Prime Minister's Office

Economic Council

Environmental and Energy Taxation in Finland
- Preparing for the Kyoto Challenge

Summary of the Working Group Report

Prime Minister's Office Publication Series
2000/4

To the Economic Council

At its meeting on September 8, 1999 the Economic Council appointed a working group with the brief of preparing a report on the level, targeting and impact of environmental and energy taxation in Finland. The working group was to consider international trends in environmental taxation and the level of energy taxation in Finland compared with other EU and OECD-countries with a focus on, Finland's commitments under international conventions, especially the Kyoto Protocol. Both the impact of environmental taxes on emissions and the effect of the resulting changes in the tax structure on our competitiveness, economic growth, employment and income distribution was to be addressed. The report was to be submitted by February 29, 2000.

Seppo Leppänen, Secretary General of the Economic Council, was appointed chairman of the group and the following persons were appointed as members: Kari Alho, research director at the Research Institute of the Finnish Economy; Sirkka Hautojärvi, permanent secretary at the Ministry of the Environment; Marja Heikkinen, deputy director-general at the Ministry of Transport and Communications; Reino Hjerppe, director-general at the Government Institute for Economic Research; Ilkka Savolainen, professor at the Technical Research Centre of Finland; Ilpo Suoniemi, senior researcher at the Labour Institute for Economic Research; Gustav Teir, financial counsellor at the Ministry of Finance; and Taisto Turunen, director-general at the Ministry of Trade and Industry. Antti Romppanen, head of research at the Government Institute for Economic Research, acted as permanent expert to the working group.

Pekka Sinko, an economist at the Government Institute for Economic Research, acted as the working group's full-time secretary at the Prime Minister's Office. Other secretaries were Jarmo Muurman, senior inspector at the Ministry of the Environment; Jukka Saarinen, senior inspector at the Ministry of Trade and Industry; and Heikki Sourama, financial counsellor at the Ministry of Finance. Iiris Koskela-Näsänen was responsible for the text processing and layout. The working group was able to draw on numerous specialist reports and consulted experts from various fields.

Climate change will be one of the most pressing global environmental problems during the next few decades and can only be slowed down if international action is agreed on and taken. In Europe, the need for international action is underlined by the rapidly advancing integration of the commodity and electricity markets and EU enlargement. Any unilateral effort to solve the greenhouse gas problem using environmental and energy taxation is problematic, especially in countries like Finland, with an energy-intensive production structure and high energy efficiency. Even if properly applied, taxation is only of limited help in efforts to lower greenhouse gas emissions to targeted levels.

As internationally coordinated tax solutions are unlikely to become a reality any time soon, Finland has only limited potential for speeding up implementation of the targets agreed in Kyoto by raising taxes. Though the impact of higher taxes could be counterbalanced by cutting taxation in other areas, the consequences (rising unemployment and growing income inequalities) could prove serious. Thus, the targets set in Kyoto can best be achieved by exploiting the opportunities provided by clean energy production, technologies, energy conservation and the various Kyoto mechanisms (emissions trading, joint implementation and clean development mechanisms).

To minimize the adjustment costs involved in any structural changes, companies and households must be provided with accurate information about such matters as advances in different forms of energy production and strategies concerning tax solutions and the Kyoto mechanisms. Gradually implemented policies with adequate transition periods enable private companies and households to take increasingly stringent environmental requirements into account when they make long-term investment decisions. This approach will decrease the need for comprehensive and rapid emission reductions at the end of the decade and will also boost the development of environmentally friendly technologies.

Finland must play an active role in efforts to find international solutions to environmental taxation and emission trading problems, and should also promote other international solutions that will reduce global emissions. Moreover, we should work to provide more comprehensive statistics and research information on the subject.

The working group respectfully submits its report to the Economic Council.

Helsinki, February 29, 2000

Seppo Leppänen

Kari Alho
Marja Heikkinen
Ilkka Savolainen
Gustav Teir
Antti Romppanen
Jukka Saarinen
Heikki Sourama

Sirkka Hautojärvi
Reino Hjerppe
Ilpo Suoniemi
Taisto Turunen
Jarmo Muurman
Pekka Sinko

CONTENTS

SUMMARY AND CONCLUSIONS

The working group was assigned the brief of preparing a report on the environmental and energy taxation system in Finland and examining the probable effects of shifting its focus to the environment and the energy sector. The working group consequently decided to compare the structure and level of environmental and energy taxation in Finland with the approach taken by our competitors, and assess the impact of taxation on the key economic aggregates and on income distribution among private households. Special attention was paid to the role of taxation in a situation where Finland is preparing to meet its commitments under the UN Convention on Climate Change. The emphasis was on matters related to the level and targeting of environmental and energy taxes and thus the report contains no examination of their detailed structure and administration. The report also discusses future use of energy and likely developments on the market. Various instruments with an impact on environmental protection are also reviewed.

