

## Comparative Evaluation of Experience in Environmental Tax Reforms in Chosen EU States

### Analiza porównawcza skutków reform systemów podatków środowiskowych w wybranych państwach Unii Europejskiej

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#### Abstract

The research presents the analysis and comparison of environmental tax reforms in the countries of the European Union, which are an effect of political decisions. The main focus in evaluation of environmental tax reforms is put on the results of improvement of environmental quality and maintenance of revenue neutrality that may be used to determine the appropriateness and benefit of the reform in the countries. The following countries which have implemented the environmental tax reforms have been chosen for the empirical study: Denmark, Germany, the Netherlands, Finland, Sweden, and the United Kingdom. Criteria of evaluation of environmental tax reforms have been determined, namely, the effect of environmental taxes on state revenue; economic-social effects of environmental taxes; the effect of environmental taxes on reduction of environmental pollution. The empirical quantitative and qualitative study has been conducted for analysis of the dynamics of the quantitative indicators by looking at their variation trends, determining the values of qualitative indicators and significance of quantitative and qualitative indicators, and applying the correlation analysis. The results of the study have suggested that the countries which have implemented the environmental tax reforms have achieved environmental, economic, and social aims. Environmental (energy intensity, GHG emissions productivity), economic-social (the share of environmental taxes in state revenue, labour productivity) indicators of the countries have improved during the analyzed period. The environmental tax reforms have not put any significant burden of taxation on the society, while some of the countries (the United Kingdom, the Netherlands) have even achieved the neutrality of state revenue.

**Key words:** Environmental taxes, environmental tax reform, the EU, comparative evaluation

#### Streszczenie

Problematyka zrównoważonego rozwoju, a zwłaszcza jej relacje prawno-ekonomiczne są ściśle związane z zagadnieniem ochrony środowiska. Zachowanie stanu środowiska naturalnego przy jednoczesnym rozwoju społeczno-gospodarczym wymaga dodatkowych nakładów finansowych. Z tego powodu powszechnie stosowanym rozwiązaniem jest nakładanie przez władze publiczne różnych obciążeń, w tym podatków i opłat środowiskowych. Zadaniem tych instrumentów fiskalnych jest pozyskiwanie środków na zabezpieczanie i odnawianie zasobów środowiska naturalnego. Jednocześnie też efektywność procesu wymaga oceny wpływu stosowanych rozwiązań na jakość środowiska naturalnego.

Kraje UE w różny sposób kształtują swoje systemy fiskalne, co determinuje zarówno wysokość i zasady naliczania podatków i opłat środowiskowych, jak i kształtuje efektywność tych systemów. Szczególne znaczenie mają w tym kontekście względy polityczne i konsekwencje prowadzonych reform. Z tego powodu niezbędne jest prowadzenie analiz i porównań ekologicznych reform podatkowych w wybranych krajach Unii Europejskiej.

Jednymi z zasadniczych kierunków oceny reform podatków środowiskowych są: poprawa jakości i utrzymanie zasobów środowiska. Są one szczególnie przydatne do ustalenia zasadności i korzyści z przeprowadzonych reform. Badaniem objęto następujące państwa: Danię, Niemcy, Holandię, Finlandię, Szwecję i Wielką Brytanię. Za główne kryteria oceny przyjęto wpływ podatków środowiskowych na dochody państwa, skutki ekonomiczno-społeczne oraz zmniejszanie zanieczyszczenia środowiska. Służyło to ustaleniu – na podstawie dynamiki wskaźników ilościowych oraz trendów zmienności – wartości wskaźników jakościowych. Efektem badań było wykazanie, że państwa, które wdrożyły reformy podatków środowiskowych osiągnęły założone cele środowiskowe, gospodarcze i społeczne. Oceniane reformy nie zwiększyły obciążeń podatkowych społeczeństwa, a w niektórych krajach, takich jak Wielka Brytania czy Holandia zaobserwowano nawet neutralność dochodów państwa. Dostosowanie podatków ekologicznych do zasad opodatkowania w najlepszy sposób przeprowadzono w Szwecji. W pozostałych państwach zidentyfikowano natomiast potrzebę usprawniania pro-środowiskowych systemów podatkowych.

**Słowa kluczowe:** podatki ekologiczne, reforma podatków ekologicznych, UE, ocena porównawcza

## Introduction

As environmental pollution levels and the use of natural resources are rapidly growing throughout the world environmental protection has captured increasing attention. Environmental protection has been a topic for various discussions and research because economic and social progress depends on the preservation of the state of the environment, landscape and biodiversity and also on the rational use of natural resources. All the aspects of sustainable development are connected with legal documents. However, in no other case is this connection so strong as with reference to law-economy relations. In the free market, where everything is expressed in money, different economic tools play a significant part (Pawłowski, 2006). With a view to promoting national economic development and protecting the environment, in the world's practice it is common to impose environmental taxes (Graczyk, 2009) on the activities adversely affecting the environment, which also encourages investments in new environmentally sustainable technologies.

As maintained by scientists, a key measure of the fiscal policy is connected with green taxes regulating the interaction of economy and environment. Revenue from these taxes is used to promote a sustainable economy based on natural environment protection and more environmentally friendly production. Environmental taxes not only purposefully reduce pollution and promote sustainable national development but also lead to changes in the national tax structure, i.e. increase the tax base that does not distort the market (taxes on products and services having an adverse environmental impact) and reduce the tax base that distorts the market (corporate income tax, personal income tax, etc.).

Not a few countries of the world (Sweden, Germany, the Netherlands, Denmark and others) have implemented green tax reforms, i.e. for the purpose of sustainable development either introduced new eco-taxes into their tax systems or raised the existing ones and reduced taxes on labour/capital. Most scientists (Ekins, 2011; Parry, 2012; Conrad, Loschel, 2005; Albrecht, 2006; Fullerton, Leicester, Smith, 2010; Pedersen, 2005; Patuelli, Nijkamp, Pels, 2005)

examined the possible benefit of environmental taxes for national economies and the outcomes of introducing these taxes. They maintain that encouragement to introduce these taxes is one of the best ways of minimising damage caused to the environment. In studies and discussions these taxes are commonly referred to as positive. It is maintained that depending on economic-social and political situations their introduction can adjust distortions in the tax system. However, there is no sufficient information about the actual influence of these taxes on the *greening* of economy, the national budget and social security improvement, also about the states in which green tax reforms have produced the best results for the economy, social sphere and environmental protection.

