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## Improving the Ecological Tax Reform in Germany - Model Based Analysis of the Ecological and Economic Impacts of Alternative Proposals

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# **Improving the Ecological Tax Reform in Germany**

## A Model Based Analysis of the Ecological and Economic Impacts of Alternative Proposals

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## Improving the Ecological Tax Reform in Germany

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by

Bernd Meyer and Christian Lutz

Paper presented at the

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### Abstract:

*In 1999 the red/green administration in Germany induced an ecological tax reform, which burdens energy consumption and uses the tax revenue to reduce social security distributions. As in other countries the design of the taxation does not follow textbook considerations, but is marked by many restrictions and exemptions coming out of the political bargaining process. The tax rates are dynamic until 2003. The further development of the ecological tax reform is subject of an intensive discussion.*

*The paper at hand compares the ecological and economic impacts of the status quo with those of different proposals to change the structure of the taxation and presents the instrument of the analysis – the model PANTA RHEI. This 58-sector econometric input-output-model for Germany fully integrates an energy system for 29 energy carriers, a traffic- model, a land- use- model, as well as an SNA- model, which depicts the redistribution of income between enterprises, households, the government and the rest of the world and calculates the budget constraints of these institutions. PANTA RHEI is part of the global INFORUM system of models.*

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## 1 INTRODUCTION

On 24 March 1999, the German Bundestag passed the "Law Introducing the Environmental Fiscal Reform"<sup>2</sup>, which defines additional taxes on several energy products that will be raised until the year 2003.

The aim of the environmental fiscal reform is to reduce energy consumption and the resulting emissions, and to promote the development of cleaner technologies. The revenues from the tax are being used to reduce pension insurance contributions. The resulting reduction in non-wage labor costs is expected to lead to employment growth. In addition, funding is being provided for a program to promote renewable energy sources. The government hoped to realize a "double dividend" with this law in terms of higher employment and lower CO<sub>2</sub>- emissions

The "text-book" environmental tax has a uniform tax per unit of environmental emissions. From an ecological point of view, a tax on primary energy consumption is to be preferred to a tax on final energy because it creates an incentive for improving the energy efficiency on all levels of the energy transformation process and the structure of production. If, however a single country introduces the tax, the problem arises that the tax can easily be evaded by substituting domestic primary energy with imported final energy (especially electricity). To avoid this, a special tax on imported final energy would be needed, but such tax discrimination would violate European Law. Therefore a single- EU-country can only introduce a tax on final energy.

Further restrictions which affect the design of environmental taxes derive from potential conflicts between environmental protection and other policy targets. Fear of negative effects on certain regions, industry branches, or household categories frequently leads to differentiated tax rates or for tax exemptions.

So it does not wonder that the realized environmental taxes in Denmark, Finland, the Netherlands, Norway and Sweden and also in Germany differ from the textbook case with a confusing variety of different tax rates and tax exemptions concerning both the energy carriers and the user groups.

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<sup>1</sup> The research on this paper was supported by the Umweltbundesamt in the framework of the project "Abschätzung der Auswirkungen umweltpolitischer Maßnahmen zur Erreichung von Umweltzielen mit Hilfe ökonomischer Modelle".

<sup>2</sup> Gesetz zum Einstieg in die ökologische Steuerreform (Bundesgesetzblatt I, p. 378, 1999).

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Since its introduction the law was and still is subject of a hot debate. The critics on the one side fear, that the environmental effects are neglect able especially because of the exemptions for industries with high energy intensity. On the other side they assume, that the in general higher energy costs will have a strong negative effect on the economy, so that the positive employment effects resulting from the reduction of labour costs will be overcompensated.

The German Ministry of Finance gave the order to calculate the effects with the general equilibrium model LEAN and the econometric input- output- model PANTA RHEI. The simulations with both models came to the result (Bach et alii 2001 and Bach/Kohlhaas/Meyer/Praetorius/Welsch 2002), that there is a reduction of CO<sub>2</sub>-emissions of about 2,2 % and a higher employment of about 150.000 persons.

What are the options for the future? The first option would be to hold the status quo. This is today (May 2002) the position of the Christ democratic opposition. The red/green coalition is discussing several alternatives of a further development of the eco-tax. There is of course a strong ecological argument to cancel the exemptions for energy intensive industries. With respect to Kyoto targets a further dynamization of the tax rates after 2003 might be useful. Other discussants want to change the use of the additional tax revenue, because the positive employment effects of the reduction of social insurance contributions may not be sizeable for the public. The additional revenues after 2003 should be used as subsidies for alternative energies or the investment in construction to reduce energy consumption for heating.

The paper at hand presents the results of model simulations of these policies using the econometric input- output- model PANTA RHEI. In section 2 the model is introduced very briefly. In section 3 the status quo of the environmental tax reform in Germany is discussed with its impacts on the economy and the environment. In section 4 as usual the business scenario is presented, and in chapters 5, 6 and 7 the effects of three alternative scenarios against the business- as- usual scenario, which covers the status quo of the environmental tax reform, are a subject. The three alternative scenarios all assume a canceling of exemptions, but differ in respect to the tax rates and the use of the tax revenue:

- constant tax rates, social security compensation,
- dynamic tax rates, social security compensation,
- dynamic tax rates, compensation for investment in construction.

The results can be summarized as follows: The canceling of the exemptions has only a weak effect on CO<sub>2</sub>- emissions, because energy demands of the energy intensive sectors have very low price elasticity's. A further dynamization of tax rates will be necessary to reach the Kyoto target for Germany. With respect to compensation we come to the result, that compensation for investment in construction is the dominant strategy. A discussion of some general arguments in chapter 8 closes the paper.

