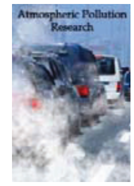
*Atmospheric Pollution Research 6 (2015) 129-137*

Critical Literature Review

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# Air quality policy in the U.S. and the EU – a review

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## ABSTRACT

The high level of atmospheric pollution is a global problem that has taken on particular significance in recent years and will continue to grow in the near future. Air pollution directly affects the health, living organisms, vegetation, water, soil and buildings. Additionally, it moves easily even over long distances. Certain air pollutants influence the climate, cause negative processes in the protective ozone layer and contribute to the greenhouse effect. Therefore it is important to protect the air by taking actions to ensure its best possible quality. In this paper, the development of air quality policies in the United States of America and European Union was analyzed and it was shown how these legislations were implemented and also the air quality policies in these states were compared. Although the U.S. and EU have achieved significant improvements in air quality, the area of air quality management in both regions still requires a more integrated and ambitious approach.

**Keywords:** *Air quality policy, air management, air protection, air pollutants*

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***Article History:***

*Received: 14 March 2014*

*Revised: 03 August 2014*

*Accepted: 04 August 2014*

**doi:**10.5094/APR.2015.015

## 1. Introduction

It has become increasingly evident in recent years that activities aimed at improving the living conditions of the ever–growing population, causing the global economy to grow intensively, are degrading ever–larger swathes of the natural environment. Increasing air pollution adversely affects the environment, destroys ecosystems, disrupts photosynthesis, causes climate change, impoverishes biodiversity, and reduces crop harvests as a result of soil acidification (Paoletti et al., 2010). Deteriorating environmental quality is a serious threat to human health. For years now, we have been observing growing numbers of cases of respiratory diseases (asthma, bronchitis, pneumonia) (Sunyer et al., 1993; Svartengren et al., 2000; Afroz et al., 2003), various types of allergies, circulatory problems (Brunekreef and Holgate, 2002), disturbances of the central nervous system (sleeplessness, headaches), and a greater incidence of cancer (Afroz et al., 2003; Sokhi et al., 2008; Lv et al., 2011) and even higher mortality (especially in the elderly and in children) (Anderson, 2009). The pathologies associated with environmental pollution are not restricted to the respiratory system, blood circulation or the occurrence of particular carcinomas: they also give rise to other chronic diseases, such as immunological deficiencies, neurological and neurodegenerative diseases, reproductive problems and a malfunctioning hormonal system (Kampa and Castanas, 2008).

Air quality improvement is a major task of environmental conservation institutions, as it affects all aspects of nature, including humans. Figure 1 illustrates how air pollution affects other elements of environments.

The aim of air quality legislation is to ensure the best possible quality of the air. This can be achieved by (GD, 2001):

- ensuring that concentrations of substances for which there is a maximum permitted level (MPL) in the air remain at those levels or preferably below them;
- reducing excessive levels of substances in the air to their MPLs.

The management of air quality can only be effective if the state of the air is monitored. This is a source of information on the current state of the air–in diagnostic form. Monitoring provides data on the chemical composition or degree of contamination of the air over an area. Air quality monitoring also allows for assessing the effectiveness of environmental policies and the effects of protective actions.

In recent years it has been observed that air pollution is a global problem. However, air quality policy is not the same in every country/region. Rich countries are introducing more stringent standards and advanced strategies to reduce air pollution. Whereas, developing countries such as China and India, which now suffer from serious air pollution, are beginning to build their environmental management systems. Probably these countries will benefit from existing standards and the experience of the leaders – the U.S. and EU. Therefore, the aim of this study was to compare the air quality of the U.S. and the EU. Both regions have long–standing experience in the management of air quality and have a similar economic and technological status. Despite these similarities, these two regions have different approaches to the protection of the environment.

