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# Adoption of NAMEA Air Emission Accounts in Hungary

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**Abstract**

The current phenomena of accelerating climate change and global warming has urged scientists and policy makers to devise a comprehensive and reliable system to identify the main causes and sources of the adverse processes. NAMEA (National Accounting Matrix including Environmental Accounts") developed by EUROSTAT has gained in popularity as it highlights the impacts of societal action on the environment by linking economic indicators to environmental material flows. The paper reports on the work done in the Hungarian Central Statistical Office to adopt and further develop the NAMEA system and demonstrates the crucial changes occurred in the emission of the major pollutants between 2000 and 2009 taking into consideration economic indicators.

**Keywords:** air pollution, NAMEA system, pollutants, environmental economic profiles.

**Rezumat. Adoptarea conturilor MCNCM pentru emisiile atmosferice in Ungaria**

Fenomenele actuale de accelerare a schimbărilor climatice și încălzirii globale au obligat oamenii de știință și autoritățile să conceapă un sistem cuprinzător și fiabil pentru identificarea principalelor cauze și surse ale acestor fenomene adverse. MCNCM (Matricea Contabilității Naționale cu Conturile de Mediu) elaborată de EUROSTAT a devenit tot mai populară, întrucât pune accentul pe impactul activității societății asupra mediului, legând indicatorii economici de fluxurile de mediu. Articolul prezintă rezultatele activității desfășurate în cadrul Oficiului Central de Statistică din Ungaria pentru adoptarea și dezvoltarea continuă a sistemului MCNCM și demonstrează schimbările cruciale care s-au produs în emisiile unor poluanți majori între 2000 și 2009, având în vedere și indicatorii economici.

**Cuvinte-cheie:** *poluarea aerului, sistemul MCNCM, poluanți, profile economice de mediu*

## Introduction

The most important task of environmental policy nowadays is to mitigate the adverse effects of climate change (Hardy, 2003). Since air pollution considerably contributes to the unfavourable process of climate change, it is crucial to be dealt with (OECD, 1995). In order to succeed in tackling air pollution, emissions need to be assigned to economic sectors, helping the elaboration and implementation of environmental policies (Rácz, 1999).

National Accounting Matrix including Environmental Accounts (NAMEA) is used to highlight the impact of the society on the environment. Developed by EUROSTAT, the NAMEA system builds on national accounts to give detailed insight into the performance of each economic sector and the harmful effects of production and service provision. NAMEA is a complex model containing data of numerous environmental domains (air, water, waste, etc.), which are compared with economic parameters.

The European Strategy for Environmental Accounting (ESEA) regards Air Emissions Accounts as a core module of Environmental Accounts. Air Emissions Accounts record and present data on air emissions in a way that they are compatible with traditional economic statistics. They record emissions in a breakdown by emitting industries and private households activities as delineated in National Accounts. Air Emissions Accounts are linked to the framework of Supply, Use and Input-Output Tables enabling numerous analytical applications. Such kind of integrated environmental-economic analyses are in high demand in the wider policy area of sustainable development (e.g. Lisbon Strategy, EU Sustainable Development Strategy, Global Climate Change, EU policies on Sustainable Consumption and Production etc.).

Beforehand, the HCSO had data on the most common air pollutants – 3 greenhouse gases ($CO_2$, $CH_4$, $N_2O$) and 3 acidifying substances ($SO_2$, $NH_3$, $NO_X$) and non-methane volatile organic compounds (NMVOC) –, covering 5 years (2000-2004). Data were combined with economic variables based on a simplified version of industry classification.

The main aim of the project was to further study the methodology of the compilation of the new NAMEA air tables, and assess the changes occurred in the emission of the major pollutants.

The objectives of our work were as follows:

- implementation of a complex, relevant, maintainable system of the air emission part of NAMEA at the Hungarian Central Statistical Office,
- compilation of national economies' emissions in a breakdown by emitting economic activities for Hungary in time series from 2000 to the latest possible year (2009),
- analysis of the results.

## Methodological background

In December 1994, the European Commission submitted a report - 'Guidelines of the European Union concerning environmental indicators and 'green' accounting: the integration of environmental and economic systems' - to the European Council and the European Parliament to describe the relationship between the economic and social system on the one hand, and the economic system and the environment on the other hand. In autumn 1996, the EUROSTAT and the national statistical offices of most Member States agreed upon projects on the production of NAMEA tables (National Accounting Matrix including Environmental Accounts).