Climate change - a major problem in coming years

Administrative and economic instruments have brought about an improvement in the state of the Finnish environment during the last few decades by, for example, reducing sulphur and nitrogen emissions. A major area where further action is needed is combating climate change. The problem is caused by greenhouse gases that can spread freely in the earth's atmosphere, so climate change can only be dealt with if global action is taken. The Kyoto Protocol of the international Climate Convention is an important step in this direction, and by signing the Protocol and the related EU burden-sharing agreement, Finland and other industrialized countries have committed themselves to measures that will bring about significant emission reductions during the next 10 years. Emissions by developing countries account for almost half of total global emissions and are also rising more rapidly than those produced by the industrialized world. Thus, it will be imperative in future to cut emissions originating in the developing world, too.

Carbon dioxide released into the atmosphere in the use and production of energy accounts for most of the greenhouse gas emissions caused by human activity. In Finland, total energy demand and consumption of electricity are on the rise, though the rate of growth has slowed down in recent decades. If the economy keeps on growing and the infrastructure and technology for producing energy remain more or less unchanged, Finland will not be able to meet the emission targets laid down in the Kyoto Protocol unless further action is taken.

There are considerable annual fluctuations in carbon dioxide emissions in Finland, depending on electricity imports and total supply of hydro power in the Nordic countries. In recent years, Finnish emissions have been lower than normal and have actually been only a few per cent above the 1990 level, which is the target set in the EU burden-sharing agreement**.** Cutting emissions to 1990 levels by 2008-2012 will be

a major challenge for Finland and requires well-focused long-term efforts involving energy consumption and production and other emission sources.

Compared with other countries, energy production in Finland is not particularly emission-intensive**.** This is because we allready draw on a diverse supply of primary energy sources and produce energy very efficiently. Thus, reducing energy-related emissions will be expensive and will require major structural changes. If the desired reductions are to be achieved with tax incentives, major tax increases will be inevitable. Should such measures be taken unilaterally, they would have a considerable cost impact on the economy as a whole. It is unlikely that there will be any harmonization of taxation at an international or EU level during the next few years. Thus, environmental and energy taxes will only be of limited use in Finland's efforts to achieve the targets set out in the Kyoto Protocol and the EU burden-sharing agreement.

Tax increases slowed down emission rises in the 1990s

The Finnish environmental and energy tax system is the product of a number of conflicting factors. In addition to furnishing the government with revenues, the taxes collected have also been used to promote various policy goals involving environmental, energy and transport considerations. Administering the system has proved complicated and difficult. This is partly because of tax subsidies and partly because of procedures related to combined heat and power production (CHP). The system has also been changed several times. The tax subsidies incorporated into the system make long-term decision-making and planning especially complicated, as they are subject to approval by the EU Commission. Such approval is usually on a temporary basis and is often conditional on a gradual lowering of the subsidies. On the other hand, should the subsidies be abolished, many companies would be saddled with major costs. The need to streamline the system is widely recognized, and in fact a separate working group was appointed in January 2000 to consider the problem.

Taxes that have gone up in real terms have resulted in lower carbon dioxide emissions. The calculations made for the working group indicate that the higher taxes introduced in the 1990s brought about a considerable reduction in emissions. According to the calculations, 1998 carbon dioxide emissions were several million tonnes lower than they would have been if no measures had been taken. At the same time, the tax structure has become more environmentally friendly: the percentage of the total tax burden accounted for by energy taxes has gone up, while that of taxes on earnings has decreased.

The OECD countries are making more and more use of environmental and energy taxes. In 1997, environmental taxes accounted for about 7 per cent of all taxes in the OEDC countries. Measured relative to GDP, environmental taxes in Finland are well above the OECD average, accounting for 3.4 per cent in 1999. Taxation of fossil fuels, especially petrol and diesel oil, continues to be the source of most environmental tax revenue. In OECD countries, transport taxes account for more than 90 per cent of all environmental tax revenue (in Finland about 83 per cent). Electricity consumption is also an important source of tax revenue in a number of countries, including Finland. The various other environmental taxes have only minor fiscal importance, though they can have considerable environmental impact in their own limited areas.

International comparisons show that there are no major differences between the prices and taxes households in northern and central European countries are charged for oil products. Finnish consumer prices and taxes are in the middle range. The same applies to the taxes we have to pay for electricity, but consumer prices in Finland are well below the European average. However, integration of the electricity market and tougher competition will probably lower electricity prices in Western European countries too, as has recently happened in Germany.

For energy consumed by industry, any accurate comparison of taxes and prices is difficult, because in many countries heavy industry, especially, enjoys low energy prices and tax relief. Based on the material at its disposal the working group concluded that the price industry in Finland and the other Nordic countries pays for electricity is lower than in Western Europe. The total energy taxes paid by Finnish industry amount to almost 1 per cent of value added, which is well above the OECD average. This is partly because Finnish industry is so energy-intensive, though in some energy-intensive branches, too, the relative tax burden is high by international comparison.