## 2 THE MODEL PANTA RHEI

PANTA RHEI is an ecologically extended version of the 58 sector econometric simulation and forecasting model INFORGE (Interindustry Forecasting Germany). The name PANTA RHEI is no abbreviation but a program referring to the Greek philosopher

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Heraklit and means “all things flow”. Its performance is founded on the INFORUM philosophy (Almon 1991), what means to build econometric input-output models *bottom up* and *fully integrated*. The construction principle *bottom up* says that each sector of the economy has to be modelled in great detail and that the macroeconomic aggregates have to be calculated by explicit aggregation within the model. The construction principle *fully integrated* means a model structure that takes into account the input-output structure, the complexity and simultaneity of income creation and distribution in the different sectors, its redistribution among the sectors, and its use for the different goods and services the sectors produce in the context of globalizing markets. In this way one succeeds to describe properly the role of each sector in the interindustry relations, its role in the macroeconomic process as well as its integration into international trade.

These conceptual advantages in comparison to other models end up in a consistent and powerful processing of sectoral and macroeconomic information. The about 45.000 equations of INFORGE describe the interindustry flows between the 58 sectors, their deliveries to personal consumption, government, equipment investment, construction, inventory investment exports as well as prices, wages, output, imports, employment, labour compensation, profits, taxes, etc. for each sector as well as for the macro economy. In addition the model describes the income redistribution in full detail. The model frequency is annual.

The actual version PANTA RHEI IV, on which the paper at hand is based, is an extended and actualized version (database 1978 – 1996) of PANTA RHEI III, which is documented in Meyer et alii (1999) and Meyer (2001). A new version PANTA RHEI V is under construction, which will be based on the new time series of NACE input- output-tables for the period 1991 – 2000.

The economic part of PANTA RHEI can briefly be described as follows:

- The input coefficients are in general variable and depending on relative prices and time trends. Material inputs are assumed to be imitational at the non observable level of the different products (Georgescu-Roegen 1990). In input-output tables we can only observe product groups. Their input coefficients are price dependent due to of changes in the product mix of the sector and to technical progress, which is induced by price changes.
- The model distinguishes three vectors for investment demand: equipment, construction and inventory investment. For investment in equipment and in construction we first explain the decisions of the investing industries by interest rates, capital productivity and real profits. With a given bridge matrix these vectors are transformed into final demand investment in terms of goods. Inventory investment is modelled by accelerator assumptions.
- Behavioural equations for real personal consumption are estimated for 24 intended consumption uses. Real disposable income of private households and the relative price of the category defined as the relation between the intended consumption uses price index and a macro consumer price index are the main explaining variables next to the interest rate for consumer durables and some special influences like the annual average temperature for heating expenses. With a bridge matrix the intended consumption uses are transformed into consumption of the 58 product groups.

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- Sectoral exports are linked by a bilateral trade model to the INFORUM International System (Ma 1995, Nyhus/Wang 1997). The shares of country l's export of good i in the imports of good i in country k are depending from relative prices, trends and other variables. The bilateral trade model also links import prices to the export prices of the exporting countries. So the different country models give the vectors of import volumes and export prices to the bilateral trade model and get the export vectors and the import prices from the bilateral trade model.
  - Imports of a product group are divided into intermediate imports and finished product imports. The last are determined by real disposable income and the relation between the domestic price of the product and its import price. Intermediate imports are observed for each of the 58 inputs in each of the 58 sectors. We define a matrix of import ratios, in which each element is variable and depending upon the relation of the domestic price and the particular import price. Multiplying the import shares with total intermediate inputs in that cell yields intermediate imports.
  - The price vectors for intermediate demand, private consumption, public consumption, investment in equipment; construction and exports are determined by the mark-up hypothesis: Unit costs, competing import prices and the degree of capacity utilization explain the prices of a product, so that the relation between price and unit costs is variable.
  - Labour demand of every sector (measured in hours) is explained by its output or real value added the real labour costs per hour and a time trend. The nominal wage rate of every sector is depending from the basic wage - which is realized in the automotive industry - and specific sectoral variables. The basic wage rate is explained by macro-variables like productivity and a macro price-index.
  - Capital input of the industries is given by depreciation, investment and the stock of the preceding period.

The economic part of the model further has a complete SNA system to calculate the aggregate variables and the income redistribution between the government, households, firms and the rest of the world. So for these institutions disposable income and their flow of funds can be estimated, and the budget of the government including fiscal policy and the social security system are endogenously depicted.

PANTA RHEI additionally is equipped with a deeply disaggregated energy - and air-pollution-model, which distinguishes 29 energy carriers and their inputs in 58 production sectors and households as well as 8 air pollutants (CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub>, NMVOC, CH<sub>4</sub>, CO, N<sub>2</sub>O) and their relations to the 29 energy carriers. The energy demand is fully integrated into the intermediate demand of the firms and the consumption demand of the households. In general energetic input coefficients are explained by relative prices and trends.

The supply of nuclear energy and renewable for electricity is exogenous, because in Germany it is deeply depending from policy decisions.

Demand for gasoline and diesel of households and firms is calculated by an extended road traffic model, which explains the stocks of cars and trucks and their usage as well as technical progress in the new vintages.

Land use for living, recreation and for traffic is explicitly modelled. The land use for agricultural purposes is given as the rest. Land use for living is linked to the investment in

construction decisions of firms and households. Of course we additionally explain the living space per invested € and the land use per living space by relative prices and other variables. Land use for traffic is linked to the traffic demand of the carrier's railways, water, airways and roads. The physical traffic demand of the latter is already given from the road traffic model. For the other carriers the input- output system gives us demand in values that are transformed in physical dimensions like personkilometers or tonkilometers. Confrontation of these figures with the existing infrastructure gives us capacity utilization figures. Policy response functions with the lagged utilization variables as important determinants then extrapolate the plains for roads, airports, waterways and railways.