The basic idea of NAMEA is to merge economic and environmental data in a consistent way, so it allows for direct comparison of parameters from both ranges on a sectoral level. The core of the framework is a set of tables of economic data and to form a national accounting matrix (NAM) as compiled in national accounts. The environmental accounts (EA) comprises tables containing data in physical units (mass, volume or energy units). The presentation of the data is based on the classification of economic activities, i.e. on NACE (Nomenclature générale des activités économiques dans les Communautés Européennes) Rev. 1 including private households. Thus, the economic performance (e.g. gross value added, persons employed) can be linked to the resources used for production or to the emissions generated (e.g. air pollutants, waste, waste water) in a given year.

This perspective can be used for scientific analysis and to assessment policy measures by comparing the sectoral performance either over time or across countries and the distance from emission reduction targets can also be determined. NAMEA helps to identify the sources of air pollution, too. This system allows an analysis of the performance of an industry where the emissions are normalised by the size of the economy. If a particular industry exhibits a development (e.g. measured as $CO_2$ emissions per million € output) that diverges from its past performance or from the average of the EU average, the reasons for the differences need to be investigated. The variations can be due to heterogeneous industry classifications, structural differences or technological changes.

The major advantage of the NAMEA Air Emission Accounts is the possibility to interlink data on air emissions with macroeconomic or even social data. That means a coherent set of environmental, social and economic indicators can be derived with a high degree of international comparability of the results and all indicators are closely linked to one another. This is a key basis for integrated economic and environmental analysis and modelling, including cost-effectiveness analyses, scenario modelling and economic and environmental forecasts. This integrated framework allows sectoral policies and indicators to be a part in a comprehensive economic, social, and environmental context.

In 2000, a set of NAMEA for air emissions standard tables was prepared by EUROSTAT and was finalised at the fourth NAMEA workshop. These tables focusing on air emissions also covered some economic data, but they were not to be reported in a matrix format. The standard tables were revised in 2002 in order to improve the comparability of data between countries as well as with other air emission statistics. Meanwhile all Member States have become involved in the compilation of air emission accounts for NAMEA. Some produce and publish NAMEA data on an annual basis, for other EU countries the compilation

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is still at the stage of pilot applications. In 2005 EUROSTAT published the "NAMEA for Air Emissions - Compilation Guide" and in 2009 „The Manual for Air Emissions Accounts". The guides introduce the basic principles that apply in the NAMEA framework in general and provide an in-depth presentation of the methods on which the two main approaches used by EU countries in the compilation of air emission accounts are based.

Regarding the history of compilation of NAMEA in Hungary it is necessary to mention the 2-year bilateral co-operation established between the Dutch and Hungarian statistical offices (CBS-HCSO) in 2003 and the NAMEA grant project in 2005. The main result of the previous projects in Hungary was the compilation of the air emission part of the NAMEA tables for the years 2000 and 2004, thus completing a short time series and creating a draft version of the NAMEA Air Emission Accounts with a detailed table consisting of all required economic variables and air pollutants. We can highlight that at the present stage the Hungarian NAMEA follows a so called "light version" with respect to the combination of emissions and economic data following the NACE classification of economic sectors.

## Principal structure of the calculation

For calculating emissions, the residence principle has to be taken into account. The concept of residence in National Accounts is not based on national or legal criteria. An institutional unit is said to be a residence unit of a country when it has a centre of economic interest in the economic territory of a country.

Consequently, emissions stemming from the economic activities of resident units have to be accounted for rather than those stemming from sources on the national territory. Conversely, all emissions by non-resident entities on national territory (foreign lorries and tourists) have to be excluded. In short, Air Emission Accounts record emissions arising from all resident unit's activities, regardless from where these emissions actually occur geographically.

## Methods for calculation of air emissions

In general, the Air Emission Accounts belong to the block of physical supply of residuals. Air emission in EUROSTAT's Air Emission Accounts relate to those physical net flows of gaseous or particulate matters that origin in the economic system and are released into the atmosphere and remain suspended in the air for substantial time.

For compiling Air Emission Accounts, two main compilation approaches can be distinguished (Eurostat, 2009). The "inventory-first approach" starts from existing national emission inventories, which are compiled to report to international agreements on emissions of air pollutants and greenhouse gases, and re-arranges those data to a format compatible with National Accounts.

The "energy-first-approach", what our system was also based on, starts from energy statistics which are re-arranged to Energy accounts from which air emissions are calculated using certain emission factors.