**The aim of research** is to analyse and compare environmental tax reforms in EU countries.

**The object of research** is environmental tax reforms.

### Research tasks:

- To develop a methodology for the assessment of environmental tax reforms.
- To evaluate the results for the economy, social area and environmental protection achieved by individual countries having introduced environmental tax reforms.

To achieve the aim general **research methods** were employed: induction and deduction, comparative analysis, correlation and regression analysis, and graphical representation.

### Research methods

Economy and nature (ecosystem) have always been interrelated and complementary systems. An ecosystem has a direct impact on economic growth as it is a provider of what is necessary for a full-fledged human life and society development. However, where only economic growth is pursued disregarding the impact of economy on the ecosystem, in the long-term this may have a feedback on the economy itself and at the same time on each member of the society in different aspects: increased pollution emissions, health problems, degradation of natural resources, etc. One of the instruments to address these problems – environmental taxes. Environmental taxes mean

taxes that are imposed on an adverse environmental impact and the use of environmental resources. Scientists and researchers (Musu, I., 2010, according to Brock and Taylor, 2005) point out the paramount factors behind the impact of economic activities on natural environment:

- 1) growth of the scale of the economic system (scale effect);
- 2) changes in the productive structure (composition effect);
- 3) impact of technological development (technique effect).

Recently, scientists and authorities worldwide have increasingly focused on environmental protection and measures for its implementation. On 4-5 November 2009, the European Economic and Social Committee shared Sweden's opinion on the subject *Towards an Eco-efficient Economy* that economic crisis presents both a threat and an opportunity for breaking the mould and adopting a win-win eco-efficiency fiscal strategy that will help to revive the economy, improve its competitiveness and create new jobs, at the same time transforming the energy base and reducing emissions substantially. One of the steps to achieve that is to promote and encourage green fiscal reforms.

United Nations Conference on Sustainable Development, Rio+20, held in Rio de Janeiro (Brazil) in 2012, acknowledged that the green economy was the main tool to achieve sustainable development. Environmental taxes make an inseparable part of the green economy.

Analysis of environmental tax reforms mainly focuses on determining whether or not these reforms are efficient and meet state's expectations. Works by many authors (Albrecht, 2006; Bosquet, 2000; Ciaschini, 2011; Fernandez, Perez, Ruiz, 2011; Fraser, Waschik, 2013; Fouquet, Johansson, 2003; Kosonen, Nicodeme, 2009; Fullerton, Leicester, Smith, 2007; Štreimikienė, Bubnienė, 2005; *et al.*) principally focus on results showing environmental quality improvement and national budget revenue neutrality maintenance which provide scientists with the basis for determining the suitability and utility of reforms in countries. On the basis of the aforementioned scientists' works the authors of the article have pointed out three criteria for assessing environmental fiscal reforms. Thus, the current economic, social and environmental dimensions are evaluated using these criteria:

- the impact of environmental taxes on state budget revenue;
- economic-social efficiency of environmental taxes;
- the impact of environmental taxes on environmental pollution reduction.

It is important to implement an environmental fiscal reform, on the basis of the general equilibrium concept, so that the state budget revenue equilibrium is not upset. In the fiscal policy it is desirable that the

tax base should remain stable when taxes are introduced or increased. It is possible to achieve sustainable revenue through levying taxes on products/services that are inelastic in respect of consumer demand. Meanwhile, the objective of environmental protection is to reduce emissions or the use of products causing pollution, thus reducing the tax base, which would, in turn, reduce tax revenue. These are the most important criteria for environmental tax reform assessment which were used by OECD countries in adopting decisions on sustainable development.

Therefore, it is vital that environmental tax reforms are effective and yield not only economic benefits but also have an environmental effect. A survey of scientists' and researchers' works has shown the lack of comprehensive studies assessing the efficiency of green fiscal reforms because it is a difficult and complex process.

While surveying green fiscal reforms in the context of EU states the main outcomes of reforms are measured. The outcomes are evaluated using the comparative, and correlation and regression analyses. Applying such research method the authors of the article use the below ratios.

The analysis of environmental tax reforms in EU countries uses the environmental tax revenues/ GDP ratio (Speck, Jilkova, 2005):

$$\text{Ratio to GDP} = \frac{\text{Revenue from environmental taxes}}{\text{Gross domestic product}} \quad (1)$$

This ratio can show the share of environmental taxes in GDP. After adjusting the formula presented by Speck and Jilkova (2005), the share of environmental taxes in gross state tax revenue (GSTR) can be determined:

$$\text{Ratio to GDP} = \frac{\text{Revenue from environmental taxes}}{\text{Gross state tax revenue}} \quad (2)$$

Environmental taxes have a positive impact on tax revenue if this ratio has a growing tendency; however, if the ratio remains unchanged, it can be stated that introduction of environmental taxes has no importance to the state budget.

For the purpose of assessing the impact of environmental tax reform on state budget revenue, Miguel and Manzano (2011) suggest using the formula:

$$G_t = \tau_t^c c_t + \tau_t^h p^h e h_t + \tau_t^f p^f e f_t + \tau_t^w w_t n_t + \tau_t^k r_t k_t + T_t \quad (3)$$

where:  $G_t$  – government budget revenue;  $\tau_t^c c_t$  – other state tax revenue;  $\tau_t^h p^h e h_t$  – revenue derived from energy consumption by households;  $\tau_t^f p^f e f_t$  – revenue from energy used in production;  $\tau_t^w w_t n_t$  – revenue from labour taxation;  $\tau_t^k r_t k_t$  – revenue from capital;  $T_t$  – transfers.

The suggested formula makes it possible to evaluate how environmental taxes impact gross national revenue and how the share of revenue from other collected taxes, particularly labour taxes being one of the main instruments of environmental tax reforms, changes.

