APPLICATION OF TRADABLE DISCHARGE CREDITS TO WASTEWATER MANAGEMENT: A FEASIBILITY STUDY

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Abstract. *The paper presents results of a field study on the feasibility of applying tradable discharge credits approach to wastewater management. The hypothesis that formed the basis of the present study is that conversion of the existing municipal wastewater discharge management system in Lithuania into the one that uses tradable discharge credits can bring both private and overall (social) economic benefits in the form of increased flexibility of the sewerage subscribers to select the most cost-effective means of compliance with the discharge limits. Research has been conducted in order to determine whether the tradable discharge credits can be employed for municipal wastewater management and, if so, how it can be done. The presented framework of wastewater management, based on tradable discharge credits, can serve as a blueprint for similar applications in other countries or regions, as well as a basis for policy steps.*

Key words: *wastewater management, tradable discharge credits*

Introduction

Environmental policy instruments are broadly classified into economic and non-economic ones. While the latter category usually rigorously regulates (or even dictates) the behaviour of economic agents, economic instruments affect the costs and benefits of alternative actions open to economic agents, with the effect of influencing their behaviour in the ways that are favourable to the environment. To put it briefly, economic instruments aim to ensure an appropriate pricing of environmental services in order to stimulate their efficient use. The abundant theoretical research and application practice (for a comprehensive survey see Bohm, Russel, 1985; Compton et al., 1998, 1999; Rietbergen-McCracken, Abaza, 2000) show that economic instruments increase the flexibility of environmental management systems, bring substantial cost savings by allowing polluters to determine the most economical ways of meeting environmental policy targets, and offer a permanent incentive to look for cheaper and more efficient ways to comply with environmental regulations.

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The range of the economic instruments that are used for pollution control includes subsidies, deposit-refund systems, charges and tradable permits. The latter two are deemed to be *market-based* policy instruments; however, they markedly differ by their underlying principle: charges are price-based, while tradable permits are quantity-based. This means that pollution charges set a price for the pollution that leads (via decisions of economic agents) to a certain pollution level, while tradable permits determine the boundary of pollution that, via market activities, leads to the establishment of the price of pollution.

The tradable pollution permit (also known as marketable pollution permit, tradable discharge or emissions credit) approach to environmental management was first introduced in the United States in the beginning of 1970s. Tradable pollution permits (TPP) were defined as emission (discharge) allowances that, once initially allocated by the authorities to economic subjects, can be traded (bought or sold) subject to a set of prescribed rules. The *spiritus movens* of the trade is that polluters can either save on abatement costs (when they buy TPP) or profit on surplus abatement activities (when they sell TPP). Since 1970s, this policy instrument has been both theoretically developed and empirically tested (OECD, 1999; Stavins, 2003; Tietenberg, 2006; Freeman, Kolstad, 2007). It has been shown that under proper conditions the TPP system features both ecological effectiveness (in the sense of accurate accomplishment of pollution target) and economic efficiency (in terms of compliance cost savings), as well as considerable flexibility and adaptability to changes in socio-economic conditions (e.g., inflation, economic growth, cyclical variations, etc.). Moreover, while in principle the same emission targets and compliance cost savings can be achieved also with pollution charges, tradable pollution permits possess a number of essential advantages. First of all, the noted above flexibility of TPP significantly reduces the error margins associated with "guessing" an efficient pollution charge rate and eliminates the need for frequent charge rate adjustments that might be both administratively cumbersome and politically difficult. Secondly, due to the possibility of the free-of-charge allocation of initial tradable pollution quotas, they are unlikely to harm – as in the case of unilateral introduction of pollution charges – the international competitiveness of the economic agents in the country that is undertaking pollution management efforts. Finally, application of tradable permits for pollution control opens interesting possibilities to adopt some options that are intrinsic to finance, such as permit banking, lending, trade in futures and options.

The favourable conditions for the application of tradable permits are characterized by the following features: (a) there should be observable differences in the marginal costs of abatement across polluters; (b) the number of emission sources involved should be large enough to create a permit market; (c) environmental impacts from emissions should not be sensitive to the location of emission sources; (d) polluters should be technically able to react to the provided incentives; (e) TPP implementation, enforcement and supervision should not be too complex or too costly (i.e. envisaged costs should be substantially lower than expected benefits).

