



Effects of Germany's Ecological Tax Reforms on the Environment, Employment and Technological Innovation

Summary of the Final Report of the Project:

„Quantifizierung der Effekte der Ökologischen Steuerreform auf Umwelt, Beschäftigung und Innovation“

Research Project commissioned by the German Federal Environmental Agency (UBA)

August 2005

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Table of Contents

1	Background	2
2	Introduction	3
3	The Ecological Tax Reform	3
3.1	Design of the Ecological Tax Reform.....	4
3.2	Use of the Ecological Tax Reform Revenue	5
3.3	Derogations in the Ecological Tax Reform.....	5
4	The effects of Germany's Ecological Tax Reform	6
4.1	Public Perception of the Ecological Tax Reform	6
4.2	Variations in the Production Sectors' Tax Burdens due to the Ecological Tax Reform	7
4.3	Effects of the Ecological Tax Reform on the Economy	8
4.4	Effects on Private Households.....	8
4.5	Effects of Ecological Tax Reform for Selected Companies.....	9
4.6	Effects of the Ecological Tax Reform on Innovations and Market Penetration	12
5	Summary and Outlook	14

1 Background

The German ecological tax reform was introduced in 1999, furthered in 2000, and its provisions were partly modified in 2003. The reform consists in an incremental increase in taxes on fuel and in the creation of an energy tax. The additional public income is used to contribute to the lowering of non-wage labour costs, so that the reform is for the most part revenue-neutral.¹ The reduction of non-wage labour costs creates stimuli for more employment, while the price increase of energy generates incentives for an economical energy use. However opinion polls demonstrate that the link between higher energy prices and lower payroll fringe costs is generally not well understood.

Against this background, Ecologic and the German Institute for Economic Research (DIW Berlin) analysed the effects of the ecological tax reforms on the environment, employment and technological innovations. Commissioned by the German Federal Environmental Agency (UBA), the study investigates the impacts of the reforms in particular on industry and producers. It identified companies and sectors which benefited particularly from the tax reform. The DIW examined the effects of the eco-tax on various economic sectors and its macroeconomic impacts, and additionally analysed the effects of the eco-tax in terms of technical innovation and the launch of new products and services. Also, Ecologic conducted and evaluated a survey on the adaptation of private households to the new taxation framework. The results are presented in five reports:

- Modelling burdens and benefits of the Ecological Tax Reform for different economic sectors;
- Macro-economic analysis of the impact of the Ecological Tax Reform;
- Effects of the Ecological Tax Reform on private households;
- Effects of the Ecological Tax Reform on selected businesses; and
- Impacts of the Ecological Tax Reform on innovation and market diffusion.

The present volume presents a summary of the five reports. The first and second reports were compiled by the German Institute for Economic Research (DIW); the third, fourth and fifth reports were prepared by Ecologic. In addition, the main results of the study were summarised in a brochure by the agency neues handeln. Ecologic also organised an event in November 2004 in Berlin to present the project (more information at <http://www.ecologic-events.de/oekosteuer>).

¹ A small percentage is used to promote renewable energy sources and the renovation of buildings to increase energy-efficiency. Part of the revenue additionally goes into the Federal Budget, especially since the 2003 modification.

2 Introduction

Protect the environment and create jobs: those were the goals of the German federal government as it introduced the Ecological Tax Reform (ETR) in 1999 and further developed it in 2003. It consists first off in an incremental increase in taxes on oil and the introduction of an energy tax. Energy becomes systematically more expensive so as to encourage with a price incentive rational energy use and the adoption of renewable energy sources. The ecological tax reform represents an important pillar in the German contribution to climate and resource protection. Second, the revenue generated by the tax reform goes for the most part into the public pension scheme, thus lowering the non-wage labour costs. Labour becomes cheaper, and this creates impulses for more employment. In this way, the ecological tax reform is 90% revenue-neutral.

Markets offer powerful and effective mechanisms, but only deliver efficient results when prices express true ecological costs. Wrong prices set wrong signals, for instance when they do not take into consideration external effects such as environmental destruction, thus generating a too high demand for the commodity in question. The resulting market malfunction results in increasing climate change due to the use of fossil energy. The ensuing costs for present and future generations are not entailed in energy prices. A major concern of the ecological tax reform is therefore to correct these signals and to further internalise the external effects of energy and environmental consumption.

