

ENVIRONMENTAL MANAGEMENT SYSTEMS' EFFECTIVENESS OF ENTERPRISES IN DEVNYA MUNICIPALITY

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Abstract

Environmental performance of organizations is a key indicator for environmental management systems' efficiency. Present research focuses on Solvay Sodi AD, TPP Deven AD, Devnya cement AD and Agropolychim AD - risk potential enterprises in Devnya Municipality. Environmental management systems are applied in these enterprises. Conducted analyses for a ten-year period (from 2011 to 2020 year) proves that the implementation of environmental management systems at the listed enterprises leads to a significant improvement in their environmental performance.

Keywords: environmental management system, environmental performance, risk potential.

INTRODUCTION

Industrial areas' plurality with a high concentration of enterprises of chemical industry, processing industry and the processing of fuels are carriers of a significant environmental risk. This requires in terms of industrial zones, especially when they involving risk potential enterprises to take proactive measures to prevent and minimize environmental risks. Environmental management systems implementation stands out from all organizational-management measures with a high potential positive effect on environmental protection.

Devnya's industrial zone is an important industrial complex, involving enterprises from chemical industry, electrical engineering, limestone mining and processing enterprises, electricity production. Taking into account the increasing standards and requirements for environmental protection and ensuring healthy working conditions, for technological capacities renewal and improving the performance of enterprises in terms of environmental performance significant investments are needed. [7, 8]

Current study focuses on ambient air quality, although the enterprises' impact affects all environmental components.

MAIN FEATURES AND ECOLOGICAL PERFORMANCE OF ENTERPRISES IN DEVNYA INDUSTRIAL COMPLEX

In a previous study [7], justified are selected for analysis the applied environmental management systems of Solvay Sodi AD, TPP Deven AD, Devnya cement AD and Agropolychim AD. Because of this, current study monitors the effectiveness of environmental management systems, exactly of these enterprises. Solvay Sodi AD is classified as a low risk potential enterprise. [2] Currently TPP Deven AD is merged with Solvay Sodi AD, since 2017. Devnya cement AD is the largest cement producer in Bulgaria, up to present time. According to the Programs for planned inspections for industrial pollution prevention and under the Complex permits conditions of Regional Inspectorate of the Environment and Waters (RIEW) - Varna for 2020 Devnya cement AD is classified as a high risk site, still. Agropolychim AD is classified as a high risk potential enterprise. The listed enterprises are main pollution sources for Devnya Municipality, which is the Northeastern planning region of Bulgaria. [7]

Study focuses on enterprises' ecological performance. The air quality at Devnya muni-

unicipality is most severe affected by the above-mentioned enterprises and their manufacturing activity. Thus, emissions of: CO, CO₂, NH₃, NO_x/NO₂, SO_x/SO₂, Fine Particulate Matter < 10µm (PM₁₀) (major air pollutants) are observed by emitting enterprises. [5, 6, 9, 11, 12] Data for ten-year period, from 2011 to 2020, is collected and analyzed (from company's own environmental monitoring and from Annual Environmental Reports). The environmental performance effectiveness is assessed and efficiency of introduced EMS is accordingly determined.

The terrain of Devnya municipality is

mainly flat with an average altitude of 16 meters; the prevailing winds are from North and North-West direction. The relative share of windlessness in the year is relatively high. Ground inversions and fogs are typical for Devnya Industrial Complex. [10, 11] An adverse impact on atmospheric air quality is caused by frequent droughts implying long retention of pollutants. [12]

Enterprises that are object of the study have different objects of activity. Table I presents their activity and industry type. Table II presents their production capacity by production plants and installations.

TABLE I. RISK POTENTIAL ENTERPRISES IN DEVNYA INDUSTRIAL COMPLEX

Company name	Activity	Industry type
Solvay Sodi AD	Production of soda ash, including production of quicklime	chemical
TPP Deven AD	Production of electric energy and thermal energy Biomass volume reduction mill	supply of electricity and thermal energy, gaseous fuels and water
Devnya cement AD	Production of cement clinker Production of cement	construction industry
Agropolychim AD	Production of nitrogen fertilizers – “Stabilized ammonium nitrate” and “Liquid nitrogen fertilizer” Production of phosphorus fertilizers	chemical