The use of TPP for environmental management is still rather in the "infant stage" in Central and Eastern European countries. Few studies exist on the possibility to apply permits for pollution control in these countries, and the number of practical application cases is limited to the Chorzów experiment in Poland (for its survey, see OECD, 1999: 151–153) and the Europe-wide trading of carbon dioxide emission rights. Furthermore, while the experience with tradable permits for *air* pollution control is quite extensive, the number of applications of tradable discharge permits for *water* pollution control so far has been quite low and limited to a few cases in the USA and Australia (for an extensive survey, see Kraemer et al., 2004). Taking into account that the condition of pollution impact to be non-sensitive to discharge location is hardly met when dealing with rivers or lakes, it is rather not surprising.

What differentiates the present study[1] on TPP application for wastewater management, which was conducted in the Panevėžys Water Company, Lithuania, from those conducted and/or implemented elsewhere is that in our case we considered point-source discharges not into water bodies (rivers, lakes, lagoons), but into the municipal water treatment system. This helps to avoid the aforementioned problem of the significance of source location for the impact of discharge on the ambient environmental quality. Furthermore, as noted by Harrington (19930) and examined by Čekanavičius (1998), the system of regulating pollution in Lithuania provides a potential opportunity for a relatively easy introduction of tradable pollution permits by making individual emission limits tradable.

The charge-based wastewater management system

In general, *modus operandi* of the Panevėžys Water Company (further referred to as PWC) is the following one.

The PWC establishes normative limits for the concentrations of effluents (BOD, suspended solids, oil products, total nitrogen, phosphorus, copper, nickel, zinc, chromium) in wastewater discharges for subscribers. Collected fees depend both on the concentration of pollutant *and* on the volume of wastewater discharged into the sewer system.

The main indicator of wastewater pollution is taken to be organic pollution, defined as *biological oxygen demand* ($BOD_{5)}$[2].) A charge rate[3] of 0.88 Litas (LTL) per m^3 of discharged wastewater is applied at the binding BOD_5 concentration standard of 250 mg/l.

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[2] BOD_5 indicates a five-day biochemical oxygen demand, i.e. the amount of dissolved oxygen consumed in five days by biological processes breaking down organic matter.

[3] Water and wastewater tariff rates have to be approved by the Panevėžys Municipality which is the main shareholder of the PWC.

As shown in Table 1, each additional "step" of 250 mg/l adds an additional 0.16 LTL to the charge tariff.

Each polluting firm claims and negotiates with the PWC the binding BOD_5 concentration standard for its wastewater discharges. For BOD_5 emissions with average concentrations at *or* below the approved standard, the tariff schedule shown above is applied. If the standard is violated, the tariff rate is tripled.

Although maximum permissible concentrations (mg/l) are established for pollutants other than BOD_5 (e.g., suspended solids, chromium, total nitrogen, zinc, copper and oil products), emissions with average concentrations at or below firm-specific standards are *not* charged.[4] If the standards are violated, polluters pay a substantial fine – its tariff for discharged wastewater is tripled. However, there are no limits established for the discharges of nickel and phosphorus into the sewerage system.

TABLE 1. **The PWC wastewater tariff scheme**

BOD_5 concentration, mg/l (normative)	Tariff, LTL/m^3	Fee tariff, Lt/t
250	0.88	3520.0
500	1.04	2080.0
750	1.20	1599.6
1000	1.36	1360.0
1250	1.52	1216.0
...	...	
3750	3.12	846.6
4000	3.28	820.0

The reason for the exclusive selection of BOD_5 emissions as a wastewater charge basis is the fact that the wastewater treatment equipment possessed by the PWC is technologically oriented towards addressing only the BOD problem (mainly via oxidization of wastewater), and the cost of wastewater treatment mainly depends on the BOD_5 concentration in wastewater discharges *and* on the volume of treated water. Partial removal of the rest of pollutants is just a "side product" of BOD treatment.

However, the PWC pays effluent charges to the government for the discharge of *all* pollutants – BOD_5, suspended solids, oil products, total nitrogen, phosphorus, copper, nickel, zinc and chrome – into the environment, e.g. the river Nevėžis. These discharges are monitored by the local agency of the Ministry of Environment (ME), and the payments are based on the quantity (measured in tons) of pollutants discharged. About 80–90% of all fees paid by the PWC are for non-BOD_5 pollutants. Note that while there are no limits established for discharges of nickel and phosphorus into the sewerage system, the PWC itself pays effluent charges for these pollutants.