The economic-social efficiency of environmental taxes is determined by analysing population employment in individual countries which is determined by social security contributions paid by employers. To determine efficiency the authors of the article use the formula suggested by Ekins (2011):

$$\text{Labour productivity} = \frac{\text{Gross domestic product}}{\text{Population employment}} \quad (4)$$

The ratio shows the value of social security contributions in a country. In order to measure economic-social efficiency resulting from environmental taxes when other factors are stable, the ratio of labour productivity has to be analysed together with population employment levels. Ekins (2011) analysed how that indicator changed over a certain period of time in a country having implemented environmental tax reforms. In the interests of higher employment levels, countries reduced social security contributions payable by employers and raised environmental taxes. It can be stated that when a level of employment, and at the same time the ratio of labour productivity, is growing and an increasing amount is collected in environmental taxes, the economic-social efficiency of environmental taxes is achieved. The impact of environmental taxes on environmental pollution abatement was analysed using the following ratios (Bongaarts, 1992):

$$\text{Energy intensity} = \frac{\text{Amount of consumed energy}}{\text{Gross domestic product}} \quad (5)$$

Energy intensity shows the amount of energy consumed for the production of one relative unit of production. Energy intensity over a certain period is analysed when other factors are unvarying. The decrease of this ratio shows efficient energy consumption and sustainable development of a country and at the same shows that environmental taxes fulfil their function, i.e. promote the efficient use of natural resources. However, the efficient use of energy is in relation not only with reduced use of natural resources but also with the abatement of pollution emissions. Consequently, environmental taxes should encourage more efficient use of the sources of energy, and investments in environmentally sound equipment, technologies and vehicles for the purpose of cutting emission levels.

In implementing the energy policy in the area of renewable energy sources EU countries act in conformity with EU and national legislation and IRENA (International Renewable Energy Agency) directives (Renewable..., 2014). The EU Climate Change Package has set ambitious targets regarding climate change management until 2020:

- a 20 % (or 30 % in the event of agreement between countries) reduction in greenhouse emissions from 1990 levels;
- raising the share of energy consumption to 20 %;
- a 20 % share of consumed energy must be produced from renewable sources (including a 10 % share from biofuels).

In order to achieve a 20 % consumption of energy from renewable energy sources on EU scale until 2020 the states act in conformity with the EU Directive on the promotion of the use of energy from renewable sources. The Directive provides for the package of legal measures aimed at encouraging renewable energy development nationwide, and introduces the mechanisms of cooperation among EU states for achieving common goals in this area (Directive on the promotion..., 2009). This Directive regulates the guarantees of origin of energy and lays down sustainability criteria for biofuels used in the transport sector.

Thus, a change in the amount of greenhouse gas emissions in the environment is evaluated pursuant to international directives and provisions under which the states are obliged to abate environmental pollution:

$$\text{Greenhouse gas emission productivity} = \frac{\text{Gross domestic product}}{\text{Greenhouse gas emission amount}} \quad (6)$$

Using this ratio (Ekins 2011) the amount of GDP is determined when one greenhouse gas emission unit is released into the atmosphere, while other factors do not change. The increase of this indicator shows that national production and services have a less harmful effect on the environment, as the production of one GDP unit results in lower environmental pollution levels.

The EU countries selected for research on the basis the aforementioned ratios: Sweden, Denmark, Germany, Great Britain, the Netherlands, and Finland. The enumerated countries are among the first to implement environmental tax reforms as already before the start of reforms they paid major attention to the environment and ecology (e.g. Sweden) and are economically strong states of Northern Europe.

The period 2000-2011 has been selected for a comparative analysis of the results of environmental tax reforms. Such a selection was prompted by the fact that the aforementioned states launched green tax reforms in different years from 1990 (Sweden) to 1999 (Germany). Considering that the environmental tax reform provides performance results in terms of economy and eco-friendliness in the long-run only, it is expedient to evaluate the results that have already been achieved.

The comparative analysis of environmental tax reform was carried out using the method of correlation and regression analysis. First, the analysis covered the relationship between tax revenue productivity and these factors: the labour tax share in state expenditure, the corporate income tax share in state expenditure and the environmental tax share in state expenditure. The correlation analysis used data for 2000-2011 since environmental tax reforms were launched in 1990 and the last reform at issue was implemented only in 1999; therefore, a period that is the same for each country was selected for the analysis of taxation principles. Taxation principles, in this case the productivity of tax receipts, were ana-

lysed through the employment of *PASW Statistics* software using Spearman's rank correlation coefficient –  $r_s$ . A dependent variable – the productivity of tax receipts, and the aforementioned factors – independent variables were selected during analysis. Also, the correlation analysis was carried out in order to determine the dependence between state budget revenue (dependent variable) and certain taxes (independent variables), i.e. the analysis examined whether or not a strong relationship existed between environmental taxes and other taxes as well as state revenue.

To analyse economic-social and environmental indicators, linear regression equations were made and a different research period for each state depending on the start of reform implementation was selected. However, for the insufficiency of information on income from environmental taxes until 1995 it is important to take into account the fact that the years during which countries implemented reforms are not included in the period of analysis as the outcomes of reforms could be measured only after a year elapsed from their implementation. The analysis was performed on the assumption that other factors affecting the indicators at issue did not change. For this reason the analysis has selected income from environmental taxes as an independent variable ( $x$ ) (EUR million) and labour productivity ( $y_1$ ), energy intensity ( $y_2$ ), greenhouse gas emission productivity ( $y_3$ ) – dependent variables. Hence, the regression relationship is determined using the Excel function *Data Analysis* and composing a linear equation:  $y = a + bx$ . It has to be noted that the data of analysis are distorted by a financial-economic recession Europe slipped into several years ago. Therefore, until 2008 the data of analysis have one tendency of change, while change unsteadily in some countries in 2008-2011.

The EU's countries Sweden, Denmark, the Netherlands, Germany, Finland and Great Britain have been selected for research. The aim of environmental tax reforms in these countries was to levy taxes on energy consumption and CO<sub>2</sub> emissions by correcting the existing green taxes, reduce income taxes and social security contributions (Speck, Jilkova, 2010). Conditions were promoted for the business sector to receive support for investments in the efficiency of energy consumption. This enabled the comparison of results. The research used data presented in the EU-ROSTAT's database.

### Research results

Environmental taxes are aimed at rearranging the tax system so that the economic-social and environmental factors responsible for sustainable development are promoted. Compliance by these taxes with taxation principles was determined according to taxation principles (fairness, the productivity and elasticity of tax receipts, and administrative simplicity), whereas environmental tax reforms were evaluated according

to special criteria: the influence of environmental taxes on state budget revenue (the share of environmental taxes in GDP and state revenue), the economic-social efficiency of environmental taxes (labour productivity); the influence of environmental taxes on environmental pollution abatement (energy intensity, the productivity of greenhouse gases).

In order to determine whether or not environmental taxes distort the tax system the degree of compliance by environmental taxes with taxation principles is evaluated.

The fairness of taxation is analysed according to fair income taxation which is measured by the Gini coefficient (Table 1).