TABLE II. ENTERPRISES' PRODUCTION CAPACITY BY PRODUCTION PLANTS AND INSTALLATIONS

RPE	Production plant / installation	Capacity
Solvay Sodi AD	light soda	1550 thousand t/y
	heavy soda	1300 thousand t/y
	sodium bicarbonate	30 thousand t/y
	quicklime	3850 t/24h
TPP Deven AD	Combustion plant for thermal energy production, including: - SG CFB* №7; - SG № 3 (reserve); - SG CFB № 8; - SG № 6 (reserve) - SG № 2 (reserve);	485 MWh
	Combustion plant for thermal energy production - SG CFB № 7	6,25 t/h
	Biomass volume reduction mill	150 t/24h
Devnya Cement AD	Installation for the production of cement clinker - furnace 5, 6, 7	furnace № 5 – 70 t/h furnace № 6 – 70 t/h furnace № 7 – 192 t/h
	Installation for the production of cement - four horizontal ball mills 1-4	mill № 1 – 100 t/h mill № 2 – 100 t/h mill № 3 – 100 t/h mill № 4 – 100 t/h
Agropolychim AD	Ammonia 100%	207 900 t/y
	Nitric acid 100%	363 000 t/y
	Ammonia water 24%	64 000 t/y
	Stabilized ammonium nitrate	412 500 t/y
	Liquid nitrogen fertilizer	792 000 t/y
	Phosphoric acid (100% P ₂ O ₅)	205 000 t/y
	TSP (100% P ₂ O ₅)	164 000 t/y
	MAP (54% P ₂ O ₅)	270 600 t/y
	DAP (54% P ₂ O ₅)	293 700 t/y
NPK (54% P ₂ O ₅)	363 000 t/y	

Enterprises, in which there are implemented certified systems for ecological management (ISO 14001:2004) are Solvay Sodi (since 2006), TPP Deven (since 2006) and Devnya

cement (since 2004). [1, 2, 3] Agropolychim performs systematic environmental management in accordance with requirements of its Complex Permit and meets requirements

according to ISO 14001. In 2017 Solvay Sodi is recertified in accordance with ISO 14001:2015 requirements. [2] Policies developed by the enterprises make smooth operation of management systems continuously reviewed and updated to ensure their effectiveness.

Devnya Municipality is an ecological “hot point” in ecological terms. Enterprises’ emissions are determining for the deteriorated air quality, so enterprises are the subject of the study. As well as emissions from domestic solid fuel heating during the winter months and the intensive transport for contribute the deteriorated air quality. [5, 10, 11, 12] Devnya Municipality is included in region for assessment and management of ambient air quality (AAQ) “Agglomeration Varna” during 2010. In 2015 Municipality is exempted from obligation to develop a program for AAQ improvement, the analysis done to estimate fine particulate levels at 90.4% indicates that the norm is observed. [5, 10, 11, 12] But in 2016, Ministry of Environment and Water announced a procedure “Development / Update of municipal programs for ambient air quality”, which lists specific beneficiaries of the procedure. Devnya is again on the list of municipalities with impaired air quality in terms of fine particulate matter (PM₁₀), nitrogen oxides (NO_x) and others. This aims planning of measures to improve air quality, which will lead to the lasting achievement of the set air quality standard norms.

According to the Republic of Bulgaria legislation regarding the environmental monitoring [6], the following indicators are obligatory for the purpose of the atmospheric air quality assessing: CO, CO₂, NH₃, NO_x/NO₂, SO_x/SO₂, Fine particulate matter <10µm (PM₁₀). Enterprises in Devnya - subject of the study, reports emissions of atmospheric pollutants as part of their environmental performance. Specific air pollutants issued by enterprises are not subject of this analysis.

Efficiency assessment of the implemented certified EMS is carried out through the enterprises' environmental performance. To determine its performance, quantitative and qualitative measures are required (the indicators listed). In addition, they need to be scrutinized over a long-time period.

