data administered by the Czech Hydrometeorological Institute and the regulatory impact assessment of the Air Protection Act.

4 Conclusions

The instruments for regulating air pollution from stationary sources in the Czech Republic consist of complex technical requirements on the operation of individual installations or that apply over the lifetime of plants. They include emission concentration limits and mandatory BATs that may also include emission concentration limitations, emission ceilings and an air pollution tax. This case study concentrated on assessment of the emission concentration limits and the air pollution tax, using empirical data from stationary sources. The assessment of the air protection instruments focused on the period since 2013, when the current Air Protection Act entered into force.

The main objective of the assessed instruments is to decrease emissions of pollutants into the environment, and consequently decrease the negative impact of exposure to the polluting substances. Emissions from industrial stationary sources decreased by 21% for TSP, 26% for SO_2 and 19% for NO_x emissions in 2017 compared to in 2013 (see Figure 4.1). There was not much change in the level of NMVOC emissions over the same time period. The complexity of the policy environment with regard to air pollution from stationary sources does not allow assessment of the contribution of individual instruments as drivers for behavioural change of polluters. The impact of the different instruments on emission reduction remain imprecise considering structural changes, such as the fast modernisation of the economy in the 1990s and the clean energy transition. Further work would be needed to provide a fuller assessment of the emission limits and air pollution tax. The assessment presented in this paper focuses on the design of emission concentration limits and air pollution tax, therefore it is not able to provide an appraisal of the full policy instruments mix and its environmental efficiency in the Czech Republic. Moreover, also other instruments, such as subsidies in relation to air protection, would have to be included.

Figure 4.1. Total emissions of TSPs, SO_2, NO_x and NMVOCs from stationary sources



Note: The figure captures total emissions from industrial stationary sources.
Source: Ministry of the Environment of the Czech Republic and the Czech Environmental Information Agency (2018[26]) Statistical environmental yearbook of the Czech Republic 2017.

The total costs of air pollution in the Czech Republic remain above the OECD and European Union averages, despite the achieved progress in emission reduction in recent years. Exposure to ambient $PM_{2.5}$

is liable for almost 8% of premature deaths and DALYs lost in 2017, which is 5.5% of the GDP equivalent.[17] Air pollution from stationary sources still represents a considerable part of the total air pollution in the country, and the analysis revealed there is room for improvement in the emission limits and the air pollution tax, to achieve better environmental and social outcomes.

Analysis of emission concentration limits and measured concentration levels from industrial stationary sources in 2013 and 2017 shows that the regulatory instrument does not properly address real possibilities of emission abatement. While the stipulated emission limits in emission weighted averages were tightened by 23% for TSP, 11% for SO_2 and 22% for NO_x emissions between 2013 and 2017, the measured emission concentrations remained at the same level or decreased even further. As a result, average measured concentrations were 38% of TSP, 67% of SO_2 and 64% of NO_x emission limits in 2013, whereas in 2017, they were 36% of TSP, 56% of SO_2 and 62% of NO_x emission limits.[18]

Most stationary sources above 50 MW of rated thermal input benefit from the vintage-differentiated provisions in emission limits allowed by the IED. Vintage-differentiated emission concentration limits apply to 19% of total TSP emissions, 68% of SO_2 emissions and 42% of NO_x emissions from industrial stationary sources.

Although two other instruments (BATs and emission ceilings) affect the overall stringency of the air protection policy, the assessment suggests there is room for improvement in relation to the emission concentration limits. Especially in implementation of stricter emission limits by regional authorities, which could take the opportunity to regulate local polluters in the operation permits using individual assessment of installations' measured concentrations and technical levels. Furthermore, the extent of the vintage-differentiated emission limits for large sources should be evaluated critically, and a gradual phase-out should be considered.

The air pollution tax introduced in the Czech Republic in 1967 has undergone several different settings, with this assessment concentrating on the latest tax design. The tax addressed a wide variety of pollutants and a broad tax base (including small installations) before the Air Protection Act entered into force in 2013. In theory, the tax base should be as broad as the polluting behaviour; however, there is a natural trade-off of tax efficiency in terms of high administration and compliance costs. Air pollution from numerous small stationary sources, including households, as well as from mobile sources, may, to a large extent, be addressed effectively by the energy excise taxes, with corresponding tax rates that would be set according to the environmental and social costs.

The decision to tax only the main pollutants (TSPs, SO_2, NO_x and NMVOCs) and to narrow the tax base to the listed activities has led to a significant improvement in the administrative and compliance costs to revenues ratio. This has changed from about 15% to 5% by reducing the number of taxed entities from more than 5 000 to several hundreds, while keeping most of the emissions from stationary sources taxed and retaining the fiscal revenues (10% of the largest polluters are responsible for most of the emissions and revenues). The tax obligation is aligned with the IED and the MCP Directive in terms of requirements

[17] The estimate represents only the cost of premature mortalities and is calculated using estimates of the VSL and the number of premature deaths attributable. Thus, the estimate excludes any morbidity impact (labour productivity losses, treatment costs and willingness to pay to avoid pain and suffering from illness). It also excludes impact other than that on human health (e.g. on built structures, agricultural productivity and ecosystem health). The social cost of the exposure to these environmental risks is thus greater. The VSL also captures non-market values that are unrelated to expenditures and therefore they are not an integral part of the calculation of the GDP. Consequently, comparing with the GDP serves only for illustration.