Regardless of the compilation approach applied, there are two steps required when compiling Air Emissions Accounts. These two generic compilation steps are as follows:

- Adjusting the system boundaries to correspond with those of National Accounts (geographic versus economic system definition), and
- Assigning the environmental data to economic activities (industries and households) actually inducing respective energy uses and/or air emissions.

Irrespective of the starting point, allocating data to economic activities requires the use of auxiliary data to help distribute the figures from one classification system to another. Generally one attempts to find a relationship between the two categories that is as close as possible to the data to be distributed. If nothing specific can be found then employment or production output is used as a last resort.

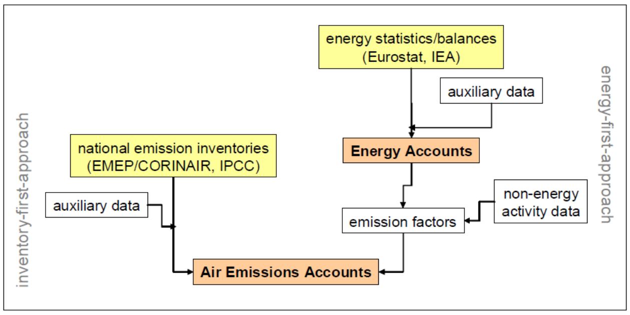


**Fig. 1: Schematic overview on two generic compilation approaches for Air Emissions Accounts**
*Source: Eurostat 2009*

 

The first step of the "energy-first approach" is to adjust the system boundaries from geographic to economic to meet the requirements of the residence principle. Second, the energy use needs to be assigned to industries and household based on NACE classification. Finally, emissions are calculated for each industry and households separately using industry and technology specific emission factors for each energy carrier. In order to develop comprehensive air emission inventories, accordingly, Air Emissions Accounts, it is crucial to add emissions from other sources to energy related emissions. These include industrial processes, solvent and other volatile organic product use, agriculture (number and types of animals and manure management information) and waste (treatment and incineration also).

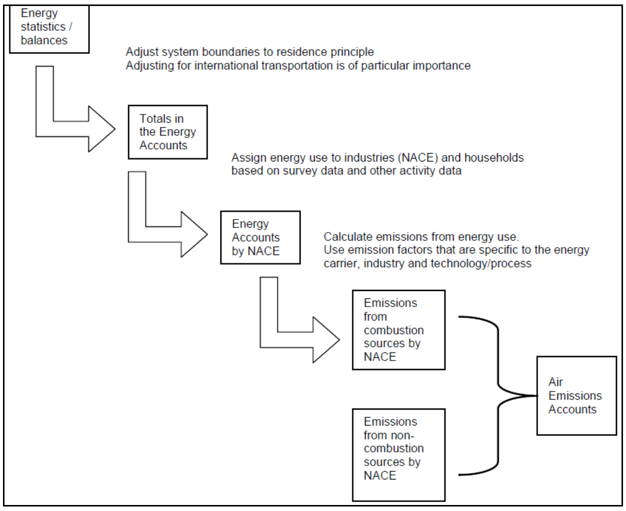


**Fig. 2: Schematic flow chart on energy approach of Air Emission Accounts**

*Source: Eurostat 2009*

Figure 2 shows the structure of calculation paying particular attention to the combustion and non-combustion sources of emissions and emission factors. Regarding methodological aspects, an important result of this project is that our system building will be based entirely on EUROSTAT's methodology taking into account local circumstances. The NAMEA was compiled according to the EUROSTAT (2009) guide. Consequently, accounts are complete and coherent with the guide.

For calculating air emissions for NAMEA the following points are to be taken into consideration:

- Measuring: the most reliable origin of data,
- Expert advice to take notice of the local specialities (factors);
- Calculation on the basis of material balances;
- Comparative calculations, analogy;
- Calculations on the basis of emission factors with the help of air emissions inventory experts;
- Entire consistency of EUROSTAT methodology on the score of Manual for Air Emissions accounts;
- Legal compliance: the best possible correspondence with proposal for a "Regulation of the European Parliament and of the Council on European environmental economic accounts (preparation of bridge tables, etc.).

When calculating emissions five essential requirements are to be met:

- Completeness: examination has to cover all available data sources;
- Consistency: calculation has to be made according to equal aspects ensuring comparability;
- Transparency: calculation process has to be understandable for everyone;
- Accuracy: results have to converge to real values as much as possible.
- Continuity: the results must be produced each year.