Concerning ambient air, emissions of CO, CO₂, NH₃, NO_x/NO₂, SO_x/SO₂, Fine particulate matter <10µm (PM₁₀) are analyzed on an annual basis for enterprises that are considered to be major. Ammonia indicator (NH₃) is not applicable to TPP Devn AD and Devnya cement AD, and for Solvay Sodi AD - Fine particulate matter <10µm (PM₁₀). The collected data from enterprises' Annual Reports about environment for the period are presented in Figures 1 - 22 by indicators and enterprises. Threshold value is presented by legislative regulations for each indicator. Thresholds for the observed indicators coincide. For the period 2011 - 2020 the situation in the studied objects is the following:

- Solvay Sodi AD (Fig. 1 - 5) [2]: Regarding to main ambient air pollutants CO (threshold = 500 t/y), CO₂ (threshold = 100 000 t/y), NH₃ (threshold = 10 t/y), NO_x/NO₂ (threshold = 100 t/y) shows significant exceedance of granted by International Plant Protection Convention (IPPC) permits, although in different years there are lower and higher measured values. The recorded maximum of 18 504 t/y CO is in 2011. It accounts 37 times the annual limits of all production installations. From 2012 to 2013 the amount of CO reduces to 13 087 t/y or 26-fold exceed of threshold. In the next three years emitted CO increase to around 16 000 t/y, after that in the next two years this indicator again decreased to 12 449 t/y and in 2019 there is a peak - 15 977 t/y. In the last year of the analyzed period (2020), CO quantity is decreased to 11 t/y, which is 22 times higher than the norm. For the observed period CO₂ stays above the limits of 100 000 t/y. Moreover from 2011 to 2014 the trajectory is increasing from 499 402 t/y in 2011 to 558 406 t/y in 2014, followed by decreasing trend to the end of the period (2020 - 428 265 t/y). During the first six years of the analyzed period, NO_x/NO₂ emissions increased to 164 t/y at a norm of 100 t/y, then gradually decreased to 124 t/y, and in 2020 they increased by about 3,5 t/y. For the analyzed period indicator SO_x/SO₂ with threshold 150 t/y does not exceed the values set in the legislative regulations, but is sustainably increasing. This results in drastic increase and measured value of the 285 t/y (about 1,5-fold exceedance) in

2015 and 2016 - 242 t/y. In 2017 emissions sharply decreased to 39 t/y, but by 2020 the values of this indicator have an increasing trend. However, data analyzing shows that values in recent years vary so much that supra-threshold values can be expected again, if no more serious measures and actions are taken.

Regarding specific for Solvay Sodi AD air

pollutant NH_3 recorded data are causing serious concern too. According to IPPC permits the limit is set to 10 t/y. The minimal recorded value NH_3 is 509 t/y in 2013. The extreme of 2 117 t/y is measured in 2017. The overall trend with respect to NH_3 for the analyzed period is decreasing, although emissions are over 120 times the threshold.