Another goal of the ecological tax reform is to prepare for the foreseeable shortages and price increases of fossil resources. Unlike the erratic fluctuations of crude oil prices, the increase of energy prices linked to the ecological tax reform are moderate and predictable, giving affected businesses and households the possibility to plan. It thus leads to investments in energy-saving technologies and to the development of new solutions.

Finally, an essential goal of the ecological tax reform was to relieve the financial pressures on the public pension scheme and to lower payroll fringe costs. The tax burden could thus be shifted from the factor work to the factor environment and energy use and to create impulses for more employment.

The introduction of the ecological tax reform lies six years back. On this occasion, the German Federal Environmental Agency commissioned Ecologic and the German Institute for Economic Research (DIW) to complete an ex-post evaluation of the ecological tax reform and determine whether it reached its qualitatively expressed goals.

3 The Ecological Tax Reform

The idea of an ecological tax reform has been the subject of discussions in Germany since the 1980s. The basic concept was developed by the Swiss economist Binswanger and entails a restructuring of the tax system pursuing two targets: First, taxes and charges are levied on activities that are environmentally damaging in order to give an economic incentive to reduce environmental pollution. In a second step, these tax revenues are used to replace existing taxes or charges, especially non-wage labour costs. These are widely perceived to represent one of the main obstacles to an increase in employment levels. The tax burden is shifted from labour to environmental pollution and energy consumption, thus creating

incentives for energy conservation and environmentally friendly behaviour, and in parallel giving impulses for job creation. The hope was then to get a double dividend with less environmental pollution and increasing employment.

The impacts of such a policy were the subject of heated debates in Germany, especially after the German Institute for Economic Research (DIW) developed a concrete proposal for an ecological tax reform in the mid-1990s and, supported by a model-based quantitative analysis, expected overall positive macroeconomic impacts.² An ecological tax reform could thus contribute substantially towards energy conservation and the reduction of greenhouse-gas emissions while stimulating employment. Objections were raised against this position, stating that an increase in energy costs would compromise German competitiveness, especially in energy-intensive sectors, thus impairing macroeconomic development.³

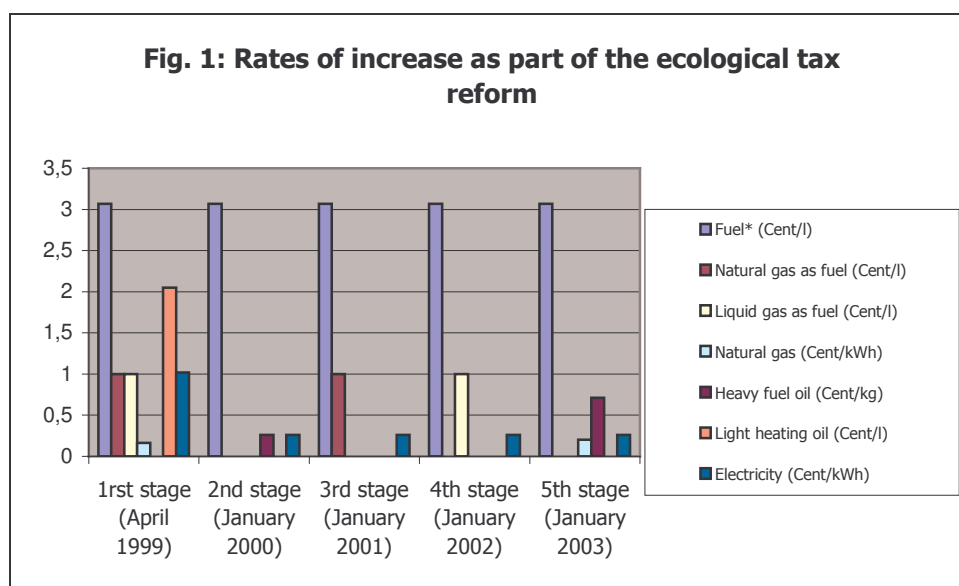
3.1 Design of the Ecological Tax Reform

Since April 1999 and over the course of the ecological tax reform, the tax rate on mineral oil for fuel, gas and heating oil has been increased and an electricity tax introduced:

- The tax rates on mineral oil for fuel (gasoline and diesel) was increased in five steps between 1999 and 2003 by 3,07 Cent per litre each year, i.e. by a total of 15,37 Cent per litre compared with 1998.
- The tax on mineral oil for light heating oil increased by 2,05 Cent per litre in 1999.
- The tax on mineral oil was increased in 1999 for natural gas by 0,164 Cent per kWh for liquid gas by 12,78 Euro for every 1 000 kg; in 2003 the tax rate for natural gas was increased by a further 0,2 Cent per kWh and by 22,26 Euro for every 1 000 kg for liquid gas.
- Starting in 1999, an energy tax of 1,02 Cent per kWh was introduced. The tax rate increased until 2003 by 0,26 Cent per kWh yearly to reach a current 2,05 Cent per kWh.
- From 2000 on, the tax rate on mineral oil for heavy fuel oil for heat and electricity production was fused to a uniform mineral oil tax rate of 17,89 Euro per 1000 kg. This rate has been increased since 2003 and now reaches 25 Euro per 1000 kg.
- Brown coal and hard coal, as well as fuels produced therewith, are not comprised in the ecological tax reform and have been exempt of energy tax to date.

² DIW (1995): Wirtschaftliche Auswirkungen einer ökologischen Steuerreform. By Stefan Bach, Michael Kohlhaas, Volker Meinhardt, Barbara Praetorius, Hans Wessels, Rudolf Zwiener. Special Edition of the DIW no. 153, Berlin.

³ Refer for example to BDI (2004): Für ein attraktives Deutschland. Freiheit wagen – Fesseln sprengen. BDI-Gesamtreformkonzept, version: 28. 6. 2004. Bundesverband der Deutschen Industrie, pp. 82.



Source: Ökosteuer – sparen oder zahlen? Umweltbundesamt, November 2002.

3.2 Use of the Ecological Tax Reform Revenue

The ecological tax's revenue was primarily used to reduce non-wage labour costs put towards public pension scheme or to limit their increase. In 2003, the revenue generated by the eco-tax amounted to approximately 18,7 billion Euro, from which 16,1 billion, i.e. about 90%, went into the public pension scheme. Employers and employees could thus benefit from a reduced contribution rate, from 20,3% in 1998 to 19,5% in 2005. The relief offered by the ecological tax reform is however larger: without the ecological tax reform, contributions to the public pension scheme would have further increased in the same time-period as a result of demographic and economic pressures. Without the ecological tax reform, contributions in 2005 would thus have been at least 1,7 percent points higher, i.e. at 21,2%.

3.3 Derogations in the Ecological Tax Reform

Numerous derogations were anchored in the ecological tax reform from its inception in 1999, due for instance to social or economic motives.⁴ The most important special regulations concern in the first place the manufacturing sector and agriculture, and were introduced to avoid jeopardising these sectors. Parts of these special regulations were revised in 2003.

- Industry and agriculture enjoyed until the end of 2002 a reduced tax rate amounting to 20% of the regular tax rate, provided a basic amount of 511 Euro per year spent on electricity and gas or heating oil was exceeded. From 2003 on, the reduced tax rate went up to 60% of the regular tax rate, and the basic amount was changed to 512,50 Euro per year.

⁴ To prevent social hardship, electricity used to operate electric night storage heating is taxed at only 60% (until 2002: 50%) of the normal tax rate if the heating unit was installed before 1. April 1999. This advantage comes to an end on 31. December 2006.

- The manufacturing sector can additionally apply for a tax cap ("Spitzenausgleich"): Until 2002, an enterprise with a burden resulting from the eco-tax that is 1.2 times greater than the tax relief from the reduction in pension contributions were refunded the full differential amount. With the 2003 modification, only 95% of the excess tax is reimbursed. Thus a tax rate of 3% (5 of 60%) of the regular tax rate remains.

In addition to the economically and socially motivated tax reductions, derogations were introduced to accelerate the development and introduction on the market of certain environmentally-friendly and energy-saving technologies:

- Highly efficient combined heat and power plants (cogeneration and use of electricity and heat) with a minimum utilisation rate of 70% are exempt from the mineral oil tax and the ecological tax; with a rate of 60%, they are only exempt from the ecological tax.
- Gas-steam power plants are exempted from the mineral oil tax and the eco-tax for five years after first generation.
- Electricity from renewable sources meant for the use of the producer is exempt from the electricity tax. Electricity consumption in the framework of contracting is also exempt from taxes.
- Fuel with a sulphur content over 10 ppm are taxed with an additional 1,53 Cent per litre.
- Local public transport systems pay a reduced mineral oil tax rate of 60,048 Cent/litre for petrol, 41,538 Cent/litre for Diesel, 16,695 Cent/kg for liquid gas and 1,38 Cent/kWh for natural gas.
- The public track and rail system enjoy a reduced electricity tax amounting to 56% of the regular tax rate (1,142 Cent/kWh).
- A reduced tax rate applies for natural gas until 2020, and for liquid and natural gas until 2009 when used as fuel (9 Cent/litre).
- Biofuel are exempt until 2009 from both the mineral oil tax and the eco-tax.