## Summary of actions

One of the goals of the project was to identify those modules which may have the best bases for development and implementation on a regular basis. The priorities are driven by already available know-how, data as well as financial and human resources.

The main methodological development of the project is the detailed allocation of sectors to NACE categories (2 digits) and assuring consistency with economic data from the system of National Accounts (regarding especially the disaggregation of manufacturing).

Data had been collected from the different available sources between 2000 and 2008).The new version of the Hungarian NAMEA system is now in accordance with EUROSTAT requirements. Thus, the analysis covers:

- $CO_2$, Biomass $CO_2$, $N_2O$, $CH_4$,
- HFC, PFC, $SF_6$,
- $SO_X$, $NO_X$, $NH_3$ and
- NMVOC, CO, PM10.

Air emissions originated from the consumption of fossil fuels, anthropogenic activities and different technological processes (NACE 2 digit level).

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Emissions originated from so-called pyrogenic processes (combustion of fossil fuels) and from anthropogenic (but not pyrogenic) activities have been calculated separately.

Concerning calculation of emissions originated from combustion processes, aggregation has been made according to the detailed energy statistics on use of fossil fuels.

## Results, sustainability

In the followings the main results will be demonstrated. A brief dataset will be presented and explanation will be given on the trends of the most important air emissions– greenhouse gases, acidifying substances and ozone precursors – of ten years (2000-2009). Data are combined with economic variables according to the industry classification of NACE from tables of chapter six.

### Emission of greenhouse gases

Greenhouse gases are gases in the atmosphere that absorb and emit radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. Primary greenhouse gases in the Earth's atmosphere include carbon-dioxide, methane and nitrous oxide. The Global Warming Potential (GWP) of the individual gases varies. (In a time horizon of 100 years for $CO_2$=1, for $CH_4$=21 and $N_2O$=310. It means that in a 100 year's time 1 tonnes of methane cause as much warming as 21 tonnes of carbon dioxide.) Thus, it enables scientists and policy makers to compare the indicators of greenhouse gas emissions expressed in GWP.

The most polluting industry in Hungary in terms of emission of greenhouse gases is the electricity, gas, and water supply, which represents around 30-32% of the total emission, although its size and proportion is solidly decreasing (Fig. 3). The agriculture, hunting, forestry as well as manufacturing are responsible for one-fifth of the emissions, while the share of transport, storage and communication industry continued to grow from 9.7% in 2000 to 16.7% in 2009.

Figure 4 shows that carbon dioxide ($CO_2$) is the most important greenhouse gas in Hungary and its rate decreases less rapidly than that of nitrous oxide ($N_2O$) and methane ($CH_4$).

In Hungary, 81-82% of emissions of greenhouse gases directly stem from economic activity, the rest originates in household consumptions.