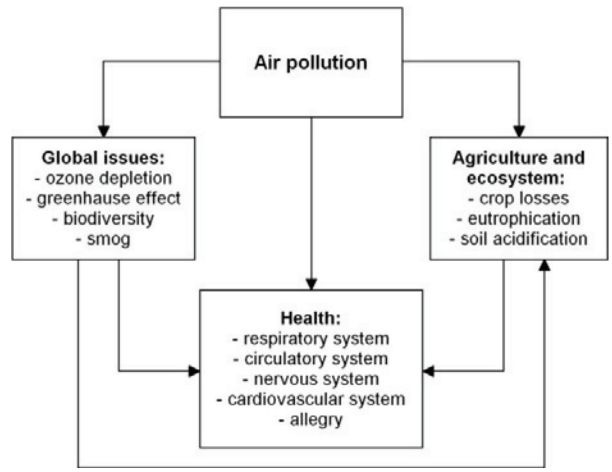


***Figure 1***. *The effects of air pollution on humans and the environment.*

## 2. The Most Important International Air Quality Legislation

The dynamic economic growth of the last century led to a drastic increase in pollutant emissions to the air. Weather conditions and serious air pollution gave rise to human health problems in many places. In 1968, experts from the World Meteorological Organization drew up a program for monitoring the levels of certain air pollutants over time. This initiative formed the basis for the first global *Background Air Pollution Monitoring Network*, which supplied information on the influence of pollutants on the climate (Kohler, 1988). In the second half of the 1970s, the problems of conserving air quality became a leading topic of international discussion. The Final Act of the OSCE (Organization for Security and Co–operation in Europe) Conference in Helsinki in 1975 stressed the transboundary nature of air pollution and the consequent need for close cooperation among states to conserve air quality. The problem of air pollution began to be seen as a cross–border. It was observed that pollutants emitted from one country can be transmitted over long distances and cause adverse effects in other countries. In 1979, the Convention on Long–Range Transboundary Air Pollution (LRTAP) was signed. Its main purpose was to protect people and the environment from air pollution transmitted over long distances by reducing emissions and pollution prevention (CLRTAP, 1979). In 1987, one of the most important documents regarding air quality conservation was issued, namely, the Montreal Protocol on Substances that Deplete the Ozone Layer (Sarma et al., 2000). This document showed that the world was not merely observing climate changes caused by environmental pollution, but that it was also taking action to limit them. In 1992, the Climate Convention (UNFCCC) was signed during the "Earth Summit" in Rio de Janeiro. It came into force two years later, having been ratified by most of the states participating in the summit. The principal objective of UNFCCC was to stabilize:

- the amounts of greenhouse gases in the atmosphere at levels that would not cause significant changes to the climate;
- the gas emissions during such a period of time that ecosystems could adapt to climate change in a natural manner.

The steps taken to achieve these aims should not threaten food production, nor should they run contrary to the idea of sustainable development. Practically all of the United Nations member states have signed and ratified the UNFCCC (Schreiner, 2004). It turned out, however, that the resolutions adopted at the 1992 Climate Convention were insufficient to normalize the situation and arrest climate changes. New regulations had to be drawn up that would bring about a radical improvement in the state of the environment worldwide. As a consequence, a legal instrument imposing the obligation to protect air quality, the Kyoto Protocol, was approved in 1997. The Protocol obliged industrialized countries to reduce their emissions of greenhouse gases ($CO_2$, $N_2O$, $CH_4$, PFC, HFC, $SF_6$) in the years 2008–2012. The original plan was to reduce greenhouse gas emissions to at least 5% below the 1990 levels. In the end, it was agreed that emissions would be reduced by 8% in EU member states, by 7% in the U.S., by 6% in Japan, Canada, Poland and Hungary, and by 5% in Croatia. New Zealand, Russia and Ukraine were obliged to maintain their emissions of greenhouse gases at the same level as in the base year. Norway, Australia and Iceland could increase their emissions by 1%, 8% and 10%, respectively (Kyoto Protocol, 1998). China was not obliged to reduce greenhouse gas emissions, because it was considered a developing country at the time of signing the Kyoto Protocol. China was not regarded as the main culprit in $CO_2$ emissions.

Despite years of discussions, the participating states have not been able to come up with a uniform, coherent approach to air quality conservation. The Protocol was criticized by many countries for the method of calculating emissions. Countries, in particular, do not agree with the way of adding and subtracting emissions from granted additional actions caused by man.Consent to the adoption of the Protocol was uncertain, because the U.S. (the world's greatest emitter of greenhouse gases) categorically refused to ratify it. For the protocol to come into effect, it had to meet the principle of "2 times 55". That meant that the Protocol had to be ratified by at least 55 countries producing at least 55% of global $CO_2$emissions. After long negotiations between the EU and Russia, Russia agreed to ratify the Protocol. In February 2005, the Kyoto Protocol was ratified by 141 countries that produce together 61% of global greenhouse gas emissions. In December 2011, Canada became the first country to withdraw from the Protocol. Canada failed to reduce greenhouse gas emissions. Canada avoided the necessity of buying carbon credits from countries which succeeded (e.g. Poland). While China, which is now considered to be one of the biggest emitters of greenhouse gases in the world, has still not world, has still not ratified the Protocol. During the climate summit, which took place in 2013 in Warsaw, it was established that China may continue to emit excessive amounts of $CO_2$. In return, China pledged to transfer significant sums of money to "fight" global warming.

The international strategy of air protection is developing. It was found that global problems connected with air pollution are the result of specific actions taken by particular countries. The main objective of this study is to present information on various approaches to air quality protection, with particular focus on the methods employed in the EU and U.S. Table 1 lists the main legislation (in historical perspective) on air quality protection adopted in the EU and U.S.