[18] Emission-weighted averages are used; therefore, the averages reflect the environmental magnitude of the concentrations instead of on a per source basis, which would not reflect the extensively diverging capacity and emission burden of the individual stationary sources.

for measuring emissions. Therefore, the tax under the current regulatory framework does not cause a substantial additional administrative burden for tax payers.

The relief provisions substantially affect the tax base – in 2017, 17% of TSP emissions, 12% of SO_2 emissions and 21% of NO_x emissions were relieved completely from the tax payment. The tax relief, which is based on the share of the measured concentration of the given installation's emission concentration limit (or BAT when it includes emission concentration limitation), apparently provides far too generous tax deductions. The provision causes broad tax leniency and disrupts the desired motivation for undertaking emission-decreasing measures by the operators if the emission limits are not strict enough on an individual source basis. The stringency analysis of the emission concentration limits revealed that the measured emission concentrations were 30-60% of their statutory emission limits (emission weighted average), and therefore provided for substantial deductions or even the complete tax reliefs. Moreover, the most-polluting operators benefit from less stringent emission limits under vintage-differentiation schemes. The emission limits for individual sources may be set more strictly by the regional authorities, and therefore the tax relief design may also create an unequal level playing field on the market among the taxed operators. The suggestion is to bind the tax leniency only to the individual installation's progress in abatement of emissions.

The general deficiency of the air pollution tax in the Czech Republic is that the tax rates do not reflect the environmental and social damage costs. The incentives created for emission reduction and the revenue-raising capacity remain negligible. Leaving the tax rates unadjusted for inflation for long periods of time leads to further depreciation of the instrument, and the suggestion is to automatically adjust the tax rates for inflation, to keep their monetary value relevant. The tax efficiency in terms of environmental and social impact will slightly increase due to the stipulated gradual annual increase in tax rates, resulting in a 350% increase in tax rates in the year 2021 compared with the level in 2016. Nevertheless, the tax rates would need to be further increased substantially to reap the full potential of the tax instrument, to achieve socially and economically effective emission reductions.

By any cost-benefit test, the benefits of the more stringent instrument outperform the costs including the comparison of the tax rates with the average abatement costs. The total additional compliance costs of the air protection policy reform in the European Union (European Commission, 2013[1])were estimated below 1% of GDP in the case of the Czech Republic and for all of the NO_x, SO_2 and PM pollutants, while premature deaths and DALYs lost caused by the exposure only to $PM_{2.5}$ are equivalent of 5,5% of GDP. Moreover, as is argued in the paper by Dechezleprêtre et al. (2019[2]), more stringent air quality regulations could be warranted based solely on economic grounds. This is because the large economic benefits from pollution reduction are greater than previously thought and compare with relatively small abatement costs: for example, reducing emissions of fine particulates by 25% across Europe would cost €1.2 billion annually according to the European Commission, but the economic benefits from such emissions reductions would be at least two orders of magnitude greater. Consequently, such a reduction in pollution would easily pass a cost-benefit test, even ignoring the large benefits in terms of avoided mortality.

There are also additional rationale behind the proposed suggestions in relation to the air pollution tax, except the theoretical foundations (see Chapter 3) and generally recognised recommendations (OECD, 2010[27]). Fundamentally, polluters may not respond at all to minor environmental taxes because the cost incurred is too low to become decisive in the internal organisation of the tax payers. Polluters must draw together information on the technology choice and tax payments in order to balance the marginal tax savings against the marginal costs of abatement. This calculation may not be worth the effort if the tax costs are negligible or if it is obvious that the abatement is much more expensive than the tax (Fullerton, Leicester and Smith, 2008[19]). Moreover, the suggestions in this case study could also lead to achieving a better innovation outcome of the tax, especially given that more-stringent tax rates and a more-predictable tax base should provide stronger incentives for technological progress (Johnstone, Haščič and Kalamova, 2010[18]).

References

Alberini, A. (2017), “Measuring the economic value of the effects of chemicals on ecological systems and human health”, *OECD Environment Working Papers*, No. 116, OECD Publishing, Paris, https://dx.doi.org/10.1787/9dc90f8d-en. [24]

Bernard, A. and J. Jensen (2007), “Firm structure, multinationals, and manufacturing plant deaths”, *Review of Economics and Statistics*, Vol. 89/2, pp. 193-204, http://dx.doi.org/10.1162/rest.89.2.193. [12]

Bushnell, J. and C. Wolfram (2012), “Enforcement of vintage differentiated regulations: The case of new source review”, *Journal of Environmental Economics and Management*, Vol. 64/2, pp. 137-152, http://dx.doi.org/10.1016/j.jeem.2012.01.006. [14]

CHMI (2017), *Report on Air Quality*, http://portal.chmi.cz/files/portal/docs/uoco/isko/grafroc/17groc/gr17cz/Obsah_CZ.html. [6]

Coysh, D. et al. (2019), “Vintage differentiated regulations and plant survival: Evidence from coal-fired plants”, *OECD Environment Working Papers*, No. 144, OECD Publishing, Paris, https://dx.doi.org/10.1787/31621ca6-en. [11]

Czech Republic (2012), *Air Pollution Act*, https://www.zakonyprolidi.cz/cs/2012-201. [9]

Czech Republic (2012), *Ministerial Decree on the permissible level of pollution and its detection and on the implementation of certain other provisions of the Air Protection Act*, https://www.zakonyprolidi.cz/cs/2012-415. [10]