Table 1. Gini coefficient in percent, 2000-2011, source: own elaboration

Year	Denmark	Germany	Netherlands	Finland	Sweden	Great Britain
2000	22.0	25.0	29.0	24.0	24.3	32.0
2001	22.0	25.0	27.0	27.0	24.0	35.0
2002	23.5	25.5	27.0	26.0	23.0	35.0
2003	24.8	26.3	27.0	26.0	23.2	34.0
2004	23.9	26.0	27.0	25.5	23.0	33.0
2005	23.9	26.1	26.9	26.0	23.4	34.6
2006	23.7	26.8	26.4	25.9	24.0	32.5
2007	25.2	30.4	27.6	26.2	23.4	32.6
2008	25.1	30.2	27.6	26.3	24.0	33.9
2009	26.9	29.1	27.2	25.9	24.8	32.4
2010	26.9	29.3	25.5	25.4	24.1	32.9
2011	27.8	29.0	25.8	25.8	24.4	33.0
Relative change in percentage points (2011 against 2000)	26.36	16.0	-11.03	7.5	0.41	3.13

The research has found that the values of the Gini coefficient changed quite unevenly (Table 1). Sweden showed the smallest change in the inequality of after-tax income distribution which remained nearly stable, i.e. an increase of 0.41 percentage points in 2011 compared to 2000. In Denmark the Gini coefficient had an increasing tendency of 26.36 percentage points. In the Netherlands the inequality of income distribution had an inverse change tendency compared to other countries, i.e. income inequality dropped 11.03 percentage points. This leads to the conclusion that the inequality of after-tax income distribution among residents is gradually decreased seeking fairness of the tax system, meanwhile in Denmark the Gini coefficient was approaching a 30% limit. Consequently, the Netherlands best coordinated the introduction of environmental taxes with the reallocation of traditional taxes. Compared to other countries, Great Britain recorded the highest Gini indicator which was in excess of 30%. Considering the Gini coefficients of all the countries in question it was observed that they stood at around 30%, which shows that the tax systems were close to the limit of injustice. Evaluation of the Gini ratios in

Table 2. Tax receipts productivity indicator, 2000-2011, Source: own elaboration

	Year	Denmark	Germany	Netherlands	Finland	Sweden	Great Britain
Total taxes/ State expenditure	2000	0.89	0.52	0.54	0.72	0.70	0.81
	2007	0.94	0.53	0.54	0.65	0.74	0,67
	2011	0.81	0.51	0.47	0.56	0.72	0,60
Relative change in percent (2011 against 2000)		-8,99	-1.92	-12.96	-22.22	2.86	-25.95
Environmental taxes/ State expenditure	2000	0.088	0.053	0.085	0.065	0.051	0,081
	2007	0.091	0.051	0.081	0.058	0.052	0,056
	2011	0.070	0.050	0.075	0.057	0.049	0,055
Relative change in per cent (2011 against 2000)		-20,60	-6.81	-12.41	-12.54	-3.16	-32.94

Table 3. Correlation analysis of the shares of labour, profit and environmental taxes in state expenditure and the productivity of tax receipts in EU countries, source: own elaboration

Country	Spearman's rank correlation coefficient	Labour taxes	Profit taxes	Environmental taxes	Productivity of tax receipts
Denmark	Correlation coefficient	0.519	0.965	0.835	1
	p-value	0.042	0.000	0.000	
Germany	Correlation coefficient	0.181	0.640	-0.430	1
	p-value	0.287	0.013	0.082	
The Netherlands	Correlation coefficient	0.450	0.897	0.897	1
	p-value	0.071	0.000	0.000	
Finland	Correlation coefficient	0.931	0.896	0.756	1
	p-value	0.000	0.000	0.002	
Sweden	Correlation coefficient	-0.306	0.555	0.302	1
	p-value	0.167	0.030	0.170	
Great Britain	Correlation coefficient	0.991	0.832	0.864	1
	p-value	0.000	0.000	0.000	

the countries having introduced environmental fiscal reforms leads to the conclusion that the introduced environmental taxes weren't fully coordinated with traditional taxes and failed to ensure the neutrality of state budget revenue which was to be attained in nearly all states.

While evaluating the productivity and elasticity of tax receipts the importance of tax receipts for national budgets is determined. Following the principle of productivity of tax receipts it is necessary to ensure such revenue from taxes which would cover country's expenditure and ensure the exercise of its functions (Table 2).

As the results show, in the period 2000-2011 the productivity of tax receipts had a growing tendency in Denmark, Germany and Sweden until 2007, while from 2008 this indicator decreased. This resulted from the worsening of Europe's financial-economic situation from 2008: enterprises in bankruptcy, increased redundancies, declined investments and other negative factors which decreased state tax revenue and increased state expenditure in an attempt to cope with the exacerbating economic situation. Yet, the highest productivity of tax revenue as regards the share of total taxes and the share of environmental taxes covering state expenditure was maintained in Denmark, accounting for 87 % and 8.4 % of the total public expenditure, respectively. The smallest share of total tax receipts and environmental taxes in state expenditure was found in Germany representing, on

the average, 48 % and 5.16 % of the total expenditure. Hence, despite decreased productivity indicators due to economic recession, Sweden is the only of all the countries in question that enjoyed an increase in productivity of nearly 3 %. Meanwhile, Denmark's tax system is the most productive, although it showed a small decreasing tendency in 2000-2011.

Introduction of environmental taxes had a diverse effect on the productivity of tax receipts due to improvements being made in the tax system by cutting some taxes. Assuming that other factors, except labour taxes, profit taxes and environmental taxes, do not vary, it is determined which taxes had a major impact on the productivity of tax receipts. Using the Spearman's rank correlation coefficient with a p-value = 0.05 it was determined that the productivity of tax receipts in Denmark, Finland and Great Britain was strongly dependent on all aforementioned taxes, as their  $p < 0.05$ , and the coefficient of determination ( $R^2$ ) ranged from 0.519 to 0.965 (Table 3). Equally, the relationship between the share of environmental taxes in state expenditure and productivity thereof was strong in the Netherlands. Countries' productivity indicators were most affected by the profit tax as the profit tax share in state expenditure in all the countries had a p-value  $< 0.05$  and a high  $R^2$ . A change in the productivity of tax receipts in Denmark can be explained by a 96.5% change in the share of the profit tax in state expenditure.