## 3. Air Protection in the U.S. and EU

### 3.1. Developments in U.S. legislation

The U.S. has a long history of legislation on air protection and was a world leader in solving air pollution problems. The passing of the first act concerning air quality in the U.S. was prompted by an event in 1948. In that year, a cloud of pollutants (smog) hung over the industrial town of Donora in Pennsylvania for 5 days. That smog killed 20 people, and disease symptoms manifested themselves in more than 6 thousand others (Hamill, 2008; Hopey, 2008). In 1955, the U.S. Congress adopted federal air pollution legislation: the Air Pollution Control Act identified air pollution as a national problem. This legislation also envisaged funding for air pollution research. The upshot was the first Clean Air Act (CAA) eight years later (1963). The primary task of the CAA was to educate and to carry out studies with the aim of cleaning up polluted air. There was no mention, however, of any intention to reduce the level of pollutants in the air. In 1965, the CAA was amended by the Motor Vehicle Air Pollution Control Act, which laid down emission standards for light–duty motor vehicles (Kubiszewski, 2008). Two years later, the Air Quality Act (AQA) of 1967 was established. This Act required that states were responsible for establishing regional air quality standards based on federal air quality criteria and comprehensive plans for implementing these air quality standards according to the timetable. However, this law was not effective, therefore, the Congress recommended new legislation. In 1970, the Congress passed a new CAA. This Act set standards for six pollutants – sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, particulate matter and lead. In addition, the act laid down requirements regarding the implementation of air quality programs, and substantially expanded the enforcement of motor vehicle emission limits. In the same year, the Congress established the Environmental Protection Agency (EPA), whose task was to over-see the implementation of the standards set out in the Clean Air Act of 1970. Since many states failed to meet mandatory air quality standards, amendments were subsequently introduced to the CAA. In 1977, the regulations regarding the Prevention of Significant Deterioration (PSD) of air quality in areas attaining National Ambient Air Quality Standards (NAAQS) were altered to include requirements for areas not fulfilling the NAAQS (CAA, 1970; CAA, 2011). Further major amendments were made to the CAA in 1990: the new regulations rectified and expanded the act. The idea of emissions trading was mooted, and the EPA was granted greater powers with regard to the implementation and enforcement of the rules aimed at reducing pollutant emissions to the air. Further changes were made to the act with the aim of (CAA, 1990; EC, 2004):

- reducing the use of ozone–depleting substances;
- reducing emissions of substances causing acid deposition;
- limiting emissions of air pollutants from specific sources;
- limiting the sources of exposure to Hazardous Air Pollutants;
- protecting and improving visibility in national parks and wilderness areas;
- introducing more rigorous norms for motor vehicle pollutant emissions;
- using alternative fuels.

The 1990 amendment also addressed the reduction of sulfur dioxide emissions from power plants. There were two phases of the program. The First Phase targeted manufacturing plants with the highest emissions that were meant to be reduced by 1995. The Second Phase, introduced in 2000, targeted also smaller plants and called for stricter reductions from plants that were included in Phase I. It also allowed companies to bank their allowances or to trade them with other companies (Burtraw and Szambelan, 2009). In addition, the CAA prescribed a complicated set of responsi-bilities and relationships among federal, state and local agencies.

The Clean Air Act sets up air quality standards in the United States. Being a federal act, it applies throughout the country. Nonetheless, each state must write its own State Implementation Plan (SIP), containing information on how to monitor air pollution in that state. If the plan for reducing air pollution is in compliance with the EPA's requirements, it is approved; if not, the EPA may impose sanctions on the state in question.

***Table 1.****The main legislation on air protection adopted in the EU and U.S.*

| EU | U.S. |
|---|---|
| | **1955** Air Pollution Control Act |
| | **1963** Clean Air Act sets Nationwide Air Quality Standards |
| | **1965**Motor Vehicle Air Pollution Control Act |
| | **1967** Air Quality Act |
| | **1970** Clean Air Act Amendments of 1970 |
| | **1977** Clean Air Act Amendments of 1977 |
| **1980** Directive on air quality limit values and guide values for $SO_2$ and PM (80/779/EEC) | |
| **1982** Directive on limit values for lead in the air (82/884/EEC) | |
| **1985** Directive on air quality standards for $NO_2$ (85/203/EEC) | |
| **1988** Directive limiting emissions of certain pollutants into the air from large combustion plants (88/609/EEC) | |
| | **1990** Clean Air Act Amendments of 1990 (acid rain, ground level ozone, stratospheric $O_3$ depletion, air toxics) |
| **1992** Directive on air pollution by ozone (92/72/EEC) | |
| | **1995** $SO_2$ Cap and Trade system introduced (1$^{st}$ Phase) |
| **1996** Council Directive concerning integrated pollution prevention and control (96/61/EC) | |
| **1996** The Ambient Air Quality Assessment and Management Directive (96/62/EC) | |
| **1999** 1$^{st}$ Daughter Directive AQ limit for $SO_2$, $NO_2$, $NO_X$, PM and lead (1999/30/EC) | |
| **2000** 2$^{nd}$ Daughter Directive relating to CO and benzene (2000/69/EC) | **2000** 2$^{nd}$ phase of the $SO_2$ Cap and Trade scheme began |
| **2001** Directive on the limitation of emissions of certain pollutants into the air from large combustion plants (2001/80/EC) | |
| **2002** 3$^{rd}$ Daughter Directive relating to $O_3$ in ambient air (2002/3/EC) | |
| **2004** 4$^{th}$ Daughter Directive relating to As, Ni, PAH in ambient air (2004/107/EC) | |
| **2008** Directive of the European parliament and of the council on ambient air quality and cleaner air for Europe (2008/50/EC) | |