Individual limits on BOD_5 discharges (in terms of concentration levels) are granted to enterprises as requested if: (a) the request does not threaten to overload the wastewater treatment capacity of the PWC, (b) an enterprise agrees to pay the costs of connection to the sewerage network. The high penalty rate creates an incentive for enterprises to

[4] Effectively, this charge structure means that BOD_5 dischargers are "cross-subsidizing" dischargers of other pollutants.

secure generous BOD_5 concentration limits in discharged wastewater[5]. Because virtually all limit requests are granted without dispute (due to the reserve of treatment capacity at the PWC), the majority of industrial water polluters usually operate with comfortably high limits.

A closer look at the PWC tariff schedule (Table 1) reveals two interesting features. The first is that the tariff schedule is consistent with the "economies of scale" at the PWC in terms of BOD_5 removal. This feature is reflected in diminishing fees *per ton* of discharged BOD_5 from 3520 Lt/t to 820 Lt/t as the pollutant concentration rises. Table 1 also suggests that the PWC cost elasticity of wastewater volume is considerably higher than the "concentration elasticity", because PWC fees for wastewater discharges into the sewerage system are much more responsive to the growth in the volume of water discharged than to the BOD_5 concentration level.

It should be noted that fees for the discharge of BOD_5-polluted waters – however low they are and however limited incentives they might provide – are higher than the pollution charge rates set by the Ministry of Environment for BOD_5 emissions *directly* into water bodies. This means that it is cheaper to discharge directly into waterways than to send effluents for treatment to the PWC [6].

The PWC does not have special facilities for the treatment of heavy metals, oil or suspended solids in wastewaters. The PWC officials speculated that the problem of heavy metals could be cheaper and more efficiently addressed at the sources of pollution (i.e. by enterprises) before polluted waters are diluted and mixed in the sewerage system. On the other hand, BOD_5 treatment technologies can vary substantially by source of pollution. Thus, it is to be expected that the marginal cost curves of their (pre)treatment are different across enterprises. Analysis of the structure of effluent charges paid by the PWC for the discharge of wastewater into the river Nevėžis reveals that fees for BOD_5 emissions comprised just about 15% of total charge payments. This observation indicates that the PWC could be interested in revising the present wastewater management system to include the remaining eight controlled pollutants into its tariff schedule.

The monitoring of compliance is performed using random inspections by taking effluent probes and analyzing the samples in the PWC laboratory. For the five major BOD_5 dischargers, inspections are carried out every day. The rest are checked anywhere on a monthly or quarterly basis.

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5 Below the limit the incremental charge increase for each concentration level is only 0.16 Lt/m^3.

6 This difference can, at least partly, be explained by the cross-subsidizing character of BOD discharge fees at the PWC. A hint to why the BOD producers, instead of dumping their wastewaters straight into the river, prefer to subscribe to the PWC at such a seemingly outrageous price could be seen in the harshly penalizing structure of the Lithuanian environmental pollution charges where violation of emission standards is met by very stiff penalty tariffs.

Critical design parameters of a tradable discharge credits (TDC) system

Every viable environmental trading programme should include the following parameters (based on Tietenberg, 2006):

- *Universe of participants*. The sources included in the trading programme should be explicitly defined.
- *Nature of TDC*. The definition of the credits that make up an allocation and can be traded. Credits can be expressed in terms of weight, concentration, or some combination of the two.
- *Baseline and allocation*. Determination of the target discharge amount and the allocation of its portions to the enterprises.
- *Creation and use of TDC.* The definition of how discharge credits can be created and what they can be used for.
- *Time validity and banking of tradable permits:* the possibility to store surplus tradable permits for the later use or sale.
- *Administration of trading.* Responsibilities in the monitoring of discharges, verification of credit creation, and registration of trades.

The framework of TDC application to wastewater management

Bearing in mind the above outlined TDC design parameters, the following scheme for "grafting" tradable discharge credits onto the current charge-based wastewater management system is suggested.