Dechezleprêtre, A., N. Rivers and B. Stadler (2019), “The economic cost of air pollution: Evidence from Europe”, *OECD Economics Department Working Papers*, No. 1584, OECD Publishing, Paris, https://dx.doi.org/10.1787/56119490-en. [2]

EEA (2019), *Air Quality in Europe : 2019 Report*, Publications Office of the European Union, http://dx.doi.org/10.2800/822355. [4]

EEA (2016), *Suspended Particulates*, https://www.eea.europa.eu/publications/2-9167-057-X/page021.html. [28]

EEA (2014), *Costs of Ar pollution from European Industrial Facilities 2008–2012 – An Updated Assessment*, Publications Office of the European Union, http://dx.doi.org/10.2800/23502. [20]

European Commission (2013), *Impact Assessment*, European Commission, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52013SC0531&qid=1616355705212. [1]

European Union (2015), *Directive 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the Limitation of Emissions of Certain Pollutants into the Air from Medium Combustion Plants*, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015L2193&from=FR. [8]

European Union (2010), *Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on Industrial Emissions (Integrated Pollution Prevention and Control)*, https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32010L0075&from=FR. [7]

Fullerton, D., A. Leicester and S. Smith (2008), *Environmental Taxes*, National Bureau of Economic Research, Cambridge, MA, http://dx.doi.org/10.3386/w14197. [19]

Heutel, G. (2011), “Plant vintages, grandfathering, and environmental policy”, *Journal of Environmental Economics and Management*, Vol. 61/1, pp. 36-51, http://dx.doi.org/10.1016/j.jeem.2010.07.002. [13]

Jaffe, A., R. Newell and R. Stavins (2000), “Technological change and the environment”, *SSRN Electronic Journal*, http://dx.doi.org/10.2139/ssrn.252927. [16]

Johnstone, N., I. Haščič and M. Kalamova (2010), “Environmental policy characteristics and technological innovation”, *Economia Politica*, Vol. XXVII/2, pp. 275-299, http://www.oecd.org/greengrowth/consumption-innovation/48097418.pdf. [18]

Kaplow, L. (2003), *Transition Policy: A Conceptual Framework*, National Bureau of Economic Research, https://www.nber.org/papers/w9596.pdf. [15]

Ministry of the Environment of the Czech Republic and the Czech Environmental Information Agency (2018), *Statistical environmental yearbook of the Czech Republic 2017*, Ministry of the Environment of the Czech Republic and the Czech Environmental Information Agency, https://www.cenia.cz/publikace/statisticka-rocenka-zivotniho-prostredi-cr/statisticka-rocenka-zivotniho-prostredi-2017/. [26]

OECD (2012), *Mortality Risk Valuation in Environment, Health and Transport Policies*, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264130807-en. [23]

OECD (2010), “A guide to environmentally related taxation for policy makers”, in *Taxation, Innovation and the Environment*, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264087637-8-en. [27]

OECD (2001), *Environmentally Related Taxes in OECD Countries: Issues and Strategies*, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264193659-en. [25]

Popp, D., R. Newell and A. Jaffe (2009), *Energy, the Environment, and Technological Change*, National Bureau of Economic Research, https://www.nber.org/papers/w14832.pdf. [17]

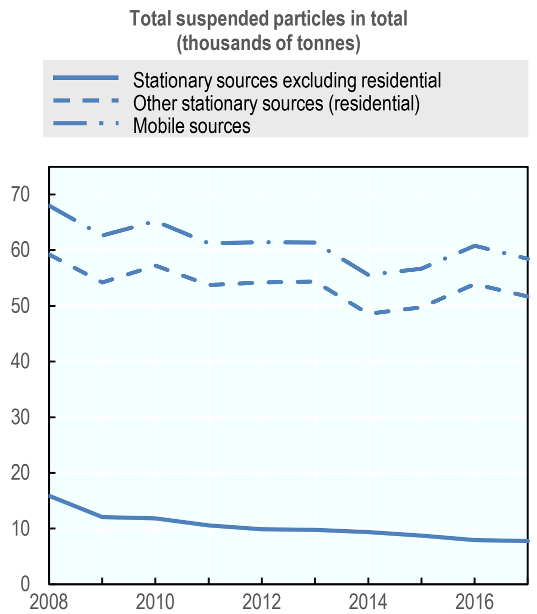
Štreimikienė, D. and I. Ališauskaitė-Šeškienė (2016), “Comparative assessment of external costs and pollution taxes in Baltic States, Czech Republic and Slovakia”, *E+M Ekonomie a Management*, Vol. 19/4, pp. 4-18, http://dx.doi.org/10.15240/tul/001/2016-4-001. [21]

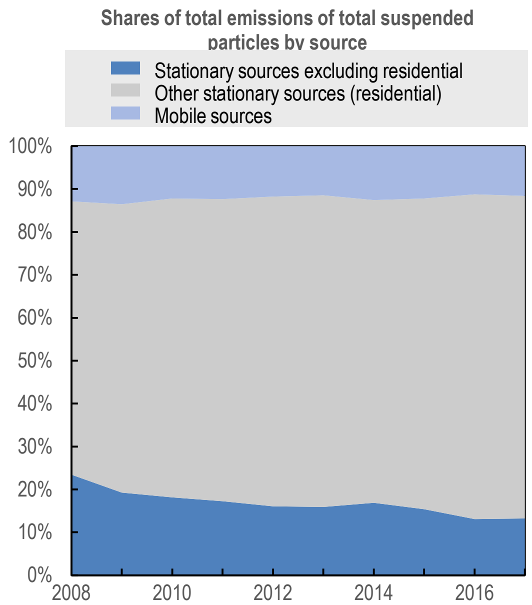
van Essen, H. et al. (2019), *Handbook on the external costs of transport*, Publications Office of the European Union, http://dx.doi.org/10.2832/27212. [22]