Motor vehicles are one of the main sources for urban air pollution. Therefore, the U.S. has also introduced standards for the emission of pollutants from motor vehicles. There are two standards for vehicle emissions. One emission standard was established by the Environmental Protection Agency (EPA) and the second, more stringent, by the California Air Resources Board (CARB). Other states may choose to follow either the Federal standard or the California standards. Table 2 shows information on the Federal emission standards and California emission standards for passenger cars.

***Table 2**. The U.S. emission standards for passenger cars (EPA, 2012b; DieselNet, 2013)*

| Emission Standard | Year Implemented | Emission Limits at 80 500 km | | | | | Emission Limits at 161 000 km | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CO (mg/km) | $NO_X$ (mg/km) | | HC (mg/km) | PM (mg/km) | CO (mg/km) | $NO_X$ (mg/km) | | HC (mg/km) | PM (mg/km) |
| | | | Petrol | Diesel | | | | Petrol | Diesel | | |
| Federal Emission Standards | | | | | | | | | | | |
| Tier 0 | 1987 | 2 112 | 620 | | 255 | | | | | | |
| Tier 1 | 1994–1999 | 2 112 | 250 | 620 | 155 NMHC | 50 | 2 600 | 373 | 780 | 193 NMHC | 62 |
| NLEV | 1999–2004 | 2 112 | 404 [a] | 920 [a] | 404 [a] | | 2 600 | 565 [a] | 1 290 [a] | 565 [a] | |
| Tier 2/Bin 9 | 2004–2010 | 2 112 | 124 | | 47/87 NMOG | | 2 174 | 155 | | 47/93 NMOG | 31 |
| Tier 3 | 2017–2025 | 870 | 99 | | 38/70 NMOG | | 1 740 | 124 | | 38/70 NMOG | 22 |
| California Emission Standards | | | | | | | | | | | |
| Tier 1 | 1994–1999 | 2 112 | 250 | 620 | 155 NMHC | 50 | 2 600 | 373 | 780 | 193 NMHC | 62 |
| LEV I | | | | | | | | | | | |
| TLEV | | 2 112 | 250 | 250 | 78 NMOG | | 2 600 | 565 | 565 | 97 NMOG | 50 [b] |
| LEV | 1999–2003 | 2 112 | 125 | 125 | 47 NMOG | | 2 600 | 187 | 187 | 56 NMOG | 50 |
| ULEV | | 1 056 | 125 | 125 | 25 NMOG | | 1 300 | 187 | 187 | 28 NMOG | 7 |
| LEV II | | | | | | | | | | | |
| LEV | | 2 112 | 31 | 31 | 47 NMOG | | 2 200 | 36 | 36 | 47 NMOG | 5 |
| ULEV | 2004–2010 | 1 056 | 31 | 31 | 25 NMOG | | 1 100 | 36 | 36 | 28 NMOG | 5 |
| SULEV | | | | | | | 520 | 10 | 10 | 5 NMOG | 2 |
| LEV III | | | | | | | | | | | |
| LEV160 | | | | | | | 1 740 | 66 [c] | 66 [c] | 1.7 HCHO | 4 |
| ULEV125 | | | | | | | 870 | 52 [c] | 52 [c] | 1.7 HCHO | 4 |
| ULEV70 | 2015–2025 | | | | | | 704 | 29 [c] | 29 [c] | 1.7 HCHO | 4 |
| ULEV50 | | | | | | | 704 | 21 [c] | 21 [c] | 1.7 HCHO | 4 |
| SULEV30 | | | | | | | 414 | 12 [c] | 12 [c] | 1.7 HCHO | 4 |
| SULEV20 | | | | | | | 414 | 8 [c] | 8 [c] | 1.7 HCHO | 4 |

*HCHO–Formaldehyde, NMHC–Non–methane hydrocarbons, NMOG–Non–methane organic gases, NLEV–National low emission vehicles, TLEV–Transitional low emission vehicles, LEV–Low emission vehicles, ULEV–Ultra low emission vehicles, SULEV–Super ultra low emission vehicles*