## 2.1 THE ENVIRONMENTAL FISCAL REFORM IN GERMANY

As already outlined in the introduction the Environmental Fiscal Reform in Germany as well as in other countries is very different from the text book case because of political and legal restrictions. This reform gives an additional excise tax on various energy carriers, and a reduction of the pension insurance contributions for both employers and employees. The energy tax has different rates on fuel oil, gasoline, diesel oil, electricity, and natural gas. There is no tax on coal. For gasoline, diesel, and electricity the initial tax rates as of 1999 are raised in four steps until 2003. The rates of the additional energy tax (henceforth referred to as 'eco-tax') are given in table 1:

**Table 1 Tax Rates of the Ecological Fiscal Reform in Germany**

	Tax rate in 1999	Annual increase	Tax rate in 2003
Heavy fuel oil	0	0.25cent/l <sup>a)</sup>	0.25 cent/l (0.06 EURO/GJ)
Light fuel oil	2.00 cent/l	0	2.00 cent/l (0.56EURO/GJ)
Gasoline	3.00 cent/l	3.00 cent/l	15.00 cent/l (4.7 EURO/GJ)
Diesel	3.00 cent/l	3.00 cent/l	15.00 cent/l (4.19 EURO/GJ)/
Electricity	1.00 cent/kWh	0.25 cent/kWh	2.00 cent/kWh (5.60 EURO/GJ)
Natural gas	0.16 cent/kWh	0	0.16 cent/kWh (0.45 EURO/GJ)

<sup>a)</sup> One-time increase in 2000.

For the demanding sectors manufacturing, construction, agriculture, electricity and mining the following exemptions are possible,

- if a firm has to pay an eco-tax of more than 500 € per year, the tax rates for the exceeding amount is reduced to 20 % of the rates shown in figure 1,
- furthermore: if the eco-tax is more than 20 % higher than the reduction of the social security contributions, the exceeding amount is repayed.

For special uses of energy carriers there is no taxation:

- combined heat and power stations,
- non energetic uses of energy carriers.

The macroeconomic impacts of this environmental tax reform after four years in its last stage, which will be reached in the year 2003, calculated with PANTA RHEI are as



follows (Bach/Kohlhaas/Meyer/Praetorius/Welsch 2002, p. 803ff): The tax revenue will be about 18 billion €. The cost shock of higher energy prices can not be compensated completely by the reduction of labour costs, so that consumption prices will be 1 % higher and real gdp 0.5 % lower than in the scenario without the tax reform. Higher energy prices reduce energy demand and CO2 emissions by 2 %. Nominal labour costs per hour - influenced by the compensation of social security payments and the endogenous wage rate - are reduced by 1.1 %. Since the price index of gdp rises by 0.7 %, we have a reduction of real labour costs per hour of 1.8 %. This overcompensates the negative employment effects coming from the slight reduction of gdp, so that the number of employed persons rises by 0.43 %, which means about 150.000 persons.

## 2.2 THE BUSINESS AS USUAL SIMULATION

The business as usual scenario assumes, that the environmental tax reform in Germany will survive until the end of our simulation period 2010 with no changes in the tax rates, exemptions and the compensations for social security payments. Business as usual means further, that the climate protection program (Klimaschutzprogramm), which was started by the German government in the year 2000, will be continued during the forecast period.

The forecast of the INFORUM international system gives us the growth rate of 3.4 % in the average for the vector of German exports and an average growth of 1.5 % for the vector of German import prices. The exchange rate for the € against the dollar will rise linearly from 1.0 in 2003 to 1.18 in 2010.

**Table 2**  
- Results for the Business as usual (BAU) Scenario -

	2003	2004	2005	2006	2007	2008	2009	2010	average annual growth rate
GDP (in billions of €)	1763,03	1785,69	1815,85	1849,73	1888,00	1925,07	1966,41	2007,56	1,86
Employees (in thousands)	34702	34533	34450	34403	34452	34548	34675	34847	0,06
CO2-emissions (in millions of tons)	840,00	828,20	823,39	811,04	815,55	815,00	817,74	819,95	-0,35
Eco-Tax (in billions of €)	18,06	17,90	18,04	17,73	18,22	18,33	18,46	18,59	0,41
Rate of inflation	1,59	1,82	1,93	1,97	1,98	1,99	2,00	2,03	

Under these conditions and a given economic policy in Germany the model calculates a growth rate for real gdp of nearly 1.9 % per year in the average for the period 2003 – 2010 (table 2). Since exports and imports will grow faster, the model expects a continuation of globalization of the German economy.

Employment will not change during the next years, and inflation will be stable around a rate of 2 % (table 2).

The environmental situation – as far as it is in the focus of this paper – is represented by the indicator CO2 emissions. Table 2 shows, those CO2 emissions - in spite of gdp growth - will be slightly reduced by 0.35 % per year in the average. There is a strong technical

progress in energy demand and in the supply of electricity coming from renewable carriers. But the forecast of the levels shows, that the reduction is overcompensated by a rising force that - beginning in the year 2007 – overcompensates the reductions. This is coming from the closing of nuclear power plants.

The Kyoto target of a 22 % reduction of CO2 emissions in relation to the levels of the year 1990 would mean emissions of 780 million tons in the year 2010. Since our bau forecast is about 820 million tons for the year 2010, the target will not be reached, but is in a not far distance.

The eco- tax revenue is rising very slowly from 18 billion € in 2003 to 18.6 billion € in 2010. The reasons are constant tax rates, moderate price developments and a diminishing energy demand.