Universe of participants: who should be able to trade? Three main alternatives could be considered: (a) the universe of participants should be limited to the several largest polluters, (b) it should include other polluting enterprises as well, (c) it should also embrace households.

The recommended solution would be to include *all* significant industrial dischargers into the trading program (alternative "b"). This conclusion is supported by the following reasoning:

- the more subjects included in the trading program and the greater their marginal abatement cost differentials, the greater the potential cost-saving possibilities of the TDC programme;
- limiting the trading programme to the major polluters can make the potential market for tradable discharge permits pretty thin and therefore is likely to reduce the activity and utility of that market;
- a system which included households would be too clumsy and costly to manage and monitor, i.e. transactions costs would likely outweigh the benefits.

Trading unit(s). Once again, three alternative solutions can be considered. Each of them has its own advantages and shortcomings.

The *first alternative* that might be called "double set 1" would be to express tradable credits by each pollutant in terms of (a) concentration, mg/m^3, and (b) quantity (weight, tons) per unit of time. The following circumstances speak in favour of this approach: concentration of pollutants is an important determinant of PWC costs; pollution charges paid by PWC are calculated based on the weight of discharged pollutants. However, it is unclear *how* reductions in concentration would be traded. While the so called ambient permits system*,* where pollution permits are defined in terms of pollutant concentrations, provides some theoretical insights for such trade, due to the extremely complicated nature it has been discussed so far exclusively on theoretical grounds. Furthermore, there is a complementarity between the two types of proposed trading units, because the concentration equals to "weight/volume".

The *second alternative*, "double set 2", would have two trading units: pollutant discharge credits expressed by weight (tons) per unit of time, and wastewater discharge credits expressed by volume (m^3) per unit of time. The advantages of this solution as seen by the author are the following:

- wastewater volume, which is both the main determinant of the PWC costs and the important factor limiting its processing (pumping) capacity, is explicitly included;
- wastewater volume is the accustomed operational unit both for the PWC and its subscribers;
- credits based on pollutant weight and wastewater volume can be traded independently of each other, because there is no inherent complementarity between the two. Thus, under the proposed scheme, each of the credit market agents would be trading in two relatively separate discharge credit markets – a wastewater credit market (defined in m^3) and a discharged pollutant market (denominated in tons per unit of time);
- due to the fact that the PWC faces the uniform mix of polluted wastewaters discharged by all subscribing enterprises (not the wastewater flows from individual enterprises), another important determinant of collected wastewater treatment costs – concentration of pollutants – is in fact wholly determined by the_total amount (weight) of each pollutant and the total volume of wastewater discharged into the sewage collection system;
- pollution charges paid by the PWC are calculated on the weight of discharged pollutants, i.e. the concentration of pollutants in the effluent is not taken into account.

On the other hand, this approach has the following serious drawbacks:

- discharge credit trading will require the individual allocation and trading of *both* pollutant emissions *and* wastewater discharge limits;

- it creates a "double market", thus complicating the system for both its supervisor and the subscribers;
- except the use of in-plant wastewater recycling, other explicit water-saving methods are doubtful. Therefore, trading in wastewater discharge credits would go rather poorly with the listed above efficiency condition stipulating that polluters should have the technical means to respond to incentives;
- there is an ample reserve of wastewater pumping capacity at the PWC.

The simplest and the most appealing is the *third* alternative which envisages the sole trading unit – tradable pollutant discharge credit expressed by weight (tons) per unit of time and combined with an independent charge for wastewater emissions. The obvious advantages of such approach is "one market" simplicity, the possibility to apply (in case of need) analogous solutions based on accumulated experience with implementing tradable discharge permits elsewhere, and a direct compatibility of this system with the national system of environmental pollution charges that are paid on the weight of discharged pollutants. However, in this case, the system would lack an explicit possibility to account for the second-important determinant of wastewater treatment costs and the limiting factor of effluent processing capacities, i.e. the concentration of pollutants in wastewater effluents. This might become problematic when the limits of wastewater processing capacities are strained (although this is not the case with, the PWC at the moment).

Creation and use of discharge credits. Tradable discharge credits are to be created by discharging an amount of pollution lower than that specified as the limit in an enterprise's discharge permit. Generally, monitoring and verification of credit creation should not be more complicated than the charge-based system for monitoring effluent concentrations and discharged wastewater volumes. In any case, the trading universe should include only those sources that are deemed by the wastewater treatment company to be verifiable and who have a sufficiently accurate record keeping, monitoring and reporting.