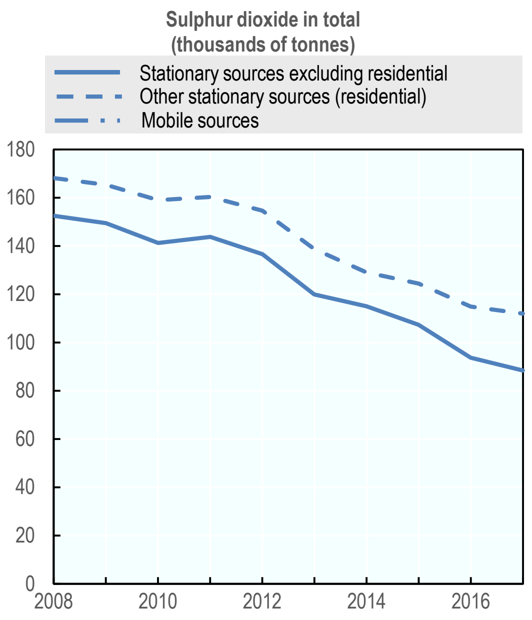
WHO (2016), *Ambient Air Pollution: A Global Assessment of Exposure and Burden of Disease*, World Health Organization. [3]

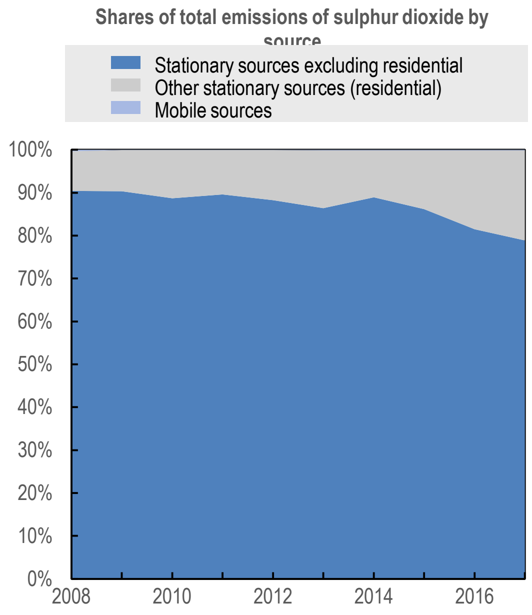
Zivin, J. and M. Neidell (2018), “Air pollution’s hidden impacts”, *Science*, Vol. 359/6371, pp. 39-40, http://dx.doi.org/10.1126/science.aap7711. [5]

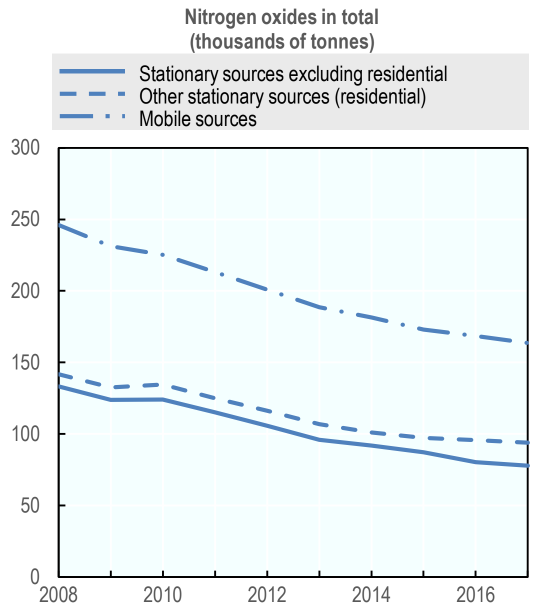
Annex A. Emissions and emission sources of TSP, SO_2, NO_x and NMVOCs in time series from 2008 to 2017