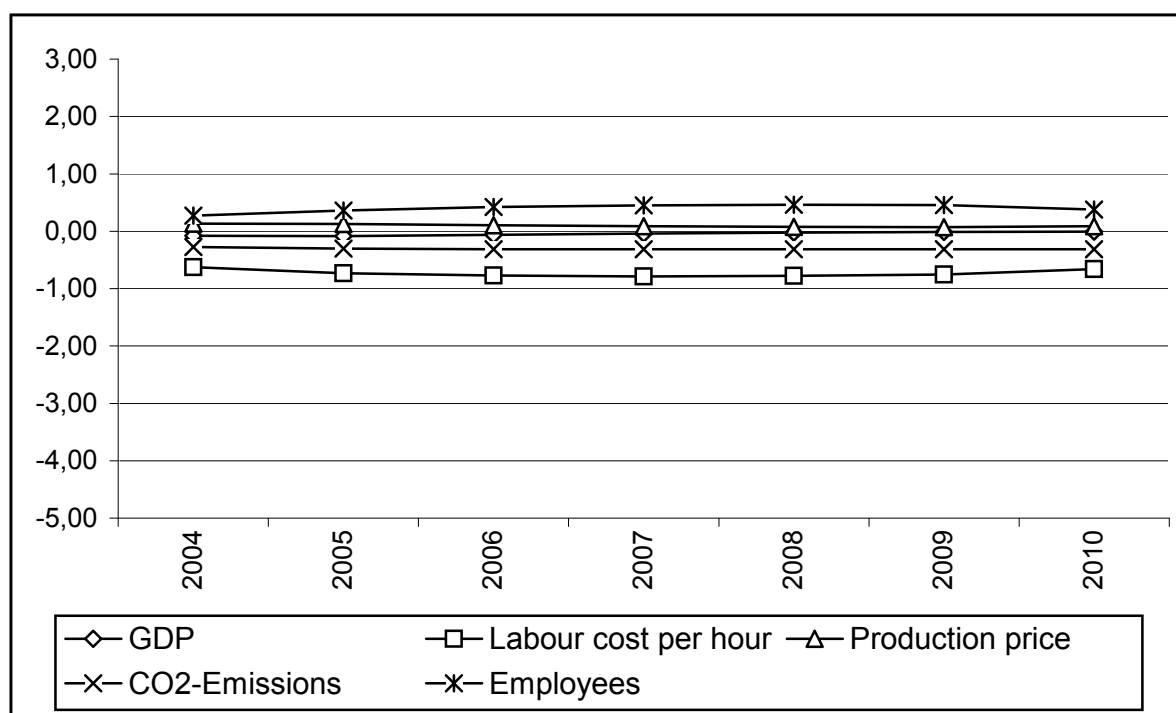
### 2.3 CONSTANT TAX RATES AND COMPENSATION OF SOCIAL SECURITY CONTRIBUTIONS

We now discuss the first option for the future: What will happen, if - starting in 2004 - there will be no exemptions for the energy intensive firms in manufacturing, but no further change in the environmental tax reform?

The very low price elasticity's for energy demand of the energy intensive sectors produce a sharp rise in the tax revenue of 5.1 billion € in 2004, that will grow to 6.1 billion € until 2010. So it is clear, that there will be only a relatively low reduction of CO2-emissions of only 0,3 % (See figure 1) in 2010. There is no effect on gdp.

Figure 1

Scenario: Constant Tax Rates, Social Security Compensation  
 – Percentage Deviations from the BAU Scenario –



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Since the additional tax revenue is used to reduce social security payments, we get a reduction of labour costs per hour of 0.7 %. The cost push in energy intensive firms spreads over the economy and induces a rise of prices around 0.2 %, so that real labour costs per hour fall about 0.9 %. Employment gets a positive impact in the other industry that is stronger than the employment losses in the energy intensive industries. Altogether we get a plus in employment of 0.4 %, which is - compared with the reduction of labour costs – relatively small, because we have drastically employment losses in the energy intensive industries. The wage rate – defined as labour costs per hour minus entrepreneur’s contribution to social security - is influenced by labour productivity and production prices. The average sectoral wage rates react on both variables with elasticity 1. So the wage rates will fall around 0.2 %, because labour productivity falls with 0.4 % and prices rise with 0.2 %. So that the direct effect of the compensation of labour costs is only 0.5 %, the rest of 0.2 % comes from the reduction of wages.

We have to imagine, that the other industries have no additional energy costs. They have to pay only higher prices for inputs from the energy intensive firms. So we are facing redistribution: Energy intensive firms are financing a reduction of labour costs for the other firms. The effect on employment is with 0.4 % and about additional 130.000 persons as high as in the case of the introduction of the environmental tax reform **with** exemptions.

#### **2.4 DYNAMIC TAX RATES WITH COMPENSATION OF SOCIAL SECURITY CONTRIBUTIONS**

The next scenario assumes that there will be no exemptions and a dynamization of tax rates. The tax for fuels rises every year with 3 cent per liter and the tax for electricity with 0.25 cent per kWh. That is why we assume the same rising speed as in the period 1999 - 2003. The additional tax revenue compared to the bau scenario is 8.4 billion € in 2004 and 29 billion € in 2010. The level of the tax will be in 2010 twice the level of the tax of the last scenario with constant tax rates.

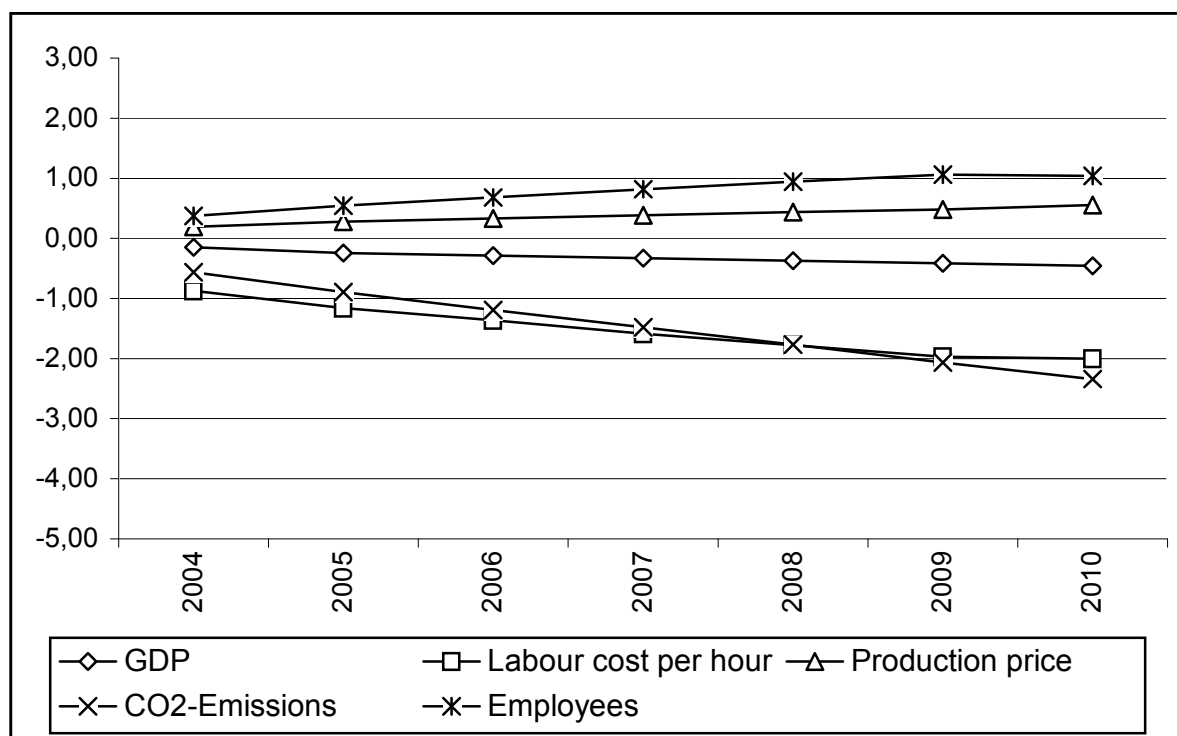
The CO<sub>2</sub> emissions reduce now with 2.3 % (see figure 2) in the year 2010 against the bau scenario. Compared with the last scenario the factor of reductions of CO<sub>2</sub> emissions is 8 and not 2, the number which we have just watched for the levels of the tax revenues. The explanation is quite clear: The rising tax rates especially in the non energy intensive sectors and in the households will now reduce energy inputs strongly.