4 The effects of Germany's Ecological Tax Reform

4.1 Public Perception of the Ecological Tax Reform

Public opinion polls have shown that parts of the German population do not have a sufficiently clear understanding of how the ecological tax reform links energy price increases and the cost reduction of work. Due to this, an ambivalent attitude towards the ecological tax reform prevails within the country, as demonstrated by the latest opinion poll commissioned by the Federal Environmental Agency and the Federal Environmental Ministry, "Ecological awareness in Germany 2004".⁵ On the one hand, one of the basic concepts behind the ecological tax reform is received with a high degree of acceptance: "It is only fair that those who pollute less and who do something for environmental protection pay less taxes." Eighty percent of the interviewed agreed "completely" or "to a large extent" with this proposition. On

⁵ Umweltbundesamt (Federal Environmental Agency) (2004): "Umweltbewusstsein in Deutschland 2004", downloadable at: <http://www.umweltbundesamt.org/fpdf-l/2792.pdf>.

the other hand, only 25 percent of the interviewed are willing to believe in the central concept of the ecological tax reform: that the tax burden of the factor "work" is shifted onto energy consumption, and that through this measure jobs are created. This is also due to the public discussion and the news coverage of the issue, in which the burden of the ecological taxes dominate, whereas the cost relief achieved through the sinking of the pension contributions is hardly mentioned. Due to these reasons the German Federal Environmental Agency decided to commission a study which would focus mainly on the reform's positive effects and try to quantify them as far as possible. The results of the study will be presented in the following.

4.2 Variations in the Production Sectors' Tax Burdens due to the Ecological Tax Reform

In this part of the study, the DIW Berlin presents model calculations, according to production sectors, of the direct increases and decreases of the tax burden produced by the ecological tax reform, based on the most recent statistical data available. The model calculations are necessary because there is no direct information for tax burden variations due to the reform according to production sectors. The calculations are based on a detailed data-set of energy consumption, energy costs, labour costs and social insurance contributions for the year 2002. The increase in tax burden is determined by means of the higher energy taxes, whereas the decrease is established through the social security contributions, according to the legal framework for the years 2002 and 2003. The results of these calculations show the immediate increase in the tax burden ("first round") due to the reform. This enables the identification of "winners" and "losers" of the reform according to sectors and company size. The main focus is on the effects on the agricultural and industrial sectors. In addition, differentiated model calculations were carried out, with the aim of establishing an adequate picture of the tax reliefs of the different production sectors. Furthermore, the increase and decrease of the tax burden due to the reform for the service sector and for private households are presented.

The study shows that the cost of the reform to the economy and private households is moderately small when compared to the tax revenue of the reform, which was 18,7 billion Euro in 2003. The net cost of the reform to the economy, for instance, was 0,3 billion in the year 2002 and 1,2 billion in 2003. This is mainly due to the fact that the bulk of the revenues are used for the reduction of the non-wage labour costs. Some sectors of the economy actually see a decrease in their tax burden due to this cost reduction; this is valid for instance for some work-intensive services as well as for the manufacturing industry, the companies of which are often competing internationally. In particular the energy sector shows production losses; agriculture and the raw materials/chemicals sector were significantly less affected.

In this respect, an important role is played by special regulations created for the agricultural and manufacturing industry sectors, which aim to strictly contain their tax burden in view of international competition. In this way, it was possible to apply the tax cap ("Spitzenausgleich") for 80 percent of the manufacturing industry's electricity consumption in the year 2003; this implies a factual reduction of the tax rate to 3 percent of the regular tax rate, i.e. to 0,0615 Cent/kWh. Of the remaining 20 percent, 16 percent was taxed with tax rate reduced by 40 percent (1,23 Cent/kWh), and only 4 percent was taxed normally (2,05 Cent/kWh).