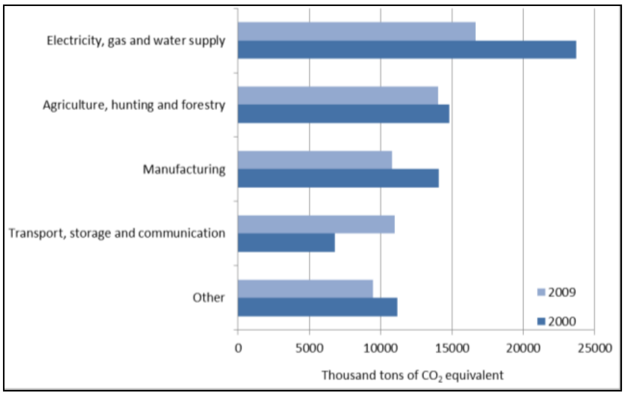


**Fig. 3: The structure of emissions of aggregated greenhouse gases from the Hungarian economy by industries**

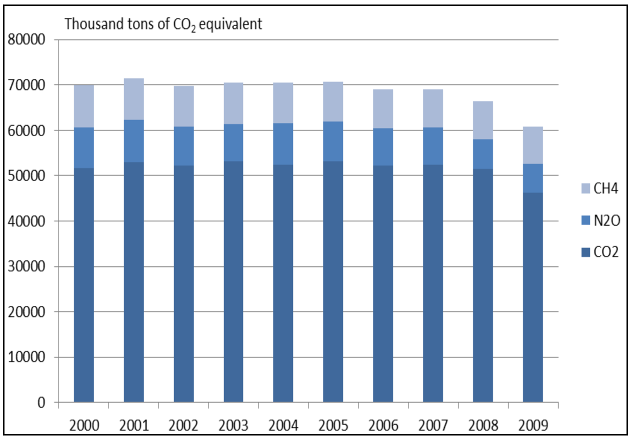


**Fig. 4: The distribution of emissions of greenhouse gases from the Hungarian economy**

### Emission of acidifying substances

Sulphur oxides ($SO_x$), nitrogen oxide ($NO_x$) and ammonia ($NH_3$) are examples of acidifying substances emitted into the air. Emissions from stationary and mobile sources have adverse impacts on the air quality, especially in cities. $SO_x$, $NO_x$ and $NH_3$ lead to acid rain and changes in the chemical composition of soil and surface water after deposition. In addition, they place great pressure on flora and fauna. Acidification has harmful effects on the biological ecosystems, forests, surface water, water supply systems, buildings and monuments.

Eutrophication of aquifers, lakes and watercourses results in excess growth of algae.

In the Hungarian economy the aggregate value of acidifying substances sank from 688 thousand tons of $SO_2$-equivalent in 2000 drastically to 287 thousand tons in 2009. The reason of this decline is the sweeping technological changes in the electricity, gas, steam and water supply branch (Fig. 5).

Besides the quantity of acidifying gases, a significant rearrangement occurred also in the proportions of the ingredients (Fig. 6). The sulphur oxides emission decreased to about one-tenths of total, so the direct emissions of ammonia and nitrogen oxide have become dominant in the examined time interval.

An increasingly significant proportion of total emissions of acidifying substances is being caused by households in Hungary. This rate doubled between 2000 and 2009. In 2009 it amounted to 17% of total acidifying substances emission. The amount of emissions from households also fell during the examined years, but not as rapidly as in the case of industry. The reason for this trend is that technological changes in the households are not as substantial as in the industry.

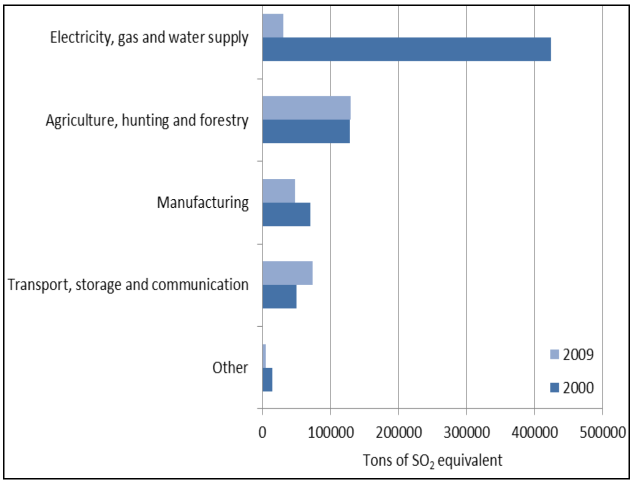


**Fig. 5: The structure of emissions of aggregated acidifying substances from the Hungarian economy by industries**

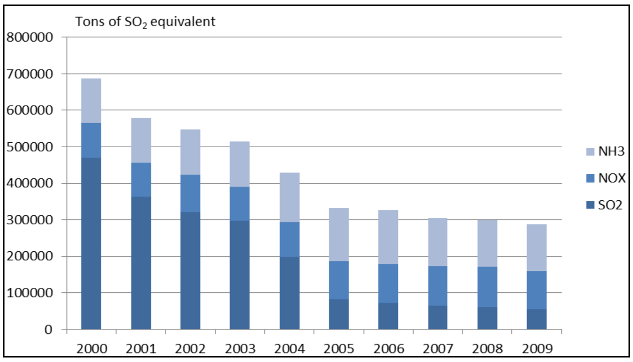


**Fig. 6: The distribution of emissions of acidifying substances from the Hungarian economy**

**Emission of ozone precursors**

Tropospheric ozone nearby the Earth surface is in connection with transboundary environmental issue. The ground-level ozone is not emitted directly into the air, but is created by chemical reactions between nitrogen oxides ($NO_x$), carbon-monoxide (CO) and volatile organic compounds (VOC) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapours, and chemical solvents are some of the major sources of $NO_x$ and VOC. At ground level ozone is a harmful pollutant.