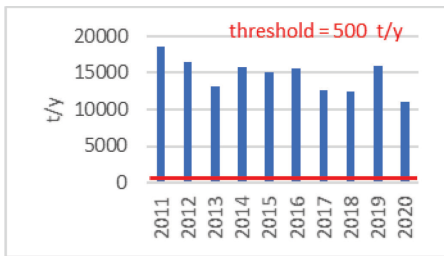


Fig. 1. Solvay Sodi AD - CO emissions

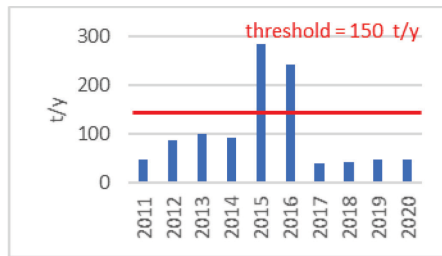


Fig. 5. Solvay Sodi AD - SOx/SO₂ emissions

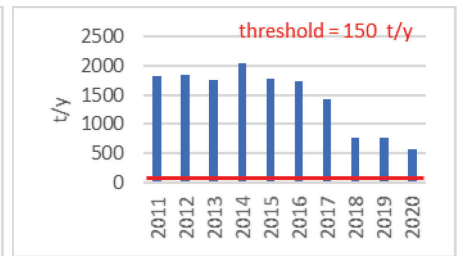


Fig. 9. TPP Deven AD - SOx/SO₂ emissions

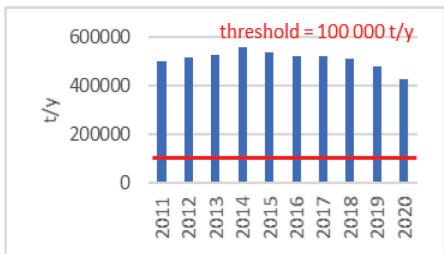


Fig. 2. Solvay Sodi AD - CO₂ emissions

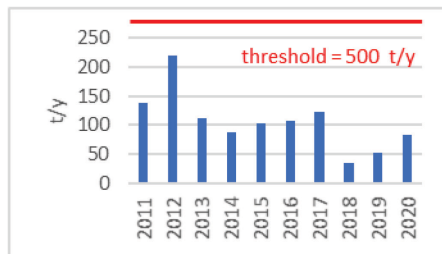


Fig. 6. TPP Deven AD - CO emissions

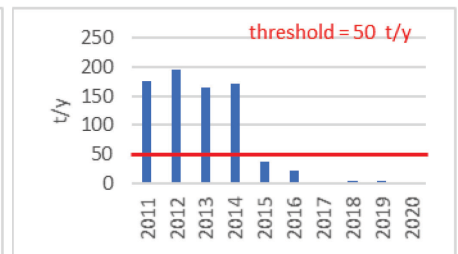


Fig. 10. TPP Deven AD - Fine particulate matter $\lt \mu\text{m}$ (PM₁₀)

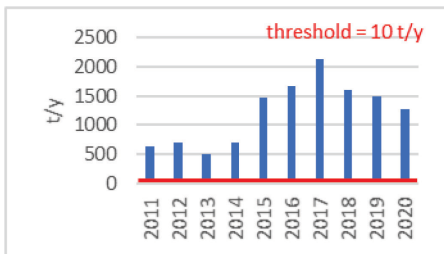


Fig. 3. Solvay Sodi AD - NH₃ emissions

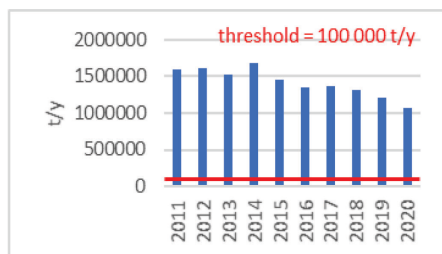


Fig. 7. TPP Deven AD - CO₂ emissions

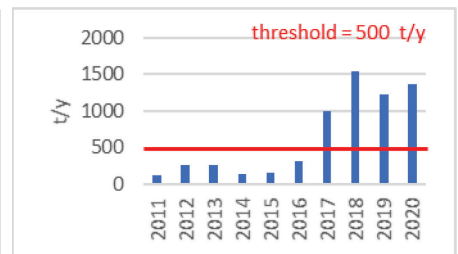


Fig. 11. Devnya cement AD - CO emissions

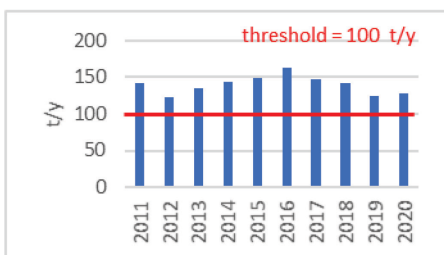


Fig. 4. Solvay Sodi AD - NOx/NO₂ emissions

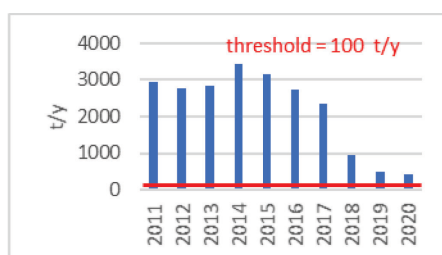


Fig. 8. TPP Deven AD - NOx/NO₂ emissions

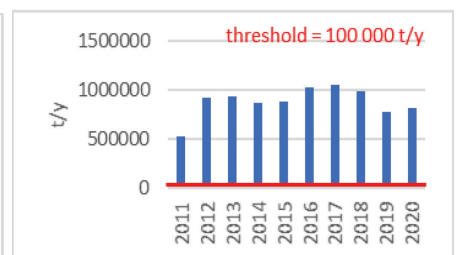


Fig. 12. Devnya cement AD - CO₂ emissions

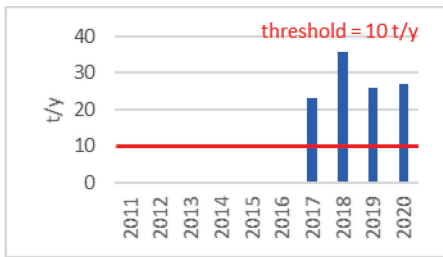


Fig. 13. Devnya cement AD - NH_3 emissions

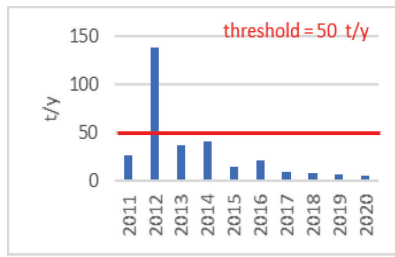


Fig. 16. Devnya cement AD - Fine particulate matter $<10\mu\text{m}$ (PM_{10})