Table 4. Environmental tax elasticity indicator, 2000-2011, source: own elaboration

Year	Denmark	Germany	Netherlands	Finland	Sweden	Great Britain
2000	-0.50	2.81	0.86	-0.15	0.68	0.74
2001	0.94	3.05	0.50	-0.05	0.80	-2.22
2002	1.83	0.96	0.07	1.90	1.41	0.57
2003	-0.54	8.22	1.71	4.30	1.09	1.63
2004	1.69	-1.09	2.18	1.27	0.51	0.78
2005	1.07	-1.23	1.53	-0.40	1.50	-0.20
2006	0.70	0.27	1.50	0.53	0.38	0.38
2007	0.30	-0.60	-0.06	-0.15	0.41	1.44
2008	-2.08	0.33	1.54	0.37	-0.59	1.03
2009	2.35	-0.30	0.68	1.24	0.63	0.51
2010	1.20	-0.22	1.31	2.37	0.81	1.20
2011	1.46	1.44	-0.25	2.96	0.18	0.51
Average	0.70	1.14	0.96	1.18	0.65	0.53

Table 5. Administrative simplicity indicator, 2000-2011, source: own elaboration

Year	Denmark	Finland	Germany	Netherlands	Sweden	Great Britain
2000	0.79	0.73	1.10	1.70	0.52	1.02
2001	0.81	0.77	1.17	1.74	0.55	1.06
2002	0.73	0.82	0.98	1.76	0.56	1.11
2003	0.87	0.82	1.45	1.39	0.57	1.04
2004	0.83	0.80	1.38	1.30	0.59	0.97
2005	0.74	0.79	1.66	1.35	0.38	1.10
2006	0.63	0.78	1.55	1.15	0.39	1.12
2007	0.62	0.77	1.38	1.11	0.41	1.10
2008	0.64	0.80	1.36	0.99	0.39	1.12
2009	0.67	0.87	1.46	1.11	0.40	1.14
2010	0.76	0.84	1.50	1.02	0.41	0.98
2011	0.71	0.80	1.40	0.97	0.40	0.83
Relative change in percent (2011 against 2000)	-10.13	9.59	27.27	-42.94	-23.08	-18.63

However, measurement of the productivity of tax receipts alone is not enough as it is closely relating with the elasticity of the tax system showing how a country's tax receipts react to economic conditions. In some years the environmental tax elasticity indicator had a negative value in all states, which shows a reverse changing direction of revenue from green taxes in respect of GDP, i.e. there was no linear dependence between these factors. This notwithstanding, the average elasticity indicator was the highest in Finland and Germany accounting for 1.18 and 1.14, respectively (Table 4). Evaluation of the general situation of these states suggests that the tax system was elastic during the years at issue. It is evident from the general situation of the tax system in 2000-2011 that Great Britain's elasticity indicator was the lowest (0.53, on the average). Hence, Great Britain's GDP changed more rapidly than revenue from environmental taxes, i.e. environmental taxes had no major effect on the increase of GDP.

The principle of administrative simplicity of taxation is measured in terms of the price of state tax collection. Based on OECD studies, the administrative complexity of all taxes was measured.

During the period analysed the price of tax administration showed a decreasing tendency in all countries except Finland and Germany (Table 5). In Germany the price of tax collection went up 27.27 %,

although the price was decreasing in 2005-2011. The biggest fall in the price of tax collection was seen in the Netherlands (almost 43 %). In Germany, the Netherlands and Great Britain tax administration is quite expensive as the administrative simplicity indicator is above one. However, in Germany the process of tax administration is complicated. Thus, tax administration requires improvement. According to Vlassenko (2001), it is desirable that the administrative simplicity indicator should stand at 1 to 3 %, in which case the state tax system is evaluated positively. In this context only Sweden satisfies this indicator, i.e. the price of tax collection in this state is the lowest.

Evaluation of the tax systems according to taxation principles in the countries having implemented reforms suggests that Sweden's tax system best corresponds to the classical principles of taxation. Yet, it can be further improved according to the elasticity of tax receipts and the Gini coefficient. Indicators for the productivity of tax receipts and administrative simplicity during the period in question show an improving situation of the tax system. Tax systems in other states require yet greater improvement in order to have the effective and efficient fiscal policy.

Evaluation of environmental fiscal reforms according to the specified criteria is a complicated process for the existence of a number of side and additional

factors impeding measurement of the efficiency of reforms. Therefore, a correlation and regression analysis was carried out and a comparison was made of the selected economic, tax system and environmental indicators used to measure post-reform outcomes.

The evaluation of environmental tax reforms first analysed revenue derived from environmental damage taxation.

The aim environmental tax reforms is to collect the largest possible amount of revenue from these taxes and make it possible for the state to exercise its functions, i.e. to protect the natural environment against damage to it and encourage economic-social processes.

Although revenue from green taxes showed a growing tendency in all countries during the period in question, in 2011 compared to 2000 the share of this revenue in GDP decreased or remained stable (Finland, the Netherlands).

It has been determined that the share of environmental taxes in the total national budget revenue increased only in Sweden and Finland, up to 10.15 % and 15.99 %, respectively. The largest share of environmental tax revenue in the total collected tax revenue was in Finland. Environmental taxes in Finland are believed to have the biggest influence on the budget as in 2000-2011 environmental taxes grew more rapidly than gross state revenue. The smallest influence of environmental taxes on state budget revenue was determined in Great Britain where these taxes represented, on the average, around 6.1 %.

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The countries at issue have levied taxes on energy as the most important component of green taxes and have introduced a tax on pollution/natural resources, which represents a smaller share of environmental taxes compared to the energy tax. The impact of a tax is described by how it affects the prices of goods and what alternatives are available. Consequently, even a small tax on pollution can have a major impact on the natural resources used if it changes the relative price of a good. No taxes may be levied on petrol and coal throughout the world but they can be subsidised, which creates preconditions for different prices of fuel.

It is noteworthy that the structures of environmental taxes in Germany and Sweden slightly differ from those in other countries.

Energy taxes in them amount to over 80 % of the total collected environmental taxes. Compared to the average of other countries, the share of these taxes in Germany and Sweden is 11 % larger. The total taxes on vehicles and pollution/natural resources, on the average, amount to 8 %. This shows that Germany and Sweden mainly focus on energy taxation and do not absolutely efficiently use the potential of taxes as an instrument of environmental pollution and transport taxation since the major share of taxation falls on energy disregarding other sources of pollution. In the meantime other countries (Finland, the Netherlands, Denmark) have distributed environmental taxes more evenly.