Time validity and banking of tradable permits. The seasonal character of BOD_5 discharge intensity indicates that the time validity of discharge permits (and earned credits) and the possibility of their banking for later use are important issues. Taking into account the heavily progressive penalty rates for above-standard emissions into the environment imposed by the environmental protection agencies and the reported constant overrun of wastewater treatment capacities at the PWC in the fall, it is obvious that any intertemporal "exchange rate" for discharge credits should be regulated to prevent overloads of wastewater treatment company's capacities and to prevent them from incurring heavy penalties. Therefore, the following principles for intertemporal pollution trading are proposed:

- establishing a quarterly time-validity for pollution permits, at least for BOD_5 and suspended solids;
- establishing different "exchange rates" between discharge credits earned in the last quarter of a year (October–December), and those earned in the "ordinary"

quarters. Those earned during ordinary quarters would be of relatively lower value (for example, polluters will need two "saved" BOD_5 tons in the first three quarters to be able to emit one ton in the fourth quarter);

- banking of tradable credits' should be allowed, but to avoid excessive accumulation of credits or "excess supply" of pollution credits there should be some fixed "depreciation" of credits (e.g., as a percentage of the "original discharge value") that occurs over time, e.g. 50% loss of the "discharge value" within one year. The renewal of discharge permits (say, for the next year) could be regulated depending on the amount of collected ("unused") ones.

Pollutant pricing. Revising the discharge fee system and expanding it to include non-BOD pollutants generates need to reform the overall system of fees for inflowing wastewater. The following approach is proposed:

- the tariff level for BOD_5 should be based on the higher of two figures: the average annual cost per unit (ton) for BOD_5 treatment (possibly, plus the fair profit rate established for the natural monopoly) and the national basic pollution charge tariff for BOD_5 [7];
- tariff levels for heavy metals, oil and suspended solids should be based on national pollution charge basic tariff rates[8];
- wastewater discharge fees should be based on the PWC water pumping costs (probably close or equal to the fresh water supply fee) plus the fair profit rate established for the natural monopoly.

Baseline and allocations. The baseline for discharges should be established as follows:

- for BOD_5: maximum quantity that the wastewater treatment company can process per unit of time (day, quarter, year);
- for non-BOD pollutants: established limits for the emissions into the environment;
- for wastewater: maximum volume that the wastewater treatment company can process per unit of time (day, quarter, year).

Allocation of the individual discharge allowances to the enterprises could be done in the following way:

- via "grandfathering", i.e. giving a specified amount of allowances to the enterprise free of charge, with quantities based on the historical average of a subscriber's

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[7] An alternative to the *average* cost per unit of BOD_5 is to take the *highest* possible cost of treatment per unit, i.e. costs incurred at the BOD_5 concentration level of 250 mg/l in the processed wastewater. In case of costs lower than the environmental charge basic tariff, setting the BOD_5 price at the national pollution charge level would provide an incentive for the wastewater treatment company to lower its costs of BOD_5 processing, as the difference between the fee and the processing costs would mean a profit for the wastewater treatment company.

[8] Taking into account that some (albeit small) part of these pollutants is captured at no cost along with BOD_5 during wastewater processing by the wastewater treatment company, there exist possibilities for the company to make profits on the difference between the *intake* and *output* of these substances.

performance (in terms of emissions of pollutants) during the last 2–3 years. In this way, both the danger of "cornering the market" would be avoided and the shock of transition to the new wastewater management system could be mitigated;

- via auction, tender bids or free-selling for the difference between the baseline emissions level and the enterprise's historical emissions. Both the existing enterprises and the new entrants should be free to buy permits for a price higher than the usual wastewater treatment company's fee, but lower than the company's penalty fee established for above-limit emissions. To prevent possible attempts to corner the market, some share of discharge permits (e.g., 10% of the total quantity) could be reserved for the new entrants and for *ex post* acquisitions by subscribers if at the end of the year more credits are necessary.