[a] *NMHC+$NO_X$*

[b] *PM standards applied to diesel vehicles only*

[c] *NMOG+$NO_X$*

One of the major pollutants emitted by cars is particulate matter. The engines primarily emit particulate matter with a diameter less than 2.5 micrometers ($PM_{2.5}$). $PM_{2.5}$isdangerous, because may result in serious health effects (Zanobetti et al., 2014). Both EPA and CARB regulate particulate matter emission standards, including $PM_{2.5}$. The diesel vehicles emit much more particulate matter than the gasoline vehicles (Rickeard et al., 1996), so the Federal and California requirements relate primarily to diesel engines. In the Tier 3 program, the U.S. EPA has committed to reduce particulate matter emissions from passenger cars from 31 mg/km to 22 mg/km. California's Low Emission Vehicles III (LEV III) regulations have introduced more stringent emission standards. Particulate matter emission limits for passenger cars should not exceed 4 mg/km. These standards are for vehicles with a useful life to 161 000 km.

### 3.2. Developments of air quality management legislation in the EU

In Europe, the leader of air quality management systems implementation was the United Kingdom, which in 1906 introduced the Alkali Works Regulations Act. Some years later, air protection came to be seen not just as a local, regional or national problem, but as a supranational (creation of the EU).

EU law has been regulating air quality management for the last 30 years and it embraces some 300 legal instruments, such as directives, orders, decisions and recommendations. *The oldest piece of legislation in the field of air protection, developed within the European Union, is the Convention on Long–range Transboundary Air Pollution. It was signed in Geneva in 1979. The LRTAP Convention and its subsequent protocols concern the limitation of emissions of the following groups of pollutants:* sulfur compounds ($SO_2$), nitrogen oxides ($NO_X$), ammonia ($NH_3$), volatile organic compounds (VOCs), heavy metals (Cd, Pb, Hg), persistent organic pollutants (POPs) and particulate matter ($PM_{10}$, $PM_{2,5}$). It primarily focused on the pollutants that cause acidification, eutrophication and the occurrence of ground–level ozone (CLRTAP, 1979).The directive regarding the limitation of $SO_2$ levels and the numbers of suspended particles in air came into force in 1980 (Directive 80/779/EEC, 1980). Subsequent years saw the issue of directives stipulating permissible levels of lead (Directive 82/884/EEC, 1982) and nitrogen dioxide (Directive 85/203/EEC, 1985) in the air. Regulations on emissions of industrial pollutants into the atmosphere were also introduced (Directive 84/360/EEC, 1984; Directive 88/609/EEC, 1988). The implementation of the recommendations in these directives led to a reduction in $SO_2$ and $NO_X$ emissions into the air. But in order to achieve more tangible effects, it was decided to introduce more stringent requirements. In 1996 the EU passed the Directive on Ambient Air Quality Assessment and Management (Directive 96/62/EC, 1996). This set out new requirements regarding air quality, and the action taken aimed at preventing or limit harmful effects on human health and the environment. It also contained recommendations regarding air quality assessment methods and criteria, common to all member states. This directive failed, however, to establish permissible levels for particular chemical compounds. In view of this, a few years later the EU passed 4 daughter directives, with more exacting requirements regarding particular compounds. The first Daughter Directive (Directive 1999/30/EC, 1999) on permissible levels of $SO_2$, $NO_2$, NO, dust and lead was passed in 1999. The second Daughter Directive (Directive 2000/69/EC, 2000) passed in 2000, laid down acceptable levels of CO and benzene. The third Daughter Directive of 2002 (Directive 2002/3/EC, 2002) related to ozone in ambient air, and the fourth Daughter Directive (Directive 2004/107/EC, 2004) established permissible levels of arsenic, cadmium, nickel and PAHs in ambient air. These directives stipulated the permissible levels or the levels to be achieved by a specified deadline. The first daughter directive sought to protect human health, plants and ecosystems; the second and fourth applied only to human health protection, and the third to the long–term protection of human health and plants.

The EU has also introduced norms for the emission of pollutants from stationary and mobile sources (motor vehicles). The former are referred to in directive 2001/80/EC (Directive 2001/80/EC, 2001), passed in 2001. This lays down very precisely the permissible levels of pollutant emissions from large coal–fired power generating plants. The aim is to gradually reduce annual emissions of $SO_2$ and $NO_X$ from existing installations, and also to specify permissible emissions of $SO_2$, $NO_X$ and dusts for existing and new incinerators. In the case of motor vehicles, pollutant emissions were initially regulated by directives 70/220/EEC (cars) (Directive 70/220/EEC, 1970) and 88/77/EEC (trucks) (Directive 88/77/EEC, 1987). With the advance of technology changes were made to these directives. Table 3 lists information on the pollutant emission standards from cars and the changes made to them (Landgrebe et al., 2008).