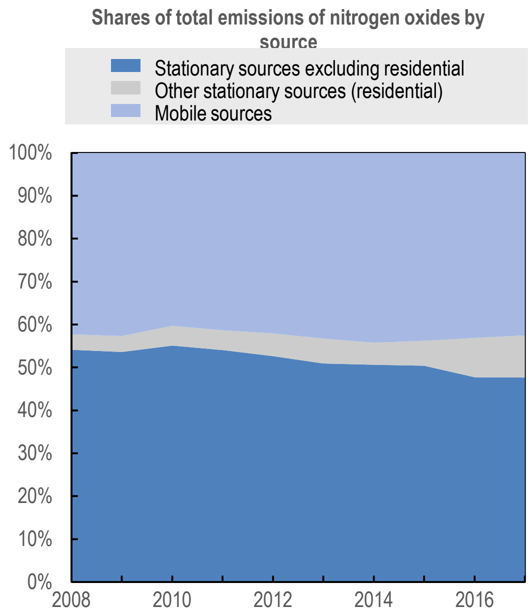


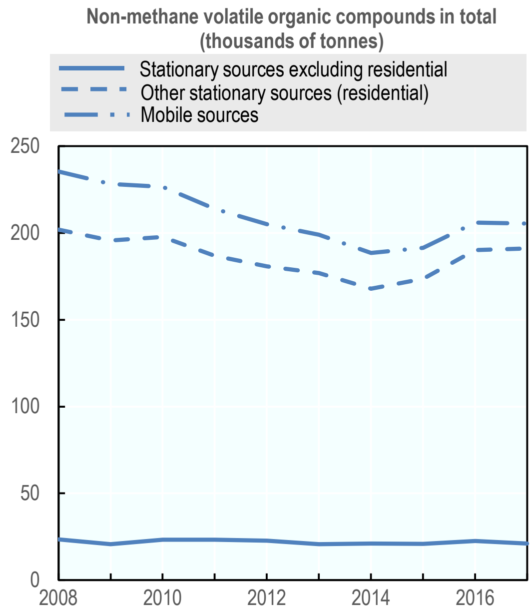


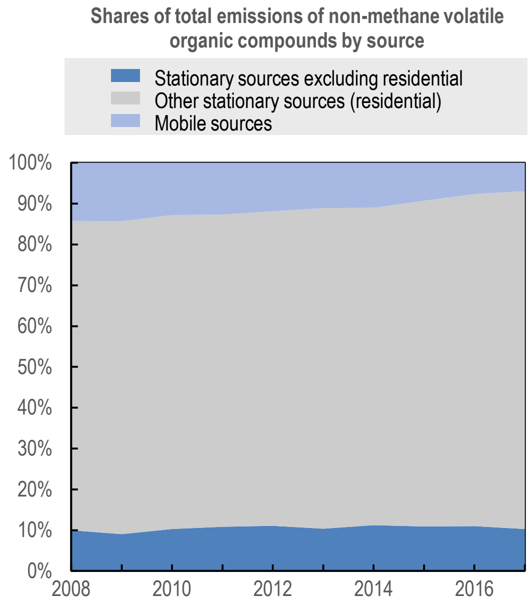




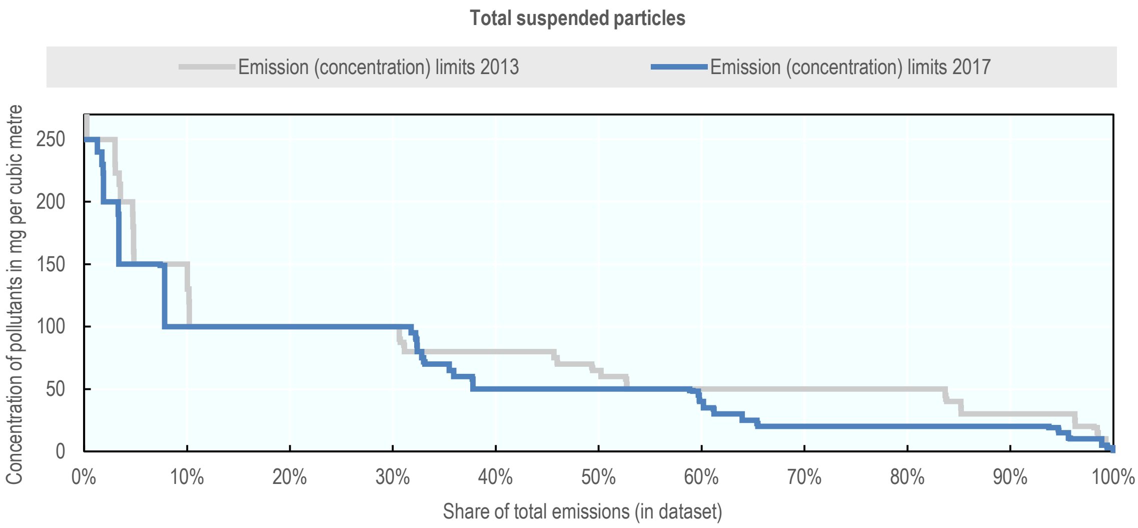

Nitrogen oxides in total
(thousands of tonnes)
Stationary sources excluding residential
Other stationary sources (residential)
Mobile sources
300
250
200
150
100
50
0
2008
2010
2012
2014
2016

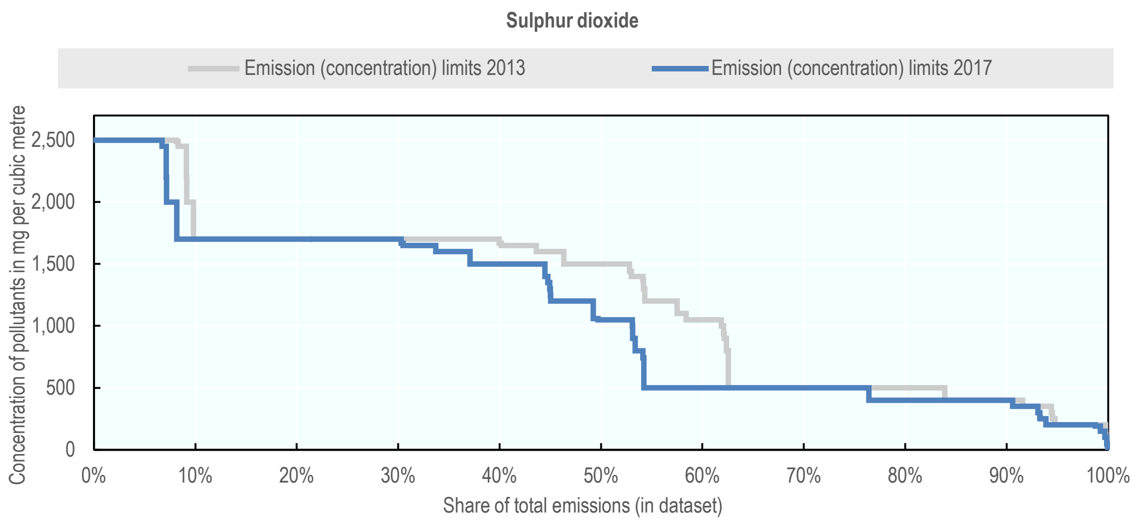

Shares of total emissions of nitrogen oxides by source
Stationary sources excluding residential
Other stationary sources (residential)
Mobile sources
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2010
2012
2014
2016