4.3 Effects of the Ecological Tax Reform on the Economy

The increase and reduction effects on the tax burden caused by the reform were used as input parameters in a macro economic model, so as to determine the adaptive reactions of the different sectors of the economy, and the effects on the Gross Domestic Product (GDP), employment and CO₂ emissions. The calculations were carried out using a scenario method, in which two scenarios are quantitatively described and compared: a reference scenario, which describes a development without the ecological tax reform, and a political scenario, whose only difference regarding the reference scenario is the inclusion of the measures of the reform. The differences between the results for both scenarios can thus be interpreted as being due to the ecological tax reform.

The results show that the ecological tax reform achieves the double objective aimed for: a simultaneous reduction in CO₂ emissions and improvement of the employment. During the five phases of the ecological tax reform implementation, the economy's activity as measured using the Gross Domestic Product (GDP) increased up to nearly half a percent point in comparison with the reference scenario without ecological tax reform; subsequently, it gradually returns to the reference level.

The reduction in CO₂ emissions when compared to the reference situation amounts to approximately half a percent point during the first year, and develops to a reduction of approximately 2,4 percent or 20 million tons in the year 2003, the point in time up to which tax rates for fuel and electricity increased. After 2003 the emissions continue to decrease gradually, even though from then on no further increases in the taxing of energy were realised. In the year 2010, the reduction in CO₂ emissions achieved is around 3 percent; this corresponds approximately to 24 million tonnes of CO₂. When compared with a scenario with no ecological tax reform, the employment situation with the reform is consistently better. The largest effect on employment occurred in 2003, consisting in approximately 250.000 additional jobs. The GDP, whose rate of change is the growth indicator for the complete economy, shows a higher level due to the ecological tax reform. After the freezing of the ecological tax rates in 2003, it shows a long-term trend towards the reference level.

The clearly positive effects on GDP and employment can be attributed to the investments related to energy cost reduction which were carried out in the early stages of the ecological tax reform. Later on, the reduction of salary-related costs – generated through the use of the tax revenues for decreasing pension contributions – gains in importance. This causes a replacement of the production factors capital and energy by the factor work.

4.4 Effects on Private Households

Private households are affected by the ecological tax reform mainly through the price increases for electricity, heating and fuel. These lead to higher costs of energy use, thus creating incentives for a more efficient use of energy. Ecologic investigated the changes generated by higher energy prices in consumers' everyday behaviour with the aid of a public opinion poll. From the 21st to the 24th of September 2004, 1002 persons were interviewed by telephone. The questions referred to electricity use, housing/heating and mobility.

Generally speaking, the results show that the majority of the population actively tries to reduce energy consumption, according to their own statements. The measures preferred are

the ones that are simple and realisable in the short term; in most cases the measures taken correspond to changes of behaviour. A large majority of the population claims to realise substantial efforts for reducing its electricity consumption, for instance through completely switching off electrical appliances. Seventy-eight percent of those who apply energy-saving measures declared that the ecological tax had played a role in this behaviour: for 18 percent the ecological tax provides very strong motivation, for 25 percent a strong motivation, and for 35 percent a less strong motivation to save electricity. Only a fifth (21%) declared that the ecological tax does not play a role in their motivation to save electricity.

For the subject housing and heating, it was determined that a predominant portion of the queried had resorted to concrete measures so as to save electricity. For example eighty-eight percent of those interviewed claimed that they regularly turn off their heating when absent, 82 percent air their premises through shock-airing, and 59 percent decrease the room temperature of unoccupied rooms. Limiting the analysis to owners of buildings, houses or flats shows that approximately half of them invested in heat-insulating windows or general heat insulation within the last 3 years. The price increase of heating energy as a consequence of the reform is an important contributing factor in the decision to take these measures: 21 percent claimed it is a very strong motivation for deciding to invest in insulation, 26 percent declared it is a strong motivation, and 32 percent said the price increases are a less strong motivation. Only 18 percent stated that the ecological tax reform has no influence in this respect.

Similar results were obtained in the sector mobility and transport. The poll showed that approximately three fourths of the car drivers within the interviewed (73%) saved petrol through changes in their driving behaviour. Furthermore, one fifth (20%) of the interviewed occasionally leave their car at home and use other means of transport so as to save petrol. Of the interviewed who stated that they change their car use to save petrol, 76 percent declared the ecological tax is a factor influencing their behaviour: 27 percent said it is a very strong one, 26 percent a strong one and 23 percent a somewhat strong one. The ecological tax has no influence on car use or choice of means of transport for 21 percent of the interviewed.