In spite of the measures taken and the consequent considerable improvement in air quality, the negative effects of air pollution were not alleviated. During the Sixth Environment Action Programme of the European Community, a strategy was worked out for achieving such levels of air quality that would no longer adversely affect or threaten human health and the natural environment. This led to the drawing up of the Clean Air for Europe Programme (CAFE). Implemented by the European Commission in 2001, CAFE's task was to explore whether the current regulations were sufficient to achieve the aims of 6EAP by 2020 (CAFE, 2001; COM 245, 2001; Tuinstra, 2007; EAP, 2011). Despite these efforts, it was predicted that the negative effects would continue to be felt. In 2005, the European Commission presented a Thematic Strategy on air pollution; this recommended that current regulations should be updated to focus on the most important pollutants (COM 446, 2005). Both documents formed the basis for a new directive.

The Directive of the European Parliament and of the Council on ambient air quality and cleaner air for Europe was drawn up in 2008 (Directive 2008/50/EC, 2008). At present this is the basic legal instrument regulating air quality management. When this directive came into force on 11 June 2010, it replaced directives 96/62/EC, 1999/30/EC, 2000/69/EC, 2002/3/EC and council decision 97/101/EC (CD 97/101/EC, 1997). This new directive requires EU member states to guarantee that the permissible levels of substances it lays down shall not be exceeded. They are thus obliged to prepare and implement plans and programs to remove discrepancies. The permissible levels stipulated in the directive are the minimum values that EU states must strive to achieve. This means that member states may introduce more demanding standards on their territories if they wish so. In the case of states which, despite having taken all appropriate measures to reduce their emissions, still exceed permissible levels, the directive allows the deadline for achieving the prescribed levels to be put back, albeit on condition of certain criteria being fulfilled. Nonetheless, the Commission has to be notified of all changes. The most urgent priority of the directive is to introduce a new approach to the monitoring of suspended particles. Not only must particulate matter less than 10 µm in diameter ($PM_{10}$) be assayed, maximum levels of "fine" particles less than 25 µm in diameter ($PM_{2.5}$) in ambient air must also be established. The reason for this is that these latter particles can seriously affect human health. In the decade from 2010 to 2020 member states should limit human exposure to $PM_{2.5}$ particles. Furthermore, the directive anticipates a more ramified system for monitoring particular contaminants: this will make for better identification of pollutants and facilitate the implementation of a more effective policy for improving air quality (Directive 2008/50/EC, 2008). The CAFE program is useful in the implementation of the directive and the assay of $PM_{2.5}$ particles (Tainio et al., 2010).

***Table 3**. EU Emission standards (CO, $NO_X$, HC, PM) for cars (Landgrebe et al., 2008)*

| Emission Standard/Directives, Regulations | CO (mg/km) | | $NO_X$ (mg/km) | | HC (mg/km) | | PM (mg/km) | |
|---|---|---|---|---|---|---|---|---|
| | Petrol | Diesel | Petrol | Diesel | Petrol | Diesel | Petrol | Diesel |
| Euro 1/91/441/EWG93/59/EWG | 2 720–3 160 | 2 720–3 160 | | | | | | 140–180 |
| Euro 2/94/12/WE and 96/69/WE | 2 200 | 1 000 | | | | | | 80–100 |
| Euro 3/98/69/WE | 2 300 | 640 | 150 | 500 | 200 | | | 50 |
| Euro 4/98/69/WE and 2002/80/WE | 1 000 | 500 | 80 | 250 | 100 | | | 25 |
| Euro 5/WE No. 715/2007 | 1 000 | 500 | 60 | 180 | 100 | | 5 | 5 |
| Euro 6/WE No. 715/2007 | 1 000 | 500 | 60 | 80 | 100 | | 5 | 5 |

In a review of the EU policy regarding air quality management, the European Commission began consultations in this matter on 30 June 2011. The aim of these consultations was to set out new, long–term targets for the period after 2020; the results will be taken into account in the review planned for 2013 (ECE, 2011).

The aim of the above directives is to harmonize monitoring and quality assurance methods in order to facilitate comparisons of air quality measurements throughout the EU, and also to supply information on air quality which will be available to all interested parties. EU member states may tighten the norms laid down by a directive and also monitor contaminants not listed in it.

The EU Regulation 1210/90/EEC (Regulation 1210/90/EEC, 1990) of 1990 called into being the European Environmental Agency (EEA), and its work started in earnest in 1994. The Agency's task is to supply reliable and objective information on the state of the environment, the direction which changes to the environment are taking, and also social and economic pressures on the environment. The EEA's tasks focus on four main areas:

- counteracting climate changes;
- counteracting biodiversity loss and identifying changes in spatial management;
- protecting human health and the quality of life;
- exploiting and managing natural resources and waste.