The emissions of ozone precursors grew slowly from 2000 (337 thousand tons of NMVOC-equivalent) until 2008 (351 thousand tons), then fell back to 321 thousand tons in 2009. While the majority of economic sectors reduced the emission of precursors, in the most polluting industry, namely the transportation, storage and telecommunication, it increased by 15-16% (Fig. 7).

Figure 8 illustrates that among ozone precursors, the non-methane organic compounds and nitrogen oxides are the most significant. In 2009, the manufacturing industry was responsible for more than two third of NMVOC emissions from Hungarian economy.

The Hungarian economy accounts for less than four-fifths of total ozone precursor emission, while households amount to more than 20%. This means that households' emission is the highest in the case of ozone precursors among the three groups of contaminants scrutinized (greenhouse gases, acidifying substances and ozone precursors).

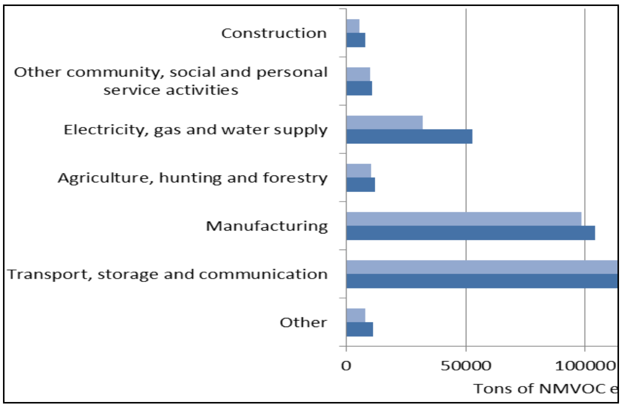


**Fig. 7: The structure of emissions of aggregated ozone precursors from the Hungarian economy by industries**

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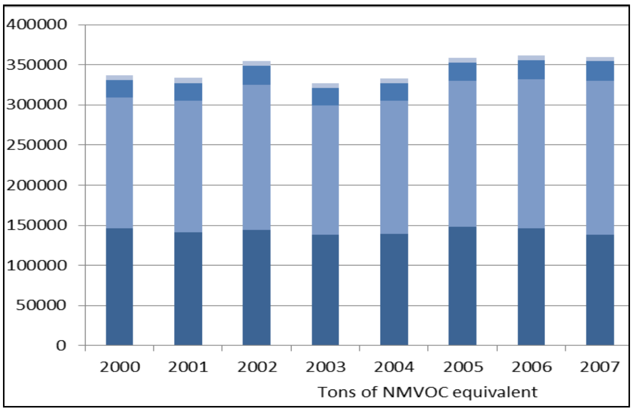


**Fig. 8: The distribution of emissions of ozone precursors from the Hungarian economy**

**Environmental – economic profile by main industries**

Air emissions accounts present air emissions by industries which are the same as shown in the National Accounts. This offers the possibility to compare several air emissions with economic parameters, hereby providing the base for conducting a deep analysis on a certain industry's emission. In so called environmental – economic profiles, both parameters can be demonstrated jointly for selected single industries. Those profiles show the share of a particular industry out of industry's total for a number of parameters such as greenhouse gas emissions, emissions of acidifying substances and ozone precursors, gross value added and the number of people employed.

In the case of direct emission of greenhouse gases, the electricity, gas, and water supply was the major emitting economic sector in Hungary (Fig. 11). However, taking into account emission per gross output, the industry with its 7.8 tons of $CO_2$-equivalent barely reaches 60% of mining and quarrying (12.3 tons of $CO_2$) in 2008. The difference is even greater if we consider the emission per employment. In the mining industry it equals to 262 tons of $CO_2$-equivalent of greenhouse gas emission, in the agriculture, hunting, forestry and fishing industry to 93 tons, in the transport storage and communication sector to 30 tons, while in the electricity, gas and water supply "only" 29 tons.

In the case of acidifying gases the most significant change occurred in the electricity, gas and water supply industry, where due to stricter regulations more efficient filters were installed, reducing the emission of acidifying substances considerably (Fig. 11). This change led to the increase in the share of other industries' acidifying gas emissions.

For the emission of ozone precursors, the share of different sectors did not change significantly between 2000 and 2008. Transport, storage and communication sector still have the highest share (45%, illustrated in Fig. 12), followed by the manufacturing industry (nearly 35%, shown in Fig. 10).