In summary, the interviews show that in all three sectors – electricity, housing/heating, mobility – a majority of the population claims to realise efforts so as to reduce their energy consumption; the ecological tax played an important or very important role for around half of those who apply energy-saving measures. Although other motives, e.g. environmental protection or energy costs in general, also play an important role, the additional impulse provided by the ecological tax can be clearly identified. In this way the ecological tax has made a comprehensive contribution to a more economical energy consumption in private households.

4.5 Effects of Ecological Tax Reform for Selected Companies

For this part of the study, Ecologic used structured interviews at the company level to analyse how individual companies react to the changes in the general framework due to the ecological tax reform. Exemplary research was conducted on 16 companies that adjusted successfully to the ecological tax reform – for instance through the opening up of new markets, through the introduction of new production technologies or new products and

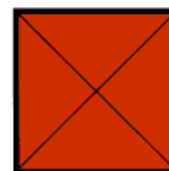
services, through an increase in business volume, through internal measures for saving energy or through the reduction of pension-scheme payments.

The study shows that companies belonging to the most varied economic sectors have profited from the ecological tax reform. Companies that on balance profited from the reform were identified in the service sector, in transport, industry and construction, among others. Similarly, companies of every size were able to gain advantage out of the reform. The companies range from very small firms with few workers, over classic medium-sized companies, up to companies active internationally and whose shares are traded on the German stock exchange (DAX).

Several differing tendencies were deduced by means of the survey. A number of companies, for instance, given the rising electricity and energy prices, profited through the promotion of the production and distribution of products that are energetically more efficient. In this case, the amortisation period had been sharply reduced thanks to the ecological tax and the general price increase of energy, which implied additional incentives for investment.

Example Moresby Hausplanungs und –vertriebs GmbH, Hamburg:

This company works in the planning, construction and marketing of ecologically “active” and “passive” buildings. Thanks to the heightened sensibility displayed by building constructors regarding ecological issues and energy consumption, Moresby faced a larger demand for its services and increased the number of its employees.



Moresby Haus®
natürliches Bauen

Energy consulting firms are on the upswing due to the increase in demand. The ecological tax reform favoured innovations and the formation of companies in this area, which also produced positive effects for employment. In many cases, the companies that profited were ones that produced environmentally sound or energy-efficient products before the ecological tax was applied: the heightened awareness regarding ecological and cost issues which were a by-product of the reform were responsible for an increase in the demand.

Example Dezem GmbH, Berlin:



The company Dezem, formed as recently as May 2003, has specialised in the elaboration of energy-use profiles in real time, aided by sensors developed for this purpose by the firm. Through these profiles clients receive information regarding their actual energy consumption and the distribution of energy flows. Based on this information, specific measures for saving energy can be put into effect. The savings potential identified is usually over 20%, and can be up to 50% for large office buildings. The firm, with banks, industry and insurance companies as clients, has shown double-figure growth and a continuous increase in the number of its employees.

Companies that have reduced their energy costs through energy saving measures have also profited, for instance through the conversion to more energy-efficient production processes. Many of these investment possibilities only became attractive after the ecological tax reform, because their amortisation periods are reduced by the higher energy prices.

Example Brauerei Clemens Härle, Leutkirch:

This medium-sized brewery from Allgäu managed to compensate the increase in energy costs through the consistent use of energy-saving measures, as for instance the conversion of the brewing process. Through selective and well-directed investments, fuel-oil consumption was reduced by approximately 20 percent. Furthermore, the brewery converted its fleet of vehicles to “bio-diesel”, and installed a solar panel system. The amount of electricity that this system feeds back into the electrical network corresponds to 5% of the company's consumption. The use of bio-diesel, the strictly regional commercialisation of its products and being part of the environmentally-friendly reusable-system improved the brewery's competitiveness compared to the national competition.



In addition, companies who managed to make good use of the special regulations relating to the environment that formed part of the ecological tax reform were also ones to profit from the reform. To this group belong particularly companies that produce or purchase environmentally-friendly products, which are taxed at reduced rates. Examples of these products are fuels such as natural gas or bio-diesel, or energy which has been produced using energy-efficient power-heat coupling plants.

