DEVELOPMENT OF AN OPERATIONAL ACTION PLAN FOR CONFRONTING WITH ATMOSPHERIC POLLUTION IN THESSALONIKI

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INTRODUCTION

In the frame of covering country obligations against the relative EU directives, the MINISTRY OF ENVIRONMENT, PHYSICAL PLANNING AND PUBLIC WORKS assigned the implementation of the project entitled "Development of an Operational Plan for fighting the atmospheric pollution in Thessaloniki". Aim of the work is the development of a suitable Operational Action Plan for fighting the atmospheric pollution in Thessaloniki in application of the Framework Program of European Union 96/62/EU "for the evaluation and management of the air quality". The area of study covers the urban, suburban and industrial regions of the prefecture of Thessaloniki. The scope of work includes the evaluation of atmospheric pollution levels in the region of study, with the examination of the existing (2002) and future conditions (2005 and 2010), taking into account the limit values of the examined pollutants set by the corresponding EU Directives. Additionally, the study comprises the determination and examination of alternative solutions, in order to achieve the future limit values of the pollutants examined, in case these limit values are exceeded for the "do-nothing" scenario 2005 and 2010. For this aim, suitable meteorological and air quality models were applied and air emissions calculations were carried out.

EXISTING CONDITIONS IMPRINTING

Estimation and evaluation of the atmospheric pollution levels in the region of study for the existing situation (2002) are essential in order to realize the special problems (potential excess of limits) of the region. For the existing conditions imprinting, the Network Control of Atmospheric Pollution of Central Macedonia Region measurements were used.

It should be noted that for the Thessaloniki region, as for most urban regions, the road transport sector contributes mostly to the NO_x, NMVOC and CO emissions. Industry sector is an important source of particulate matter (PM) and SO_2 emissions with the latter being significantly associated with central heating during winter. As for the remaining pollution sources, off-road activities and marine transport are a relatively important source of NO_x and SO_2 emissions respectively. It is to be noted however, that the total emissions amount from these sources is not expected to determine significantly the present pollutants concentrations as very important factors in the determination of final pollution levels are the territorial characteristics and the emissions spatial distribution.

As for nitrogen dioxide (NO_2), the limit of 200μgr/m^3 for was exceeded only 4 times during the entire year (2002). Regarding the annual limit value (40 μgr/m^3), an excess was observed at AUTH and Agia Sofia stations, while precisely close to the limit are Eleftheriou-Kordeliou and Kalamarias stations. Calculations of the limits excesses of sulphur dioxide for Thessaloniki region have shown that the area does not suffer from high SO_2 levels. Regarding the PM10 concentrations, the limit of 50μgr/m3 average daily value was exceeded in all network stations by far more than 35 times (as set by the European Directive). It is to be noted that for two stations, Agia Sofia and

Eleftherio-Kordelio, that limit was exceeded for more than the two thirds of the 365 days of the year. Carbon monoxide higher concentration levels were observed only in Agia Sofia station, where the limit of 10mgr/m^3 eight hours moving average value was exceeded 2 times. Contrary to the other pollutants, the ozone problem is shifted to the suburban stations of Panorama and Neohorouda: the limit of 180μgr/m^3 was exceeded 59 times at Panorama, 5 times at Neohorouda, and only once at Eleftherio-Kordelio.

ESTIMATION AND EVALUATION OF FUTURE CONDITIONS

No significant change is expected for the estimation of pollutant's emissions for year 2005 from the main sectors of activities (transport, industry, central heating). That estimation of course is related to the short time period between the years 2002 and 2005.

Concerning the estimations of pollutants emissions from various activities, for the year 2010, generally, a reduction of emissions from all main sources (road transport, industry, central heating) is expected. This reduction will considerably influence the pollution levels in the region of study for 2010.

For the year 2010, the emissions produced by road transportation were calculated taking into consideration the new traffic conditions in relation with the operation of programmed or future planned infrastructure work as well as the new vehicle's fleet conditions (increase of registered vehicles, import of new technology vehicles, renewal of taxi fleet). Calculations of industry emissions for year 2010 take into consideration the penetration of natural gas, the operation of new units, the operation interruption of certain older ones, the environmental conformity with the directives guidance's of the troublesome installations as well as the adoption of energy saving issues.

According to the above considerations the emissions changes from 2002 to 2010 are drawn in the following table:

Annual emissions percentage change for years 2002 and 2010

2010/2002	NO_x	NMVOC	CO	PM10	SO_2
Road transport	-17%	-23%	-21%	-33%	-73%
Industry	6%	81%	-15%	-71%	-73%
Central heating	6%	81%	-15%	-71%	-73%

For the calculation of air pollution levels the Urban Airshed Model (UAM) was used. UAM is a 3D photochemical cell model, which calculates the concentrations of inert and chemically reactive air pollutants simulating those natural and chemical atmospheric processes that influence the concentrations of atmospheric pollutants. This model has been applied internationally on an operational base for urban regions and was also used by the Atmospheric Pollution Operational Centre for the Greater Athens Area. The results of the photochemical model, for all the examined pollutants, are presented below.