The effects on gdp are slightly negative (about – 0.5 % against the bau scenario in 2010) and have the expected order. Labour costs per hour reduce about 2 % against the bau scenario.

Compared with the last scenario we find factor 4 and not 2, which is the factor for the tax revenue and the compensation. The explanation for this is that the wage rate – which is the labour cost per hour minus the entrepreneur’s contribution to social security – is determined by production prices and labour productivity.

Figure 2 shows, that labour productivity – measured as gdp per employees – falls against the bau scenario in 2010 with 1.5 %. Production prices rise with 0.5 %. Since both variables influence sectoral wage rates with elasticity’s around 1, wages will fall in the average with 1 %. So the direct effect of the labour compensation is only 1 %, which is exactly factor 2 – the number which we expect from the comparison of the volumes of compensation in the two scenarios.

Figure 2  
**Scenario: Dynamic Tax Rates, Social Security Compensation**  
 – Percentage Deviations from the BAU Scenario –



The reaction of labour demand seems also to be plausible: Real labour costs in 2010 are 2.5 % lower than in the bau scenario. Labour productivity is 1.5 % lower (employment: +1 %, gdp -0.5 %) than in the bau scenario. So the average elasticity of labour productivity in respect to real labour costs is 0.6 %, which is a realistic value.

The sectoral effects on production, employment, labour costs per hour and prices for the year 2010 are depicted in table 3. We see, that energy intensive industries as iron and steel and pulp and paper have strong reductions of employment, whereas services and investment industries can expand their labour inputs.

The electric power industry and the refined petroleum products industry of course have strong reductions in demand and production, because their products are taxed. Their prices rise with 22.9 % resp. 14.8 % and their production falls with 4.2 % resp. 3.9 %. Employment in these sectors is reduced only marginally, because production is very capital intensive and labour is more or less a fix factor.

Iron and steel as well as pulp and paper as energy intensive sectors reduce their labour inputs drastically, because higher prices especially for electricity compress real value are added in these sectors. The reductions of labour inputs in these sectors together with lower labour costs per hour and of course lower energy inputs avoid rising prices and allows stable production. These sectors have to enlarge capital inputs and to search for technical progress.

Strong positive employment effects are to be found in the labour intensive construction industries building and installation with 2.5 % and 2.8 %. Further services like government (2.6 %), communication (1.1 %) and railways (3.2 %) are strong winners of employment. But also manufacturing industries like road vehicles (2.6 %) are searching for a more labour intensive technology.

**Table 3**  
**Scenario: Dynamic Tax Rates, Social Security Compensation**  
**– Relative Deviations from the BAU Scenario in 2010 –**