Example GASAG Berliner Gaswerke AG, Berlin:



In addition to the provision of natural gas and heat, its core business area, GASAG has created a new mobility division. In the last 3 years the company has invested several million Euro in building up a city-wide fuelling-station network for gas-powered vehicles in Berlin. Moreover, GASAG promotes the acquisition of gas-powered vehicles and the conversion of conventional vehicles to gas power. The company set a good example by converting 200 company vehicles to natural-gas operation. For Berlin GASAG is predicting a growth in the number of gas-powered vehicles from 1.000 in 2004 to 5.500 in the year 2009.

An important cause behind the reduction of the tax burden for all companies was the reduction in the non-wage labour costs. All companies profited from the reduction and stabilisation of the pension contributions. The companies to make the most use of this reduction were usually companies which are highly labour-intensive and not very energy-intensive. Service companies, which often employ a large number of highly qualified people with high salaries, but require relatively small amounts of energy, achieve through this measure a particularly high tax relief. However, there are very few quantitative studies analysing these tax relief effects.

Example Schering AG, Berlin & Bergkamen:

A company with a workforce of 8.000 between their two locations, Berlin and Bergkamen, Schering profited considerably from the reduction of the non-wage labour costs. At the same time energy consumption and thus the ecological tax burden were strongly reduced. Schering was the first German company to create an energy office, responsible for all energy-related areas, from production to energy consumption. Thus, the plants in Berlin and Bergkamen produce a large proportion of the company's energy requirements in their own power plants, using the modern power-heat coupling system, and which thanks to the high degree of yearly use are exempted of over 85 percent of the mineral oil tax due to the ecological tax reform. The savings add up to 1,2 million Euro per year. As concluded by internal calculations, Schering altogether profited clearly from the reform.



It is possible to differentiate between two groups among the companies to profit from the ecological tax reform. The first group is made up of companies that actively adapted to the changed general framework due to the introduction of the ecological tax reform; i.e., they brought out new products, opened up new markets and/or introduced new production technologies.

The companies of the second group are those that managed to profit from the reform without changing significantly their products or production processes. These are mainly work-intensive companies which experienced a net reduction of their costs due to the decrease of non-wage labour costs. To this group also belong companies that addressed early the issues of environmental and climate protection, through an increase in their energy efficiency, the introduction of renewable energies or by offering products for the promotion of energy efficiency and consultancy services in this area. Companies offering products and services in this last area have been given an additional impulse for company development through the population's increased ecological awareness due to the ecological tax reform.

Some companies can even be considered as belonging to both groups. Cases like that of Schering AG or Brauerei Härle show that companies that could be included among those to profit from the reform anyway can make their cost reduction even larger through efforts targeting energy saving.

4.6 Effects of the Ecological Tax Reform on Innovations and Market Penetration

The efforts regarding innovation that companies undertake depend on a wide variety of factors, with the ecological tax reform only one of them. The influence of the reform is thus hard to identify and quantify. Using as basis an intensive literature research and expert interviews, the study presents the effects on innovation of the ecological tax reform by means of case studies. In addition, the reform's effects on the market penetration of energy-efficient goods and services of prior existence to the reform, and whose spread has positive effects on the environment, are also analysed. Through these case studies, effects on innovation

attributable to the ecological tax reform can be determined. The ecological tax reform, in the extent to which it has shifted and strengthened the focus of development on energy-saving innovations, has contributed to ecological modernisation. Essentially, the ecological tax reform contributes to this process in three ways:

- The reform generated additional **financial incentives** for an economical use of energy resources, thus effecting a faster amortisation of investments in energetically efficient products. This is a product of both price increases in energy sources and special regulations favouring efficient energy use and renewable energy sources. The decrease in non-wage labour costs tends to support this effect on innovativeness, because innovation processes and their subsequent popularisation are mostly work-intensive processes – e.g. the research and development, but also the energy consultancy and the installation of energy-saving technology.
- The ecological tax has contributed to increasing the **planning reliability of investments**, because it is – as opposed to the erratic variations in oil prices – predictable and can be planned for. This effect is particularly clear for research and development, but also for the acquisition of new equipment and products.
- In addition to the financial incentives and the increase in investment reliability, the ecological tax reform produced a **signalling effect**. The debate around the reform strengthened consumers' and companies' awareness of the need for an energy use that is more economical and rational, so that the criterion "energy use" is receiving more consideration in acquisition and investment decisions. In this way, incentives for further innovation and for continuous development and distribution are created.