Acquired discharge permits and created credits can be banked for later use or sale, or traded in the TDC market with other market participants. The latter should include subscribers to the wastewater treatment company who are participating in the trading programme and any other entities wishing to take part in the regulation of wastewater pollution (municipality, industrial unions, environmentalists, etc.) as long as they agree to abide by the programme's rules. In case an enterprise exceeds a discharge limit stipulated in its permit, it should be given an opportunity to compensate for the shortfall, either via creation of discharge credits of equivalent value in another period or via *ex post* acquisition of the needed credits. For the monitoring and verification considerations, it seems reasonable that a reconciliation period after which penalty rates will be applied should be defined. Such period could be, for example, one quarter, i.e. three months, which would be equal to the smallest permit life time period. However, to prevent repeated delays that are intentional, this concession should not be given twice in a row.

Administration of trading. The administrator of the trading programme could be either local environmental protection agency or the wastewater treatment company itself. However, exactly the latter, in our opinion, has both the necessary foundation (i.e. accumulated historical data, monitoring capacities, registration and verification experience, etc.) and the interest to supervise the trading process, i.e. the wastewater treatment company should act as a kind of "credit exchange market". In that role, it would be responsible for the following activities: collection and dissemination of information regarding transactions that would be useful for the credit market; verification of credit creation; registration of trades, debiting of sellers' accounts and crediting buyers' discharge accounts.

Conclusions

The study of the feasibility of applying the tradable discharge credits approach to wastewater management (on the example of Panevėžys municipality) revealed that a tradable credit programme could be rather smoothly grafted onto the current charge-based and rigid municipal wastewater management system. More important is that such system

can introduce flexibility to sewerage subscribers, allowing them to select the most cost-effective means of compliance with the discharge limits and abatement burdens. This would most likely lead to the lower overall wastewater treatment costs and a more precise application of the "polluter pays" principle.

While these findings support the hypothesis that formed the basis of the present study, the final conclusions could be made and possible environmental policy changes performed only after carrying out the other consequent steps, namely:

- collection of relevant data on sewerage subscribers for a preliminary assessment of the economic and environmental impacts of the proposed programme;
- carrying out projections of wastewater treatment costs and revenues under various simulated scenarios of pollutant pricing and subscriber behaviour;
- development of an implementation plan that includes a detailed description of implementation steps and a time line.
- development of an operational manual that specifies issues like credit creation, trading protocols, accounting and record keeping.

REFERENCES

1. Bohm, P., Russell, C.S. (1985). Comparative Analysis of Alternative Policy Instruments. Handbook of Natural Resource and Energy Economics. Volume 1. Kneese, A.V., Sweeney, J.L., (eds). Amsterdam: North-Holland, p. 395–460.
2. Harrington, W. (1193). Air and Water Quality Permitting in Lithuania. Working paper, Harvard Institute for International Development, Cambridge (Mass.), p. 26
3. Compton P., Devuyst, D., Nath B. (eds.) (1998). Environmental Management in Practice: Vol 1. New York, Routledge, 544 p.
4. Compton, P., Devuyst, D., Nath B. (eds.) (1999). Environmental Management in Practice. Vol 2. New York, Routledge 1999, 352 p.
5. Čekanavičius L. (1998). Proposal for the pollution management reform in Lithuania: "Pollution Currency" Approach (part 1). Ekonomika, vol. 44, p. 14–36.
6. Freeman, J., Kolstad, C. (eds.) (2007). Moving to Markets in Environmental Regulation: Lessons from Twenty Years of Experience. New York: Oxford University Press, 500 p.
7. Kraemer, R.A., Kampa, E., Interwies, E. (2004). The role of tradable permits in water pollution control. Working Paper, Inter-American Development Bank, October. Retrieved on December 16, 2009, from http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=1481959
8. OECD (1999). Implementing Domestic Tradable Permits for Environmental Protection. OECD Publishing, 256 p.
9. Rietbergen-McCracken, J., Abaza, H. (eds.) (2000). Economic Instruments for Environmental Management: A Worldwide Compendium of Case Studies. London, Earthscan, 256 p.
10. Stavins, R. (2003). Experience with Market-Based Environmental Policy Instruments. Handbook of Environmental Economics. Volume I. Mäler, K.G. Vincent, J. (eds.), Amsterdam: Elsevier, p. 355–435.
11. Tietenberg, T. H. (2006). Emissions Trading: Theory and Practice. 2nd ed. Washington, Resources for the Future, 230 p.