	Production	Employees	Labour cost per hour	Priceindex of Production
Agricultural products	-0,40	0,51	-1,78	0,02
Forestry and fishery products, etc.	-0,30	0,28	-1,71	0,12
Electric power, steam, hot water	-4,22	-0,18	-2,01	22,88
Gas	0,31	-0,16	-1,95	2,33
Water	0,03	1,78	-1,72	0,00
Coal, products of coal mining	-1,88	-0,20	-2,02	0,71
Products of mining, excluding coal, crude petroleum, natural gas	-0,26	1,34	-2,22	0,65
Crude petroleum, natural gas	0,10	n.a.	n.a.	-0,04
Chemical products, including nuclear fuel	-0,23	-0,08	-2,26	0,11
Refined petroleum products	-3,86	-0,20	-2,19	14,82
Plastic products	-0,18	0,29	-2,17	0,25
Rubber products	0,20	0,47	-2,12	-0,01
Stone and clay, building and construction materials, etc.	-0,21	1,78	-2,16	0,14
Ceramic products	0,53	0,89	-2,23	-0,82
Glass and glass products	-0,69	-0,24	-2,11	0,56
Iron and steel	-0,13	-1,88	-2,22	0,21
Non-ferrous metals, semi-finished products thereof	-0,54	-0,07	-2,26	1,02
Foundry products	0,18	0,70	-2,19	-0,41
Products of drawing plants, cold rolling mills, etc.	0,14	0,33	-2,18	-0,14
Structural metal products, rolling stock	0,62	0,85	-1,91	-0,23
Machinery and equipment, excluding electrical equipment	0,13	2,22	-2,19	-0,01
Office machinery, automatic data processing equipment	-0,04	1,75	-2,33	0,06
Road vehicles	0,17	2,61	-2,30	0,00
Ships, boats, floating structures	-0,12	-0,34	-2,27	-0,21
Aircraft and spacecraft	0,67	0,26	-2,58	-0,03
Electrical machinery, equipment and appliances	-0,09	1,98	-2,40	0,13
Precision and optical instruments, clocks and watches	-0,20	1,44	-2,16	0,01
Tools and finished metal products	-0,24	1,86	-2,27	0,17
Musical instruments, games and toys, sports goods, etc.	-0,52	2,91	-2,52	0,56
Wood	-0,73	0,26	-2,21	0,91
Wood products	-0,83	1,89	-1,99	0,68
Pulp, paper and -board	-0,14	-4,28	-2,24	0,09
Products of paper and -board	-0,11	1,42	-2,45	-0,05
Products of printing and duplication	0,08	1,57	-2,13	0,00
Leather and leather products, footwear	0,33	0,91	-2,40	0,04
Textiles	-0,58	-0,58	-2,28	0,16
Wearing apparel	-0,62	2,01	-2,32	0,19
Food products excluding beverages	-0,45	0,33	-2,04	0,32
Beverages	-0,96	2,17	-2,22	0,82
Tobacco products	0,02	0,69	-2,66	0,00
Building and civil engineering works, etc.	-0,13	2,47	-1,83	0,41
Installation and building completion works	-0,05	2,82	-1,94	0,22
Services of wholesale trade, etc., recovery	-0,18	0,82	-2,18	0,02
Services of retail trade	-0,48	0,39	-2,15	0,16
Railway services	0,19	3,20	-2,05	1,09
Water transport services, services of ports, etc.	-1,44	0,14	-2,01	2,36
Communication services	-0,15	1,10	-1,94	0,00
Other transport services, n.e.c.	0,12	0,35	-1,86	0,20
Banking services	-0,34	-0,19	-2,18	-0,66
Insurance services, excluding social security funds	-0,44	-0,11	-2,19	-0,19
Real estate renting services	-0,15	n.a.	n.a.	0,15
Market services: hotels, restaurants, homes and hostels	0,01	-0,21	-2,17	-0,07
Market services: education, research, culture, publishing serv.	0,25	-0,21	-2,03	-0,47
Health and veterinary market services	0,39	0,09	-2,05	-0,59
Other market services, n.e.c.	-0,06	-0,25	-2,03	-0,55
Services of central and local government	0,03	2,55	-1,85	0,71
Services of social security funds	0,12	2,74	-1,86	0,64
Services of private non-profit institutions, domestic services	-0,16	1,79	-1,95	0,51

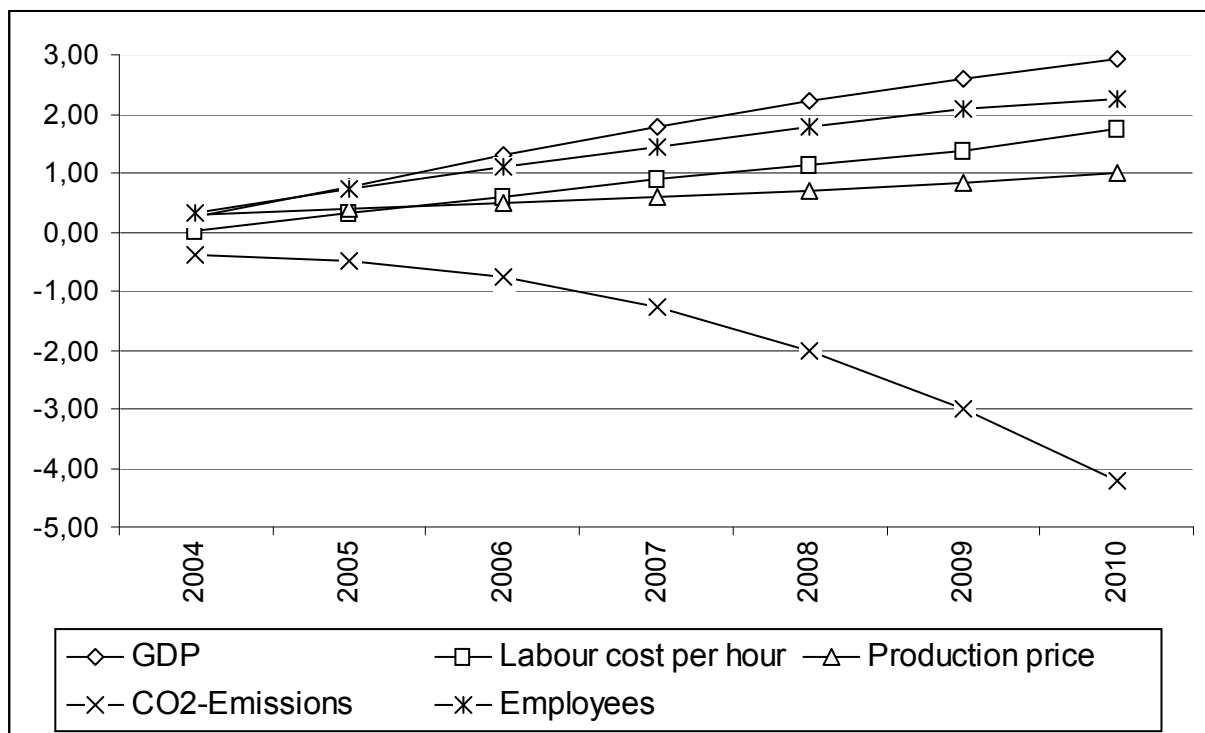
## 2.5 DYNAMIC TAX RATES WITH COMPENSATION OF INVESTMENT IN CONSTRUCTION

The third alternative scenario assumes that there will be as well as in the last scenario no exemptions and a dynamization of tax rates, but at this point we assume, that the additional tax revenue is used to support investment in construction. The idea is that a programme is launched for the improvement of the isolation of buildings.