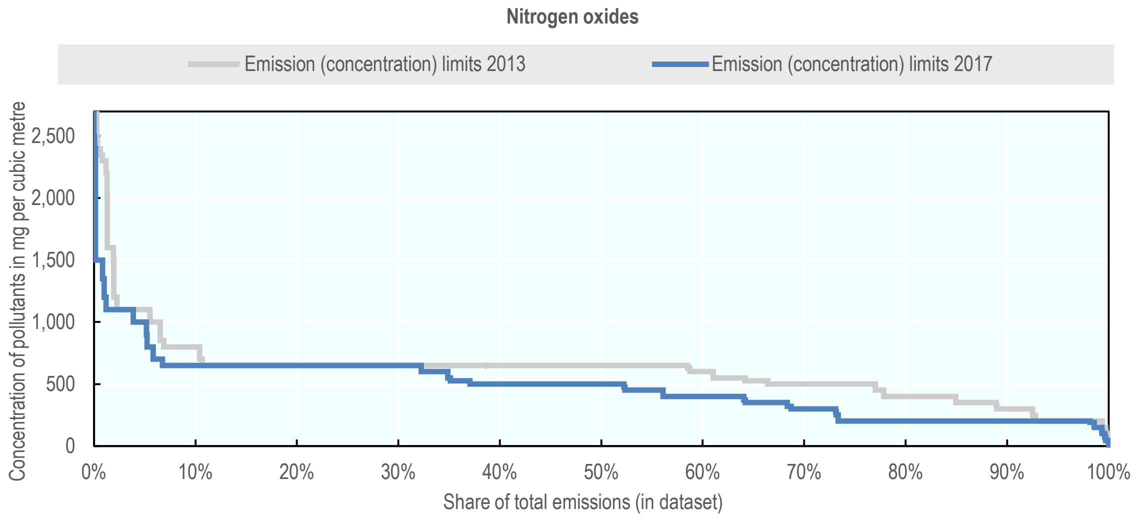

Non-methane volatile organic compounds in total
(thousands of tonnes)
Stationary sources excluding residential
Other stationary sources (residential)
Mobile sources
250
200
150
100
50
0
2008
2010
2012
2014
2016


Shares of total emissions of non-methane volatile organic compounds by source
Stationary sources excluding residential
Other stationary sources (residential)
Mobile sources
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2008
2010
2012
2014
2016