The Agency is also obliged to compile five–yearly reports on the state of the environment, subject and technical reports, reviews and publications on the most important events (EEA, 2011).

## 4. A Comparison of EU Air Protection Policies and Legislation with the U.S.

In many respects, air protection policies in the EU and U.S. are very similar. Both areas have a similar economic status, level of technology, population and surface area, and they also have similar problems regarding the protection of the environment. But there are also differences. In the U.S., air quality is a federal matter, and the relevant policies apply to the whole country. In contrast, the air quality policy in the EU consists of a mixture of norms issued by the EU Commission and those of the various member states. This means that the EU sets the standards and the member states determine how best to meet the targets within their country. In addition, in the U.S., air pollution management is implemented through a combination of the air quality standard and the emission standard strategies, whereas in the EU emission standards, emission taxation, and cost–benefit analysis are used.

The reduction of air pollution is an important element of the EU and U.S. environmental policy. Air protection strategies are designed around specific air pollutants, the presence of which have an adverse effect on the environment and human health. The EU member states and the U.S. have worked out their own rules for limiting emissions and setting air quality targets. Harmful substances in the air were designated on the basis of WHO guidelines. Table 4 lists basic information on the maximum permissible levels of air quality indicators in the EU and U.S.

Table 4 shows that air quality standards in the EU are somewhat more restrictive than in the U.S. In addition, the EU monitors a larger number of compounds than are set out in the WHO recommendations. The U.S. monitors just 7 pollutants ($SO_2$, $NO_2$, $PM_{10}$, $PM_{2.5}$, CO, $O_3$, Pb). In the EU and the U.S. there is one range of air quality – "acceptable". However, the Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations (e.g. children, asthmatics), while secondary standards set limits to protect public welfare (e.g. damage to animals, plants and buildings) (U.S. EPA, 2012a). The United States in the process of creating air quality standards are focused primarily on assessing the level of pollution that would be an acceptable level of risk to public health. The limit values of the most air pollutants (CO, $SO_2$, and $PM_{10}$) cannot be exceeded more than once a year. The European Union, on the other hand, has established air quality limits at levels at which the probability of the impact of pollution on human health is minimal or none.In addition, the EU in the process of setting air quality limits was guided by the WHO guidelines. However, the number of exceedances of air quality limits values is higher. For example, limit values of CO cannot be exceeded more than 8 times per calendar year.

However, some Member States have introduced their own, more stringent standards than the guidelines (more stringent limit values for polluting substances) and monitoring of some pollutants which are not regulated by the European directives. For example, Austria has enacted more stringent values for $NO_2$ and $PM_{10}$, and the United Kingdom for ozone. Additionally, the UK is the only country that measures 1–3 butadiene and Germany monitors nitrates, sulfates and elemental carbon.

To transparently and comparatively assess the degree of air pollution in various cities, the Air Quality Index was introduced. Usually, the index is calculated simultaneously for several substances. In the EU, each country has its own air quality index, so a special CITEAIR program was created and the Common AIR Quality Index (CAQI) was introduced. This index has a five–step scale [from very low (0/25) to very high (>100)] of air pollution and is based on three major pollutants: $NO_2$, $O_3$ and $PM_{10}$. The index can be expanded by three additional pollutants: $SO_2$, CO, $PM_{2.5}$. The CAQI defines two areas of pollutants. The first area relates to the monitoring of urban background (explaining the general situation in the agglomeration) and the second relates to roadside monitoring (represents places near city streets with a lot of traffic). Classes 1–3 have satisfactory air quality (pollution levels do not pose a risk to human health). Classes 4 and 5 are of poor air quality – the level of contamination posing threat to health, especially for sensitive groups (class 4) or the whole population (class 5) (CAQI, 2013).

***Table 4.*** *Comparison of current air quality limits/guidelines in the EU and the U.S.*

| Pollutant/Averaging Time | EU (AQS, 2011) | U.S. (U.S. EPA, 2012a) | WHO (WHO, 2006) |
|---|---|---|---|
| $SO_2$ | ppb | ppb | ppb |
| 1 hour mean | 134 | 75 | – |
| 3 hour mean | – | 500 | – |
| 24 hour mean | 47 | 140 | 8 |
| Annual mean | – | 30 | – |
| $NO_2$ | ppb | ppb | ppb |
| 1 hour mean | 105 | 100 | 106 |
| 24 hour mean | – | – | – |
| Annual mean | 21 | 53 | 21 |
| $PM_{10}$ | μg/m$^3$ | μg/m$^3$ | μg/m$^3$ |
| 24 hour mean | 50 | 150 | 50 |
| Annual mean | 40 | – | 20 |
| $PM_{2.5}$ | μg/m$^3$ | μg/m$^3$ | μg/m$^3$ |
| 24 hour mean | – | 35 | 25 |
| Annual mean | 25 | 15 | 10 |
| CO | ppb | ppb | ppb |
| 8 hour mean | 9 000 | 9 000 | – |
| 1 hour mean | – | 35 000 | – |
| Ozone | ppb | ppb | ppb |
| 8 hour mean | 40 | 75 | 50 |
| 1 hour mean | – | 120 | – |
| Benzene | μg/m$^3$ | μg/m$^3$ | μg/m$^3$ |
| Annual | 5 | – | – |
| Lead | μg/m$^3$ | μg/m$^3$ | μg/m$^3$ |
| Annual | 0.5 | 0.15 | – |
| PAH | μg/m$^3$ | μg/m$^3$ | μg/m$^3$ |
| Benzo[*a*]pyrene | 0.001 | – | – |