Fig. 19. Agropolychim AD - NH_3 emissions

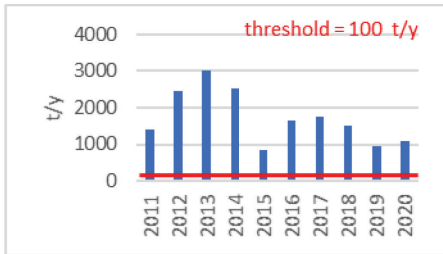


Fig. 14. Devnya cement AD - NO_x/NO_2 emissions

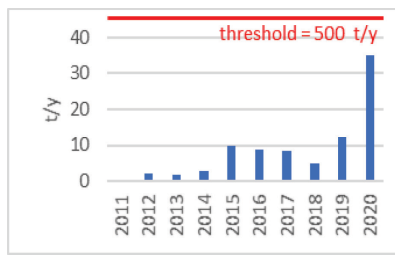


Fig. 17. Agropolychim AD - CO emissions

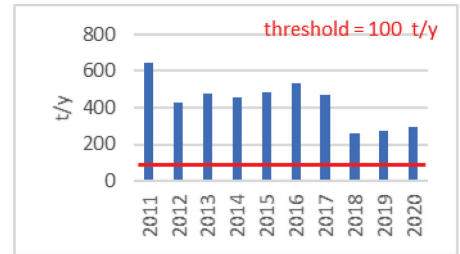


Fig. 20. Agropolychim AD - NO_x/NO_2 emissions

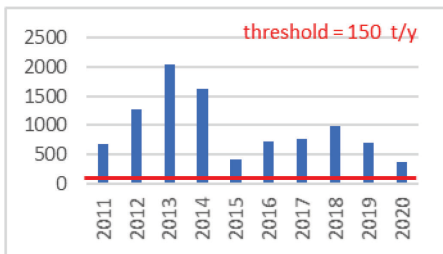


Fig. 15. Devnya cement AD - SO_x/SO_2 emissions

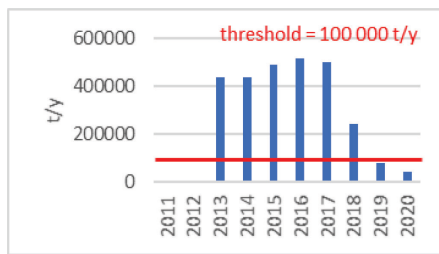


Fig. 18. Agropolychim AD - CO_2 emissions

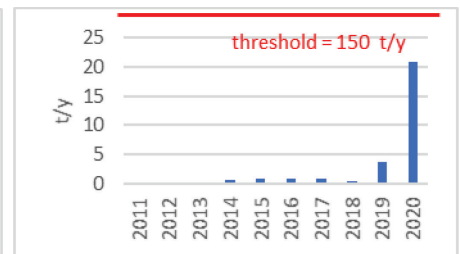


Fig. 21. Agropolychim AD - SO_x/SO_2 emissions

- The situation in TPP Deven AD (Fig. 6 - 10) [1] is almost identical to that in Solvay Sodi AD: At TPP the CO_2 , NO_x/NO_2 , SO_x/SO_2 and PM_{10} indicators shows a downward trend, although the first three of them are times above the threshold amounts defined in the complex permit. Only PM_{10} values fall below the specified norm (50 t/y) in 2015 and remain so until the end of the analyzed period (2020 - 1,9 t/y). CO does not exceed the threshold, but the quantities issued vary greatly over the years and there is no concrete trend.