Annex B. Emission limits shift of TSPs, SO_2 and NO_x in 2013 and 2017

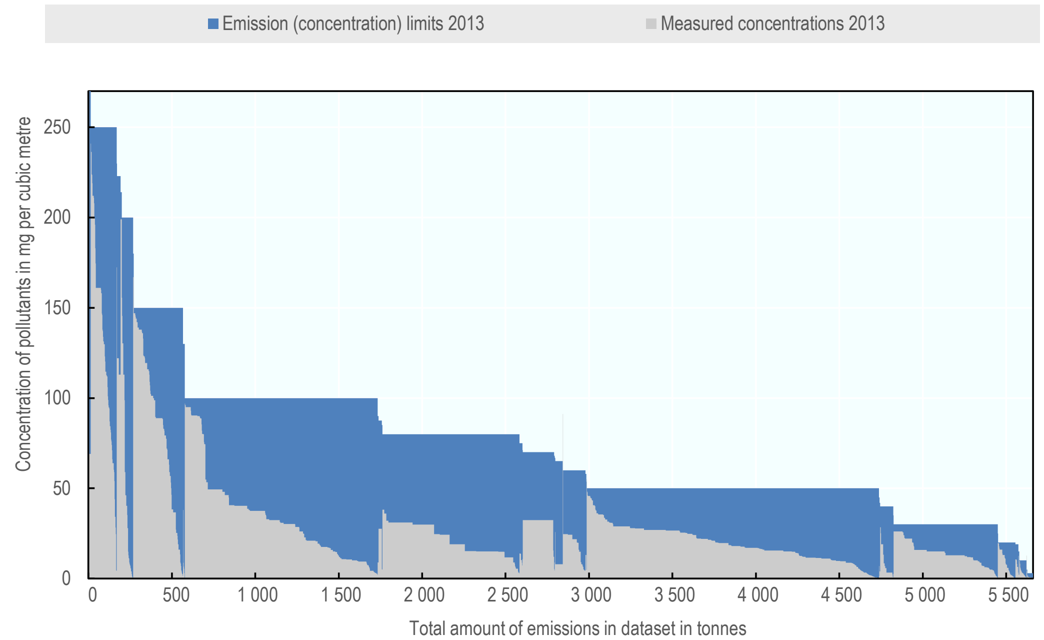




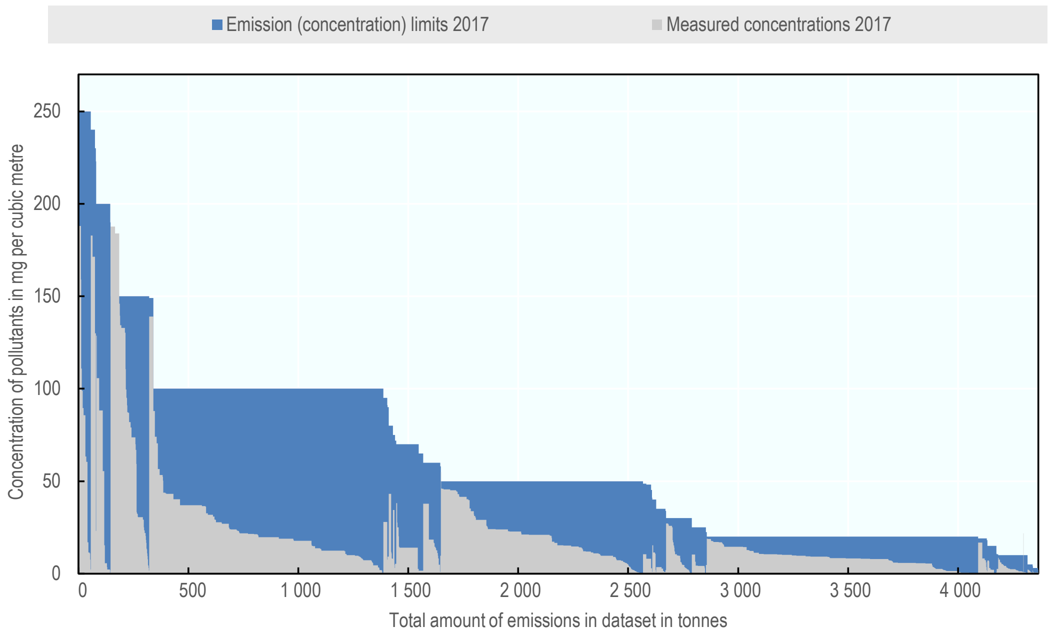

Nitrogen oxides
Emission (concentration) limits 2013
Emission (concentration) limits 2017
Concentration of pollutants in mg per cubic metre
2,500
2,000
1,500
1,000
500
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Share of total emissions (in dataset)

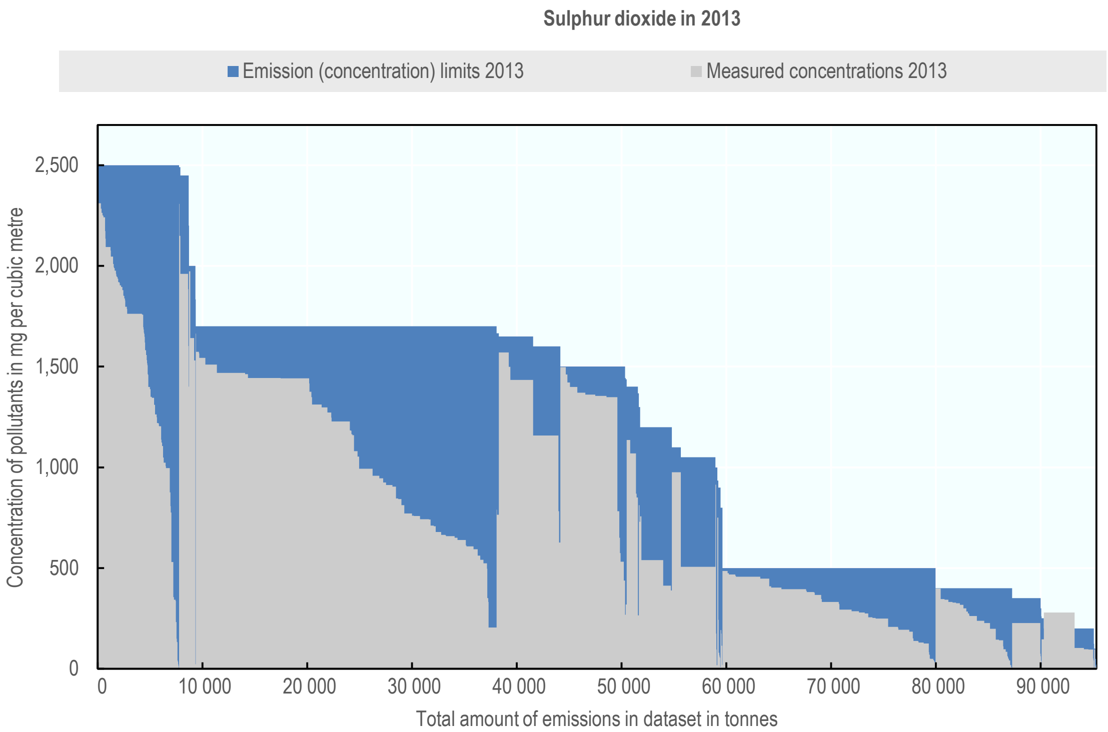
Annex C. Measured concentrations and emission limits of TSP, SO_2 and NO_x in 2013 and 2017