The main purpose of presenting CAQI indicators is not to warn people against possible adverse health effects as a result of poor air quality but to draw public attention to urban air pollution and its sources, the possibility of improving air quality by reducing emissions of pollutants and thereby indirectly influence the quality of life.

However, in the U.S. the air quality index (AQI) has 6 levels using a scale from 0 to 500. The index includes five main pollutants which are regulated by the Clean Air Act: $O_3$, $PM_{10}$, CO, $SO_2$, and $NO_2$. In addition to the numerical index, the AQI provides information about the health effects related to the measured concentration. The air quality index focuses on health effects which may appear a few hours or days after breathing unhealthy air (AirNow, 2009).

Emissions reduction targets specific pollutants differ between EU and U.S. The EU established national emissions levels for selected pollutants regardless of their sources. National emissions ceilings in the U.S. that cover emissions for all sectors are not explicitly established but the U.S. State Implementation Plan process establishes emissions limits for both all sources and specific types of emitting facilities (EC, 2004).

EU member states can autonomously delimit air management zones. In the U.S., however, states may suggest such zones for given regions. These zones are then subject to vetting and may be modified to improve their efficacy. In the EU, air protection programs are required only for areas where permissible levels of emissions are exceeded. In the U.S. such a program is compiled for all zones, even for those that are still at the planning stage.

The EU and U.S. have mechanisms for encouraging or enforcing the proper implementation of air protection plans and programs. But the U.S. rights of exaction are stronger than in other countries: if states fail to meet the NAAQSs, the federal administration has specific power over them devolved by the U.S. Clean Air Act. In contrast, the EU system is geared much more to peer pressure and persuasion. It focuses on implementing and reporting applications, and on assessing whether additional measures are needed. If an EU member state fails to meet air quality standards and does not request an extension of the deadline for achieving compliance with the norm, the Commission has the right to send warning letters and finally initiate legal action against the member.

Procedures to ensure adequate air quality in the EU include determining the type and intensity of the pollution's impact on the environment and controlling emission levels. In the U.S., the air quality is ensured through the implementation of precise guidelines, air quality modeling and analysis and determination of pollution emissions from stationary and dynamic sources. The guidelines have been designed to facilitate SIPs in achieving a required level of air quality.

## 5. Conclusions

Air quality management is an exceedingly important, complex and all–embracing problem, which can be examined at global, supranational, national, regional and local levels. In every case, the set of available legal, financial, social and structural instruments is different. But common to all is the aim of the actions undertaken, namely, to ensure the best possible quality of the air. This is measured by the levels of air pollutants present in a given area and how these compare with permissible levels.

Air quality management plays a major role in shaping a country's environmental policy. Its efficient functioning depends on a large number of factors, the most important of which are:

- knowledge of the existing state of air pollution;
- the ability to match action plans to local conditions;
- close cooperation between the various agencies participating in the system, to ensure the effective realization of planned actions;
- complete and up–to–date information on all sources of pollutant emissions.

The EU Member States and the U.S. have achieved significant improvements in air quality over the past thirty years. They have been achieved by:

- enactment and enforcement of international, national and local air quality regulations;
- introduction of best environmental practices and best available technologies, e.g. reduction in energy use, the use of unleaded petrol;
- promotion and increased funding for ecological activities in the protection of air;
- promotion of clean and energy–efficient road transport vehicles.

However, this area still requires a more integrated and ambitious approach.

Regardless of the approach, the effective air quality management is a collection of air pollution strategies designed to provide cleaner air in city and country.

Since air masses cross the borders of countries, air quality is a global problem, which is why international action is crucial, only in this way can a consensus between economic development and environmental quality be achieved.

The global problem of air pollution can only be resolved by international agreements, and the management of air quality in particular countries will have to be unified.

## List of Abbreviations

CAA: Clean Air Act
CAFE: Clean Air for Europe Programme
EEA: European Environmental Agency
EPA: Environmental Protection Agency
NAAQOs: National Ambient Air Quality Objectives
NAAQSs: National Ambient Air Quality Standards
SIP: State Implementation Plan
UNFCCC: United Nations Climate Change Conference

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