Nitrogen Dioxide (NO_2)

Even with meteorological conditions enforcing the creation of high atmospheric pollution levels, the limit of 200μgr/m^3 hourly average value is not expected to be exceeded in the whole area, not either in the city centre.

Sulphur Dioxide (SO_2)

As for SO2, no limit exceeding was reported for the year 2002. Moreover, already from year 2005 the concentrations of this pollutant are expected to decrease significantly because of the expected reduction of sulphur levels in the fuels that are used in road transport and in the central heating.

Particulates (PM10)

As a result from the calculations, without taking additional measures, at 2010, the concentrations of PM10 will not exceed the set limits at Panorama and Sindos stations. On the contrary, limit exceeding is expected at Agia Sofia and Eleftherio-Kordelio stations.

Carbon Monoxide (CO)

Even with meteorological conditions that favour the creation of high pollution levels, the limit of 10mgr/m^3 eight hours moving average value is not expected to be exceeded either in the periphery or in the city centre.

Ozone (O_3)

The maximum hourly average values of ozone concentration will decrease in comparison with 2002 data, but however the 120μgr/m^3 limit will continue to be exceeded at Panorama and Neochorouda stations.

ALTERNATIVE SOLUTIONS FOR ATMOSPHERIC QUALITY IMPROVEMENT IN THESSALONIKI

The proposed solutions aiming at the reduction of ozone precursors (nitrogen oxides and hydrocarbons) and particulate matter PM10 in the atmosphere are presented below. The whole proposal consists of different alternative scenarios in order to achieve the established limits. The individual special measures that can be applied in order that these scenarios are applicable and can achieve the desirable result are also presented.

Alternative Solutions for Ozone Limits Achievement

The alternative solutions proposed for the ozone limits achievement, concern in the acceleration of renewal of vehicles fleet and the concentrated efforts to monitoring the control and maintenance of road vehicles.

More precisely the examined scenarios are the following:

Scenario A: Intensive vehicles controls and maintenance
Scenario B: Replacement of conventional passenger cars (1st registration before 1991)
Scenario C: Replacement of conventional two-stroke motor-bikes
Scenario D: Prohibition of circulation of conventional two-stroke motor-bikes
Scenario E: Replacement of old light commercial vehicles (LCVs)

The result from the calculations is that a combined application of more than one of the alternative scenarios can lead to the achievement of ozone limit values in the area of interest.

Alternative Solutions of PM10 Limits Achievement

The alternative solutions that were selected for the PM_{10} limits achievement mainly concern in the acceleration of the HDV fleet renewal and the increase of the penetration of Natural Gas in central heating

More precisely the examined scenarios are the following:
Scenario A': *Intensive controls of heavy-duty vehicles (HDVs)*
Scenario F: *Prohibition of passage of old heavy-duty vehicles (more than 15 years old) through the city*
Scenario G: *Additional penetration of natural gas in the central heating by 30%*

By applying the additional measures, PM_{10} emissions produced by road traffic will be reduced by 72% for year 2010, whereas PM_{10} emissions produced by central heating will be reduced by 77%. The additional PM_{10} emissions reductions from the application of measures relatively to the do-nothing script, are 39% for road traffic emissions (Scenarios A + F) and for central heating 29%.

The prohibition of passage of old HDVs (more than 15 years old) through the city has a limited output in the city centre but it is more important in the Eleftherio-Kordelio region. Exactly the reverse phenomenon is observed by the higher penetration of natural gas in central heating. That can be of course interpreted, because circulation of HDVs is limited in the city centre, however central heating emissions contribution is very important and vice versa.

Finally, despite the application of additional measures, at 2010 the number of expected limit exceeding is close to the annual maximum (35 times per year) at Agia Sofia (city centre) and Eleftherio-Kordelio stations. Hence, efforts will be focused not only on imposing additional measures but on finding the reasons of the exceeding and excluding these measurements from the annual statistics. This justification can be based on two main reasons:

- The observed high background PM_{10} concentrations in the area of study (at least 15mgr/m^3), as this is presented from the minimal (2% percentile of measured average daily concentrations) concentrations of 2002 measured values.
- Long-range transport, explicitly particulates transportation from the Sahara desert, can be associated with high PM_{10} concentrations occurring simultaneously in an extended area of the Greek territory.

The invocation of these two reasons should be based on systematic researches and measurements that would concern not only the Greater Area of Thessaloniki but generally the total Hellenic territory as well.