The isolation characteristics of the buildings are not depicted explicitly in the model. It is implicitly part of the parameters of the demand equations for heating. So in contrast to the other simulations we have to implement additional information into the model concerning this structural change. Based on experiences with concrete projects, experts from the Umweltbundesamt assumed a concretely structure of isolation activities (Gebäudesanierungs-programm der Kreditanstalt für Wiederaufbau) and calculated the savings of heating in Joules for the different energy carriers. The model then calculated the results for emissions and energy demand in €.

Figure 3

Scenario: Dynamic Tax Rates, Compensation for Investment in Construction  
– Percentage Deviations from the BAU Scenario –



We accepted these assumptions concerning the technical energy side. But further we made the assumption, that the created investment will only have the magnitude of the support. In most studies it is assumed, that induced investment is by factor 3 or 5 bigger than the support. So we are very careful and assume a lower boundary for the effects. We further assume that the energy savings are effective with a lag of one period.

Sine the environmental taxation is the same as in the last scenario, the tax revenue is nearly the same.

The CO2 emissions reduce now with 4.2 % (see figure 3) in the year 2010 against the bau scenario. Compared with the last scenario the factor of reductions of CO2 emissions can be doubled, because we now additionally have the effect of the reduction of energy for heating.

Table 4

Scenario: Dynamic Tax Rates, Compensation for Investment in Construction  
Relative Deviations from the BAU-Scenario in 2010 –

	Production	Employees	Labour cost per hour	Priceindex of Production
Agricultural products	1,08	-0,26	1,43	0,01
Forestry and fishery products, etc.	3,04	0,02	1,33	-0,12
Electric power, steam, hot water	-2,88	0,30	1,81	22,93
Gas	-4,03	0,25	1,70	3,23
Water	3,66	3,33	1,32	0,02
Coal, products of coal mining	-0,93	0,32	1,82	0,55
Products of minig, excluding coal, crude petroleum, natural gas	0,31	0,09	1,69	1,07
Crude petroleum, natural gas	-0,51	n.a.	n.a.	0,23
Chemical products, including nuclear fuel	1,17	0,92	1,80	0,40
Refined petroleum products	-2,31	0,25	1,62	15,20
Plastic products	2,28	-2,51	2,08	0,04
Rubber products	1,51	0,71	1,99	0,23
Stone and clay, building and construction materials, etc.	8,78	4,63	2,05	0,17
Ceramic products	6,72	2,52	2,17	-3,04
Glass and glass products	1,38	-3,64	1,97	0,16
Iron and steel	0,55	-3,74	2,15	0,21
Non-ferrous metals, semi-finished products thereof	-0,18	0,40	2,21	1,33
Foundry products	2,12	-2,11	2,11	-0,85
Products of drawing plants, cold rolling mills, etc.	0,87	0,38	2,09	1,03
Structural metal products, rolling stock	1,42	0,23	1,63	0,05
Machinery and equipment, excluding electrical equipment	1,35	-0,84	2,11	-0,05
Office machinery, automatic data processing equipment	1,39	0,19	1,49	-0,14
Road vehicles	1,06	-1,62	2,29	-0,05
Ships, boats, floating structures	2,19	1,99	2,24	-0,27
Aircraft and spacecraft	3,03	2,03	2,75	-0,38
Electrical machinery, equipment and appliances	1,09	-0,33	2,23	0,49
Precision and optical instruments, clocks and watches	2,66	-0,25	2,06	-0,23
Tools and finished metal products	3,33	1,92	2,24	0,63
Musical instruments, games and toys, sports goods, etc.	1,18	-1,44	2,66	-0,04
Wood	3,16	0,94	2,14	0,91
Wood products	3,47	0,21	2,08	0,01
Pulp, paper and -board	0,60	-5,22	1,97	0,07
Products of paper and -board	1,53	-0,60	2,53	0,15
Products of printing and duplication	2,04	0,08	2,01	0,02
Leather and leather products, footwear	3,56	0,40	2,45	0,26
Textiles	2,13	1,62	2,25	1,26
Wearing apparel	2,19	-0,64	2,59	0,29
Food products excluding beverages	0,86	0,43	2,13	0,79
Beverages	1,43	0,38	2,16	0,51
Tobacco products	0,91	-0,66	2,90	-0,08
Building and civil engineering works, etc.	11,88	4,91	1,79	-0,38
Installation and building completion works	14,46	6,67	1,94	-1,41
Services of wholesale trade, etc., recovery	1,65	1,14	2,09	1,11
Services of retail trade	1,94	0,20	2,04	0,28
Railway services	1,89	-0,49	1,87	0,89
Water transport services, services of ports, etc.	-1,05	-0,03	1,28	3,32
Communication services	2,49	-1,60	1,99	-0,02
Other transport services, n.e.c.	1,99	0,56	1,56	0,61
Banking services	2,64	0,93	2,09	0,83
Insurance services, excluding social security funds	1,84	1,21	2,11	0,30
Real estate renting services	1,24	n.a.	n.a.	1,30
Market services:hotels, restaurants, homes and hostels	1,95	1,30	2,07	1,07
Market services: education, research, culture, publishing serv.	2,24	0,34	1,84	0,19
Health and veterinary market services	7,45	6,41	1,40	-0,19
Other market services, n.e.c.	3,63	2,07	2,14	0,18
Services of central and local government	5,65	4,85	1,88	1,14
Services of social security funds	8,39	7,52	1,66	0,94
Services of private non-profit institutions, domestic services	5,46	5,38	1,71	0,97

The effects on gdp in 2010 are strongly positive with 2.9 % against the bau scenario, because the tax revenue is invested in construction, which expands the circular flow of income.

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Labour costs per hour rise in 2010 with 1.8 % against the bau scenario. Since there is now no influence from social security distributions, we have to explain this movement by the wage rate alone. Figure 3 shows, that labour productivity – measured as gdp per employee – rises against the bau scenario in 2010 with 0.7 %. Production prices rise with 1.0 %. Since both variables influence sectoral wage rates with elasticity's around 1, wages will rise in the average with 1.7 % - 1.8%.