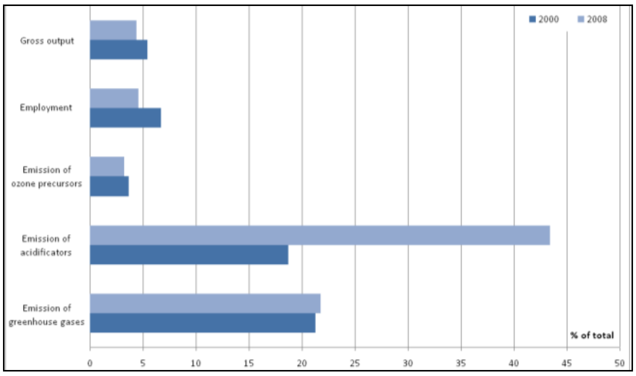


**Fig. 9: The environmental – economic profile by agriculture, hunting, forestry and fishing industry**

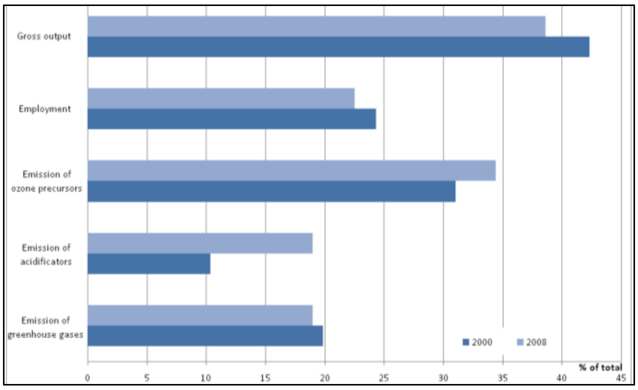


**Fig. 10: The environmental – economic profile by manufacturing industry**

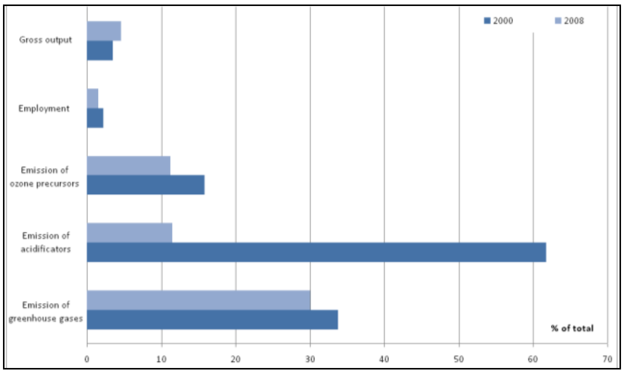


**Fig. 11: The environmental – economic profile by electricity, gas and water supply industry**

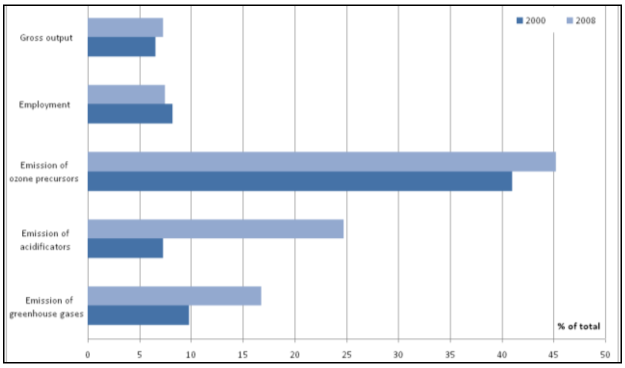


**Fig. 12: The environmental – economic profile by transport, storage and communication industry**

What is favourable with respect to the future and sustainability is that the emitted quantity of the examined contaminants decreased in all three groups. Greenhouse gas emission fell by 50% between 2000 and 2008. The emission of acidifying gases per gross output (calculated at current prices) also saw a drop of approximately 18kg, from 23.4 kg to 5.3kg in the same period, meaning that the production of goods and service entails less damage to the environment. For the ozone precursors, emission per gross output - expressed in NMVOC equivalent - sank from 11.5kg to 6.2kg.

## Conclusion

By meeting EU requirements and successfully adopting the different, harmonised statistical method, a sustainable system that can provide long term assistance in compiling NAMEA air accounts year by year was established.

On the one hand, the project provided expertise and training to have a deeper insight into the compilation of environmental accounts. On the other hand, it helped standardize the procedures for the regular production of environmental accounts. As a long term objective of our work, the system can serve as a comprehensive analysing tool for policy making processes.

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