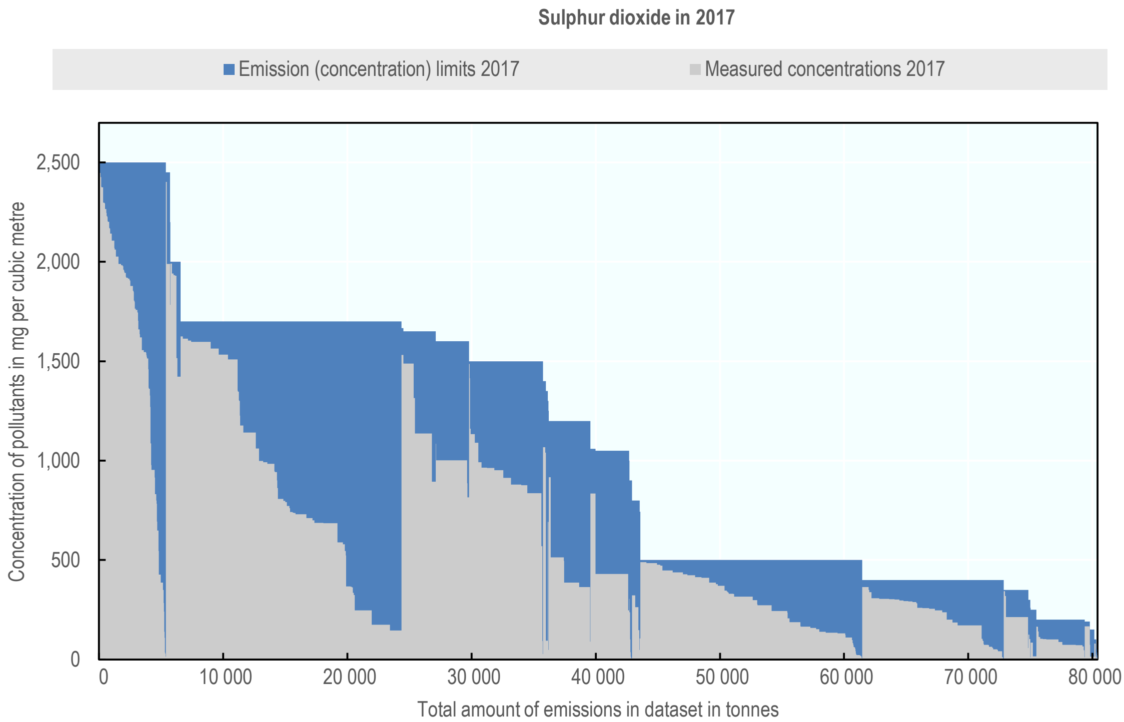
Total suspended particles in 2013



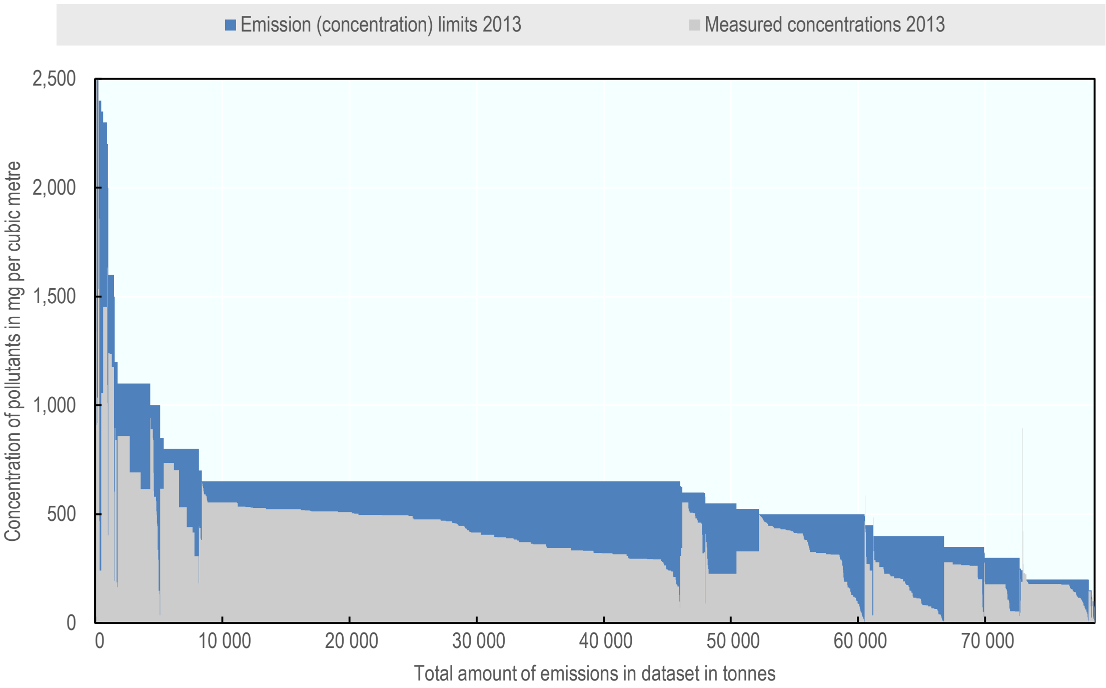
Total suspended particles in 2017




Sulphur dioxide in 2013
Emission (concentration) limits 2013
Measured concentrations 2013
Concentration of pollutants in mg per cubic metre
2,500
2,000
1,500
1,000
500
0
0
10 000
20 000
30 000
40 000
50 000
60 000
70 000
80 000
90 000
Total amount of emissions in dataset in tonnes


Sulphur dioxide in 2017
Emission (concentration) limits 2017
Measured concentrations 2017
Concentration of pollutants in mg per cubic metre
2,500
2,000
1,500
1,000
500
0
0
10 000
20 000
30 000
40 000
50 000
60 000
70 000
80 000
Total amount of emissions in dataset in tonnes

Nitrogen oxides in 2013



Nitrogen oxides in 2017