Yet, it is important to take into account not only how environmental taxes affect countries' GDP and budget revenues but also how the implemented environmental fiscal reforms affected the collection of other taxes (capital, labour). According to data given in Table 6, in most cases energy taxes (paid by enterprises) and profit taxes had no influence on increasing revenue. The strongest dependence was identified between national budget revenue and labour taxes and this dependence can be accepted because  $p < 0.05$ . Change in labour taxes in EU states has a big impact on the change of budget revenue because  $0.8 < r_s < 1$ . Energy taxes paid by households also have a considerable impact on state budget revenue in all the countries excluding Great Britain. No dependence between taxes on energy and state budget revenue was found in Great Britain because  $p > 0.05$ . The greatest impact on change in state budget revenue was made by profit taxes and labour taxes because  $p < 0.05$ , and  $R^2 > 0.8$ .

In the opinion of Andersen and Ekins (2010), revenue from environmental taxes expressed as the share of total tax revenue or GDP is regularly used as an indicator illustrating the importance of the environmental tax policy in a country. Such information, however, should be interpreted with caution as it says nothing about the suitability of the entire fiscal policy or environmental policy for the country's environment. It is important to measure the impact of environmental taxes on economic-social factors, i.e. labour productivity in a country.

The aim of environmental fiscal reforms was to reduce environmental pollution and improve social and economic factors. Therefore, introduction of new environmental taxes was followed by the reduction of taxes on labour with the aim of creating more jobs, thus ameliorating society's social environment. It has been determined that in 2000-2011 labour productivity was growing in all the countries. With population employment levels improving GDP was growing. However, with the onset of economic recession in 2008 labour productivity indicators worsened, because population employment levels lowered and countries no longer produced the pre-recession amount of GDP. With population employment levels growing the share of labour taxes in GDP, in-



Table 6. Correlation analysis of revenue and taxes of the state budget in EU countries, source: own elaboration

Country	Spearman's rank correlation coefficient	Energy taxes (household)	Energy taxes (enterprises)	Profit taxes	Labour taxes	Total revenue
Denmark	Correlation coefficient	0.797	0.376	0.847	0.947	1.000
	p-value	0.000	0.151	0.000	0.000	
Germany	Correlation coefficient	-0.685	0.587	0.755	0.790	1.000
	p-value	0.014	0.045	0.005	0.002	
Netherlands	Correlation coefficient	0.900	0.986	0.057	0.982	1.000
	p-value	0.000	0.000	0.840	0.000	
Finland	Correlation coefficient	0.767	0.758	-0.015	0.974	1.000
	p-value	0.001	0.002	0.958	0.000	
Sweden	Correlation coefficient	0.826	0.951	0.909	0.980	1.000
	p-value	0.000	0.000	0.000	0.000	
Great Britain	Correlation coefficient	0.479	0.114	0.811	0.993	1.000
	p-value	0.071	0.685	0.000	0.000	

Table 7. Regression correlation between labour productivity (EUR one thousand per person) and environmental tax revenue (EUR million), 1995-2011, source: own elaboration

	Denmark	Germany	Netherlands	Finland	Sweden	Great Britain
Type of equation	Linear	Linear	Linear	Linear	Linear	Linear
Coefficient of determination R <sup>2</sup>	0.545	0.405	0.739	0.770	0.962	0.793
p-value	0.001	0.026	0.000	0.000	0.000	0.000
Coefficient a	37998.63	16880.95	36260.888	3302.959	2323.662	-14836.583
Coefficient b	4.175	0.812	1.427	13.121	7.900	1.662

Table 8. Regression relation between energy intensity (kg/EUR 1 000 GDP) and environmental tax revenue (EUR million), 1995-2011, source: own elaboration

	Denmark	Germany	Netherlands	Finland	Sweden	Great Britain
Type of equation	Linear	Linear	Linear	Linear	Linear	Linear
Coefficient of determination R <sup>2</sup>	0.789	0.259	0.944	0.588	0.937	0.654
p-value	0.000	0.091	0.000	0.001	0.000	0.000
Coefficient a	256.580	332.466	294.561	435.072	445.31	350.981
Coefficient b	-0.017	-0.003	-0.007	-0.044	-0.033	-0.005

cluding social security contributions and personal income taxes, decreased. Although the Netherlands reduced the personal income tax and social security contributions payable by employers and taxed products causing damage to nature, the share of labour taxes in GDP grew – in 2011 compared to 2000 it grew 0.9 percentage points. The biggest decrease, 5 percentage points, was recorded in Sweden; however, yet this resulted in an increase in population employment of 1.7 percentage points being the highest among the countries analysed in 2000-2011. However, it is important to determine what impact in the states at issue environmental taxes had on these economic-social factors.

The strongest relation between a dependent variable – labour productivity and environmental taxes was identified in Sweden (Table 7).  $R^2$  is 0.962,  $p < 0.05$ , which shows a very strong correlation. In the case of linear dependence the coefficient of determination equals the square of the coefficient of correlation between variables  $y$  and  $x$ . Thus, a change of 96.2 % in Sweden's labour productivity can be explained by a change in environmental taxes. In this case the linear regression equation is composed:  $y_i = 2523.66 + 7.9x$ , i.e. when environmental tax revenue grows by one unit (EUR one million) labour productivity

grows by EUR 7.9 thousand per person. Although in 2000-2011 Germany's population employment levels had a growing tendency due to reduced social security contributions payable by employers and employees, a regression relation between revenue from environmental taxes and labour productivity is weak ( $R^2 = 0.405$ , while  $p < 0.05$ ). Generally, states achieve higher economic and social efficiency by either introducing or increasing environmental taxes since it is very important to retain the principle of *double dividends* which is the basis for environmental fiscal reforms in all countries. Hence, while protecting the environment against the impact of pollution, account is taken of energy consumption intensity, which is directly responsible for pollution processes and is important in the context of analysis of sustainable correlation between environment and economy.

Energy intensity shows energy consumption in the economy and the total energy efficiency. Total domestic energy costs are calculated as the sum of the five types of consumed energy: coal, electricity, oil, natural gas and renewable energy sources. Figure 1 shows that in 2000-2011 energy consumption had a decreasing tendency in the countries which used decreasing amounts of energy for the production of one unit of production. This resulted from improving

eco-friendly production technologies and taxes on energy.