Some sectors, e.g. fuel consumption in transport or energy consumption of private households, have shown considerable development in the last few years. Since 1999 Germany's fuel consumption has been falling for several consecutive years – the first time this happens in the last 50 years - although the number of vehicles continues to rise. This is mainly due to a reduction in the fuel consumption of the motor pool, but also a consequence of an increase in the importance of public transport, fuel-efficient cars and gas-powered vehicles. The increase in energy awareness of companies and private households in the last few years, significantly influenced by the ecological tax reform, is likewise reflected in, among other areas, the development of products with higher energy efficiency. Among other parameters, the price evolution, the technical advancement or the market penetration can be used as indicators for the growing importance of these higher energy-efficiency products.

- **Market penetration:** Both supply of and demand for products and services in the sectors studied have shown a strong increase since the introduction of the reform. Some individual products and services, e.g. gas-powered vehicles or energy-saving contracting, have only just begun to develop their market potential. Accordingly, they are characterised by large growth rates: the number of gas-powered cars, for example, has increased ten-fold between 1998 and 2004. In the year 2004, approximately every 40th additional car was a gas-powered one. The market share of gas-powered vehicles regarding inventory change has had a larger than ten-fold increase since 1998. Other goods, as for instance the energy-saving light bulbs, are already being used as staple products by large parts of the population.

Energy-saving products and services are not only being required by private consumers, but increasingly by companies, town councils and other public institutions. An example

for the adoption of products that are more environmentally friendly and which were made more convenient due to the ecological tax reform is the conversion of parts of companies vehicle fleets to natural gas, such as those belonging to parcel service companies or public transport. Energy-saving contracting and energy-delivery contracting are also being used more and more often by companies and public institutions.

- **Price development:** the market spread of innovative products was often accompanied by a price reduction, due to the cost reduction permitted by mass production. Examples for this are energy-saving light bulbs and LED lamps, whose prices have decreased significantly in the last years and which have become mass products. In addition to this, the costs of more energy-intensive products have risen in comparison to the energy-efficient innovations due to the ecological tax reform. The reform has produced a general framework that helps innovative technologies achieve a greater market share.
- **Technical development and product differentiation:** Due to the increased market distribution of innovative products and services, a differentiation and development of the product range can be observed. An example of this is the number of car models that have a serially produced gas-powered version, which has risen significantly in the last years. Likewise, energy-saving light bulbs of the most varying intensities, sizes, tonalities and forms are available on the market. In addition to the development of the product range, a development of the product qualities has also taken place. Initial problems, such as the "cold" quality of energy-saving light bulbs, have been solved. The isolation effect, and in consequence the energy efficiency, of both gas-powered vehicles and heat insulating windows has been increased.

The case histories of the energy efficient products and services analysed clearly shows that the ecological tax reform has had a noticeable effect, even when it is usually not possible to quantify precisely the reform's contribution. In individual cases, as for instance the distribution of gas-powered vehicles, the reform was a central factor for product innovation and spreading.

5 Summary and Outlook

This study presented an ex-post analysis of the impacts of the ecological tax reform on the environment, employment and technological innovations. It demonstrated that ecological tax reform, which was introduced in 1999, had a positive impact on climate protection and employment and promoted the development and market penetration of energy-saving technological innovations. Thanks to the eco-tax, the emissions of carbon dioxide have continually decreased. In 2003, emissions went down by 2,4%, i.e. 20 million tons CO₂. By 2010, emissions could even be cut down by some 24 million tons CO₂ yearly. The eco-tax thus belongs to the most important instruments for climate protection in Germany. The employment situation has also improved thanks to the ecological tax reform. Employment rose by 250.000 jobs until 2003, for the most part in labour intensive sectors and providers of energy-saving technologies. This number establishes that the ecological tax reform created jobs. Two factors play a key role: first, the eco-tax lowers non-wage labour costs, as 90% of the revenue from the ecological tax reform are used to lower employers' contribution into the public pension scheme. Second, the ecological tax reform has assisted companies that offer

products and services which allow an increase in energy-efficiency. Furthermore, it was possible to determine that the ecological tax reform has been a motivation for private households to save energy in electricity use, housing/heating and mobility. Last but not least, the ecological tax reform promotes the development and market penetration of energy efficient and environmentally friendly products, services and technologies through the increased demand in the energy-saving area.