In 2010 labour demand rises by 2.2 % against the bau scenario, which is – compared with gdp (+ 2.9) and the real labour costs per hour (+ 0.8) - relatively low, because we expect from the other scenarios an elasticity of labour productivity against real labour costs of 0.6 and in so far a reaction of labour input of 2.4 %. The explanation is given with a structural effect in the formulation of the scenarios: We now do not subsidize firms with high labour inputs. This means, that we get in the average a higher labour productivity.

The sectoral effects on production, employment, labour costs per hour and prices for the year 2010 are depicted in table 4. We see, that energy intensive industries as iron and steel and pulp and paper have even stronger reductions of employment than in the social security scenario. The reason is, that now labour costs rise and that these sectors only participate weakly in the expansion of gdp. On the other side we see, that services can expand their labour inputs because they are strongly influenced by the general expansion of outputs.

The electric power industry and the refined petroleum products industry of course have strong reductions in demand and production, because their products are taxed. Compared with the social security scenario the reduction of electricity is weaker, because the induced growth needs more input from this sector. The same argument holds for the sector refined petroleum products. Here the reductions from heating are overcompensated by additional demand from traffic etc. The gas sector, which was not hit in the last scenario, because there were no additional taxes, has now a reduction in demand from the savings in heating. Here the induced growth has no effects.

Strong positive employment effects are to be found in the sectors building and installation with 11.9 % and 14.5 %, which are directly favoured by the compensation of the tax. The fall of the prices in both sectors can be explained via falling unit costs and a strong competition in these sectors.

In general we get a very different picture of the structural effects compared with the social security scenario.

### 3 CONCLUSIONS

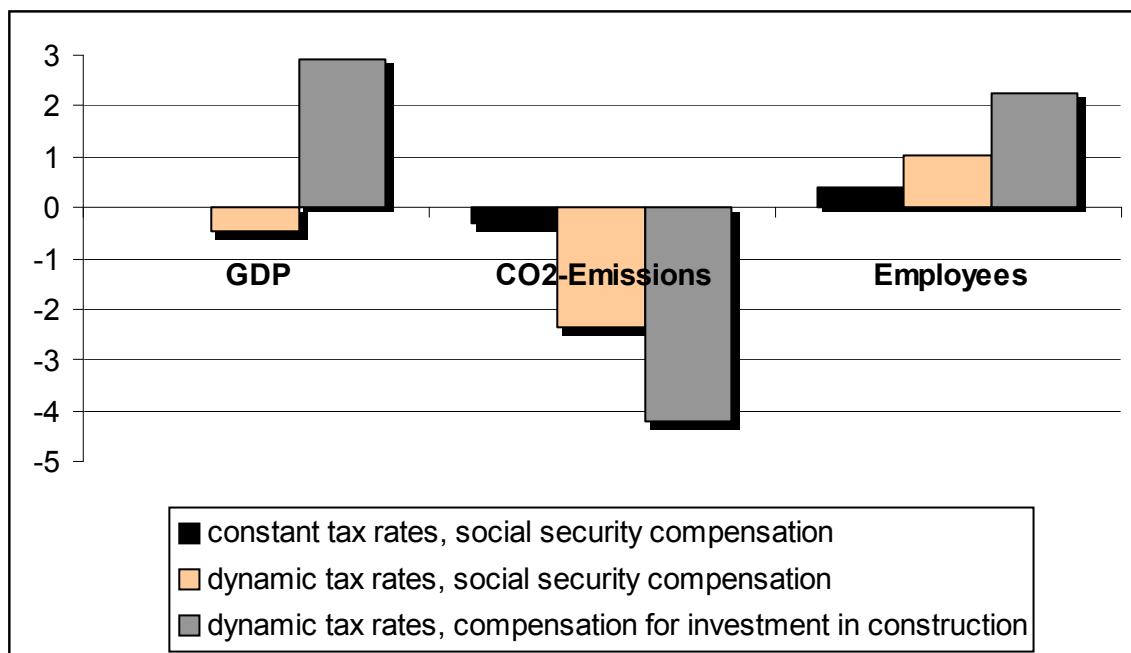
Our first result was that the loss of exemptions for the manufacturing sector has only weak environmental effects, but stronger effects for the tax revenue and via compensation of social security contributions also for employment.

Our simulations have further shown that the usage of the tax revenue is as important for the economic and environmental results as the kind of taxation. If in general an environmental tax reform is accepted, the question arises, which kind of compensation should be chosen.

Figure 4 summarizes our results for the strategic variables gdp, employment and CO<sub>2</sub> emissions. There is no doubt, that the scenario with dynamic tax rates and compensation



for investment in construction is the dominant strategy: We get higher gdp and employment, but lower CO2 emission figures than in the other scenarios. This policy would produce with 780 million tons a level of CO2 emissions that would reach the Kyoto target for Germany.



**Figure 4**  
 – Percentage Deviations from the BAU Scenario in 2010 –

We have to consider, that this scenario was formulated very conservatively: The tax revenue is supporting investments in isolation of buildings, and the induced investment is just the amount of the support. We did not describe the policy instrument in detail, so that it is still open, whether the interest rate is reduced or a direct subsidy is payed. In any case our assumption about the induced investment is very careful. So it seems to be realistic, that the reductions in CO2 and the positive effects for employment and gdp will be higher. This opens also the possibility to achieve the above depicted results with a less steep path of taxation, which might be more acceptable for the public. Further research with an explicit modeling of stocks of buildings and their energetic characteristics and the reactions of construction on subsidies will give more information about the needed path of taxation.

A compensation of an energy tax by social security contributions is based on the idea, that the economy should get a less energy intensive and a more labour intensive structure. It is a flow oriented approach that combines environmental with social arguments. A compensation via investment in isolation of buildings is flow and stock oriented. Environmental arguments give reasons for both the tax and its compensation. The taxation reduces energy demand in general and the investment improves the capital stock, which gives a second positive effect on the environment. The positive effects on employment and gdp are secondary effects that arise from the investment push. The power of this policy allows a softer taxation and therefore will be more acceptable for the public.

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