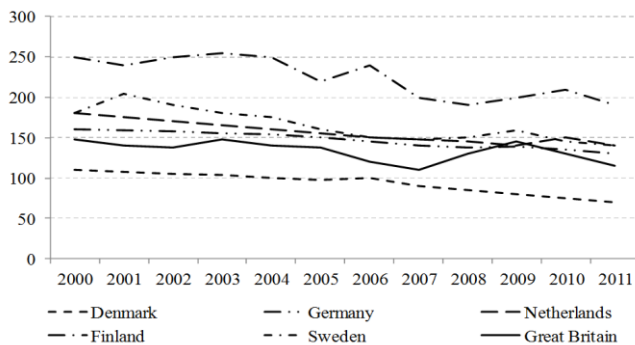


Figure 1. Change in energy intensity in EU countries (kg/EUR 1 000 GDP), 2000–2011, source: own study

In the years analysed the biggest fall in energy intensity was seen by Denmark, its change represented 31.5 %. In order to create EUR 1 000 GDP Denmark had to consume the smallest amount of energy (on the average, around 96.9 kg of oil equivalents), meanwhile Finland consumed the greatest energy amount which, on the average, was around 222.3 kg of oil equivalents/EUR 1 000 GDP. Nevertheless, in order to achieve the target of energy intensity reduction the states are encouraged to invest in research and development with the aim of finding new more efficient technologies and equipment based on a more efficient use of energy and resources.

The identified relation between environmental taxes and energy intensity is shown in Table 8.

Assuming that other factors do not affect the change of energy intensity, the dependence between energy intensity and environmental taxes exists in all the countries excluding Germany, because  $R^2$  is relatively small, 0.259, while a p-value is above 0.05 (Table 8). Therefore, the model of linear regression equation is not suitable in the case of Germany. The strongest relation between energy intensity and environmental taxes was determined in the Netherlands where  $R^2$  stands at 0.944, while  $p < 0.05$ , which explains a 94.4 % change in energy intensity by the change of environmental taxes. In the case of the Netherlands, the linear regression equation is composed:  $y_2 = 294.56 - 0.007x$ . Thus, when environmental taxes increase by EUR one million energy intensity drops 0.007 kg/EUR 1 000 GDP.

We can observe that a decline in energy demand in the EU has been determined by greater costs resulting from higher energy taxes. Indeed, these costs can be interpreted as an increase in the tax burden which the states try to compensate by the changes of other taxes associated with a better quality of the public good of the environment (Bovenberg, Ploeg, 1998). Energy is one of the main sources of both pollution and tax revenue.

When oil tax rates are increased renewable energy (solar, wind, wave, hydro energy, biomass energy, geothermal energy) is encouraged because the price

of petroleum products grows for industries and businesses as well as households. Its use can abate climate change and the consumption of products causing damage to the environment and preserve natural resources for the future generations.

Indicators in Figure 2 show that EU states implement the provisions of international agreements based on the promotion of renewable energy.

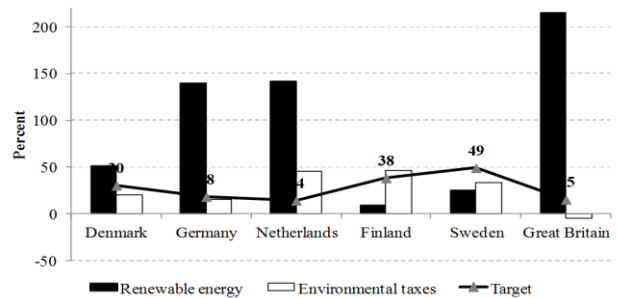


Figure 2. Relative changes in renewable energy consumption and environmental taxes in percent, 2011 against 2000, source: own study

The greatest progress in promoting renewable energy was achieved by Great Britain that raised the consumption of this type of energy from 1.2 % to 3.8 % which has resulted from the introduced tax on energy consumption for the business and industry.

The slowest renewable energy growth was seen by Finland where it upped 9 % and reached 31.8 %, meanwhile environmental taxes increased faster. Nonetheless, Finland has already exceeded the EU average rate to be achieved in 2020 and uses more renewable energy than envisaged in the Directive on the promotion of the use of energy from renewable sources. The highest consumption of renewable energy was determined in Sweden reaching 38.7 % and 46.8 % in 2004 and 2011, respectively. Environmental taxes also went up similarly the collection of which in Sweden contributed to the promotion of the use of energy from renewable sources. It is maintained that Sweden has already achieved its target share of 49 % of renewable energy consumption. Great Britain recorded the lowest consumption of renewable energy; however, of all the countries it enjoyed the biggest increase with environmental taxes therein going down insignificantly. This means that Great Britain seeks implement international commitments as regards the increase of consumption of this energy type disregarding the fact that the share of green taxes in the total revenue is the smallest.

Reduced use by industries and households of natural resources (coal, oil, natural gas, etc.) results in lower CO<sub>2</sub> emissions. This is important for reducing greenhouse gas emissions and implementing one of the key ideas of environmental taxes – to stop the process of climate warming. For this reason CO<sub>2</sub> emissions into the atmosphere dropped in all the countries in 2000-2011 (Figure 3).

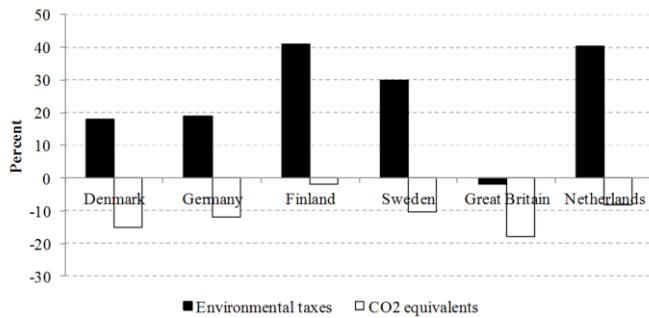


Figure 3. Relative percentage changes in CO<sub>2</sub> equivalents and environmental taxes, 2011 against 2000, source: own study.