- Devnya cement AD (Fig. 11 - 16) [3]: In the first six observed years the average level of CO accounts nearly 323 t/y, which is below the threshold value (500 t/y). But after that from 2017 to 2020 there is an increasing with maximum of 1 548 t/y in 2018 or more than threefold exceedance. For CO_2 emissions the situation is almost identical to that in Solvay Sodi AD - for the whole analyzed period values are several times over the permit level with maximum in 2017 - 1 054 807 t/y, which

is 10,5 times over the threshold. By 2020 there is a slight decrease in the reported amounts - 818 694 t/y. During the first six years of the study period, the operator is not emitted NH_3 emissions. During the next part of the period 2017 - 2020, the emissions of this indicator have an upward trend, being about three times above the norm. The maximum is reported in 2018 - 36 t/y or almost fourfold exceedance. The situation about NO_x/NO_2 and SO_x/SO_2 emissions is almost identical to that in TPP Deven AD - these indicators are several times over the thresholds. Their amounts vary greatly, respectively: in regard to NO_x/NO_2 emissions (2013) 3 018 t/y (peak) and 2019 - 942 t/y, and in regard to SO_x/SO_2 emissions - 2013 - 2042 t/y (peak) and 2020 - 384 t/y. Presented data regarding PM_{10} shows that the threshold is not exceeded excluding the reported value 137 t/y during 2012 (almost threefold exceedance of the limitations granted). The downward trend is determined by the presented low values until the end of

the analyzed period, reaching only 4,9 t/y in 2020 at a 50 t/y threshold.

- Agropolychim AD (Fig. 17 - 22) [4]: For the entire ten-year studied period by the main atmospheric pollutants group, only CO and SO_x/SO₂ are below the thresholds. But they are sharply growing (2020: CO emissions are 35 t/y and SO_x/SO₂ emissions are 21 t/y), so permitted values exceeded can be expected soon. With regard to CO₂ and NO_x/NO₂ the trend is towards a decrease in reported values, despite exceeding the threshold norms: from 2013 to 2018 CO₂ emissions are average two to five times over the complex permission values; the maximum of NO_x/NO₂ emissions is during 2011 - 643 t/y or more than sixfold exceedance, during the next six-year period reported values are little under the peak, while in 2018-2020 there is a decrease again (259 t/y - 2018), but only average four times under the maximum from 2011. However, about these indicators a downward trend is reported. Regarding specific for Agropolychim AD air pollutant NH₃ (like Solay Sodi AD) recorded data are causing serious concern too. According to IPPC permits the threshold is 10 t/y. The minimal recorded value is 18 t/y in 2012. The extreme of 86 t/y is measured in 2019. The overall trend is increasing and emissions of this pollutant are exceeded by more than 8,5 times. About PM₁₀ reported levels vary greatly, and it is impossible to determine their trend. Exceedances ranged from 0,5 to over 1,5 times the threshold - 50 t/y.

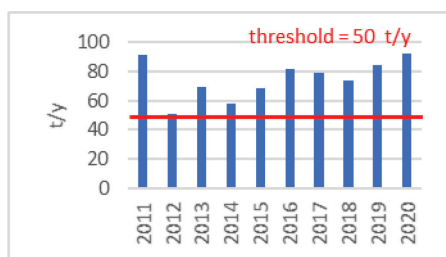


Fig. 22. Agropolychim AD - Fine particulate matter <math><10\mu\text{m}</math> (PM₁₀)

During the analyzed period most of the enterprises' installations worked with incomplete loading of production capacities.

The Environmental policies of Solvay Sodi AD, TPP Deven AD, Devnya cement AD and Agropolychim AD have set targets for ambient air quality improvement insofar as it depends

on the particular plant and its exhaust emissions. Efficiency of purification facilities is increase through planned specific measures and actions and/or through facilities' modernize. There is periodically electric filters current repair of Solvay Sodi AD, TPP Deven AD, Devnya cement AD. Charcoal production in an open way is discontinued.

CONCLUSION

Environmental performance is improving regarding management of natural resources and notably specific air pollutants reduction throught ISO 14001 introduction in studied enterprises in Devnya Municipality. The studied enterprises have proven commitments to environmental protection goals, so RIEW is refraining of further restrictive actions against them. Furthermore, these enterprises are of great municipality economic importance. ISO 14001 implementation reassures the society and responsible institutions that organizations' environmental performance is proper management object and internal control object. The enterprises' environmental performance regarding to the main pollutants of air is unsatisfactorily, despite of EMS, which are introduced in the enterprises, despite of the availability of proclaimed environmental policy and of programs for environmental risk management and supporting procedures. Solvay Sodi AD, TPP Deven AD, Devnya cement AD and Agropolychim AD systemically allow excess of IPPC limits regarding major air pollutants. Obvious is the need of further actions to reduce main pollutants of air and thus to improve its quality. Environmental management systems introduction to large scale industrial enterprises creates economy greening preconditions, but gives no guarantees for this.

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