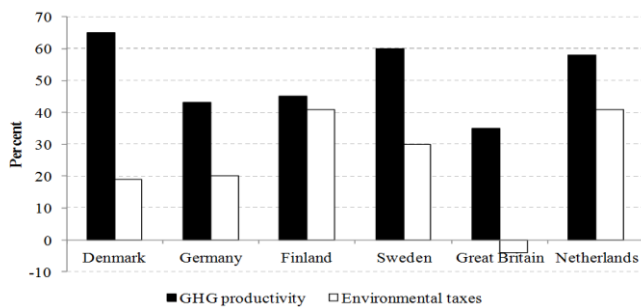


Figure 4. Relative changes in greenhouse gas emission productivity and environmental taxes in percent, 2011 against 2000, source: own study

The biggest drop in CO<sub>2</sub> emission levels was attained in Great Britain and Denmark, 18 % and 17.6 %, respectively, whereas the smallest decrease in CO<sub>2</sub> emission, 3.3 %, was recorded in Finland. Consequently, the states honour their commitments to the European Community on the reduction of greenhouse gas emissions of the developed countries by at least 5 % over the period 2008-2012 compared with 1990 levels. (European Environment Agency, 2013). Information on CO<sub>2</sub> changes should be valued with caution as CO<sub>2</sub> taxes are generally levied on energy products. It is often difficult to identify CO<sub>2</sub> taxes separately because they are integrated into energy taxes, for example, through the differentiation of oil tax rates taking account of the coal amount in fuel. Furthermore, taxes on CO<sub>2</sub> are partially introduced as an energy tax substitute because revenue from these taxes is generally considerable compared to revenue collected from pollution taxes (Stamatova, Steurer, 2011). For instance, the introduction of a new CO<sub>2</sub> tax in Denmark and Sweden was accompanied by a decrease in existing energy taxes, in particular on industry (Barde, 2004). Based on the literature analysed, CO<sub>2</sub> taxes can be included in pollution taxes but not in energy taxes as this would impede the comparison of international information.

Greater consumption of renewable energy results in lower emissions of gases producing greenhouse gas emissions. Therefore, in implementing international agreements on air pollution abatement worldwide it

is analysed how the productivity of greenhouse gas emissions changes after the introduction of green taxes. The aim is to achieve increasing enhancement of that productivity. In 2000-2011 the productivity of greenhouse gas emission rose due to a fall in countries' energy efficiency.

It has been determined that in 2011 compared to 2000, the average greenhouse gas emission productivity accounts for 53.28 % in the analysed states having introduced reforms. Nearly all the countries enjoyed a 50 % or greater increase in greenhouse gas emission productivity. The greenhouse gas emission productivity displayed a growing tendency because a particularly major focus is laid on the energy industry and the process occurring therein to make them more environmentally friendly. Hence, upon the start of environmental tax reforms the economic activities of the countries in question became more environmentally friendly, i.e. a CO<sub>2</sub> equivalent yielded a bigger GDP. Also, productivity indicators can be explained by increasing investment in low-emission equipment and vehicles (electric drive vehicles) and position with regard to technologies.

As the results show, the biggest impact of environmental taxes on a change in greenhouse gas emission productivity was felt in the Netherlands (Table 9). A 97.4 % change in greenhouse gas emission productivity in this country is explained by a change in environmental taxes. The dependence between these two variables is particularly strong. Based on data from the solved linear regression equation, the following equation is composed:  $y_3 = -257.21 + 0.142x$ . It is evident from the equation that when environmental taxes rise by one unit (EUR million) the productivity of greenhouse gas emission increases by 0.142 t/EUR 1 000 GDP. Meanwhile in respect of Germany the applied model is not suitable because  $R^2$  is 0.249, while  $p > 0.05$ .

In summary of the implemented environmental tax reforms, a positive impact of these reforms is observed not only on the environment but also on social and economic factors while preserving fiscal policy neutrality. Actually, some states expected a greater positive impact of environmental taxes on GDP than they have managed to achieve. Although reforms are relating with the shifting of part of the tax burden from labour to energy taxes, at the start of these reforms revenue from these changes was inconsiderable accounting for a mere 0.2 to 1.9 % of GDP. In Finland and Sweden as well as in Germany (over a certain period) the environmental tax reform achieved a general decrease in the tax burden and part of the reform compensated for certain deficits in national budgets. Other countries (Great Britain, the Netherlands) had the aim to achieve strict fiscal neutrality, i.e. the tax burden remained stable. During the process of reforms in Denmark too many subsidies were granted, which diminished environmental efficiency.

Table 9. Regression relation between greenhouse gas emission productivity (t/ EUR 1 000 GDP) and environmental tax revenue (EUR million), 1995-2011, source: own elaboration

	Denmark	Germany	Netherlands	Finland	Sweden	Great Britain
Type of equation	Linear	Linear	Linear	Linear	Linear	Linear
Coefficient of determination R <sup>2</sup>	0.571	0.249	0.974	0.575	0.910	0.577
p-value	0.000	0.099	0.000	0.002	0.000	0.001
Coefficient a	3395.258	-1130.933	-257.208	-496.435	-2540.970	-1421.879
Coefficient b	-0.022	0.063	0.142	0.560	0.846	0.090

## Conclusion

According to the assessment indicators of conformity by environmental taxes with taxation principles, the best results were achieved in Sweden, which already before the start of the reform paid major attention to the bettering of the environment and was the first to implement the reform.

The environmental tax systems of Finland, the Netherlands, Denmark, Germany and Great Britain require bigger improvements according to taxation principles in order to have an efficient and effective fiscal policy.

Environmental (energy intensity, greenhouse gas emission productivity) and social-economic (share of environmental taxes in state revenue, labour productivity) indicators of the countries improved over the analysed period. In Finland green taxes represented the largest share of the total taxes (around 16 %), whereas in Great Britain they accounted for about 7 % of state taxes. The strongest relation between labour productivity and environmental taxes was identified in Sweden because  $R^2=0.962$ ,  $p<0.05$  and therefore a 96.2 % change in Sweden's labour productivity can be explained by a change in environmental taxes. Denmark saw the sharpest decline in energy intensity of around 31.5 %, wherein the lowest energy consumption of around 96.9 kg of oil equivalents was required to create EUR 1 000 GDP. Therefore, a 79 % decrease in intensity is explained by higher environmental taxes. Finland enjoyed the highest energy consumption, which stood at 222.3 kg of oil equivalents/EUR 1 000 GDP. As regards CO<sub>2</sub> emission, its biggest drop was attained in Great Britain and Denmark representing 18 % and 17.6 %, respectively. All the countries took sufficient measures for air pollution abatement.

The analysed states that have implemented environmental fiscal reforms achieved environmental, economic and social objectives. Environmental tax reforms did not place a heavy tax burden on the society, while some states (Great Britain, the Netherlands) attained the neutrality of state budget revenue.

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