Economic impact of environmental and energy taxes

Several international assessments have been made on the economic impact of environmental and energy taxes. The Kyoto Protocol has prompted considerable research, especially on the effect of a hypothetical tax on carbon dioxide. The calculations give some indication of the impact of the most commonly applied environmental and energy taxes. Calculations made in Finland as well as those made by international organizations lend support to the view that if a single country raises its environmental and energy taxes to the extent that reductions in emissions would be sufficient to achieve the targets set out in the Kyoto Protocol, the economic costs of such policies would soon become prohibitive. The economic consequences of the tax increases could be alleviated by using the revenues to lower income taxes but there could still be major structural changes in the economy.

The problem with raising taxes on energy use is that they put a heavy burden on energy-intensive industries and low-income households. Any negative impact on low-income groups could, of course, be alleviated with tax cuts and income transfers. However, as even households with similar incomes use different amounts of energy and pay different amount of related taxes, compensation of income losses would be difficult. Changes in environmental and energy taxation introduced in the 1990s have probably increased the relative tax burden of low-income households. The calculations available to the working group indicate that increases in environmental and energy taxes have also slightly widened income differentials between regions. Thus, the regional and socio-economic impacts of energy taxation should be examined more closely.

Future decisions on environmental and energy taxation will be determined by the impact of integrated commodity and energy markets and EU-imposed restrictions. A good example is the rapid opening-up of the electricity market, hitherto a characteristic of the Nordic area, in other Western European countries. In this new situation, only the end consumption of electricity can be taxed, so individual countries have little room for manoeuvre as they do not want to jeopardize competitiveness, employment or growth. If they take any unilateral tax decisions, energy-intensive production might simply move to countries with less regulation. According to some international calculations, this 'carbon leakage' may even increase global environmental emissions.

The EU has been working on an energy tax directive for many years now, but progress has been slow and any joint decision seems unlikely. The latest proposal, made by the Commission in 1997, is based on a system of minimum taxes that would be specific to individual fuel and energy types. Were the proposal put into practice, Finland would have to raise the tax on diesel oil, but otherwise our taxes already exceed the minimum set out in the draft.

Use of the Kyoto mechanisms and new technology should be promoted

The Kyoto mechanisms, i.e. emissions trading and joint implementation, could significantly reduce the costs of global efforts to achieve the reduction targets for greenhouse gases. The fact that efforts to harmonize taxation at an international level have made little progress makes application of the Kyoto mechanisms all the more important. It is in Finland's interest for the Kyoto mechanisms to be applied as globally as possible, because they enable us to cut our emission reduction costs, which are high compared with many other countries. Many practical questions concerning application of the Kyoto mechanisms, especially emissions trading, remain open and should be settled in future negotiations under the Climate Convention as soon as possible. In Finland, preparations for legislation enabling emissions to be traded are already under way.

Irrespective of the way the Kyoto mechanisms are put into practice, internationally-approved emission targets will put an additional economic burden on countries like Finland, which are characterized by an energy-intensive production structure and high per capita energy consumption and emissions. There will be more need for energy forms and sources with low or zero emissions, and energy will also have to be used more efficiently. Thus, Finland should support efforts to develop such technology both domestically and through EU technology subsidies. Should the efforts to increase the use of low-emission energy fail, there will be added pressure for more forceful methods.

Use of energy involves long-term investments. To minimize the structural adjustment costs, private companies and households must be provided with accurate information, for instance about advances in different forms of energy production and strategies concerning tax solutions and the Kyoto mechanisms. Gradually implemented policies with adequate transition periods will enable companies and households to take increasingly stringent environmental requirements into account when long-term investment decisions are made.

1. INTRODUCTION

The Economic Council assigned the working group the brief of examining the levels, targeting and impact of environmental and energy taxation in Finland. The group was to consider international trends in environmental taxation and the level of energy taxation in Finland compared with other EU countries and our most important competitors. The working group was also to examine Finland's commitments under international conventions, especially the Kyoto Protocol, the impact of environmental taxes on emissions, and the effect of the resulting changes in the tax structure on our competitiveness, economic growth, employment and income distribution.

As there is no generally-accepted international definition of the concept 'environmental taxes', the working group decided to include in its report all taxes and charges with a major impact on the environment. It examined the question of environmental taxes from the point of view of international commitments, especially under the Kyoto Protocol, and did not go beyond carbon dioxide emissions in its consideration of greenhouse gases. As preparations for a national climate strategy are already under way, the working group focused on the role and impact of taxation, the task it was originally assigned.

To get a good idea of the problem with restricting carbon dioxide emissions, the working group first focused on the state of the environment and future prospects, and discussed the scope and impact of environmental problems from Finland's point of view. In view of the origins, development and containment of environmental problems, it is clear that climate change requires comprehensive and urgent international action.

Production and use of energy play a key role when efforts are made to limit greenhouse gas emissions. Chapter 3 discusses the structure of energy use and future prospects in Finland. We can rely on a fairly versatile supply of primary energy and produce our energy efficiently. Compared with other countries, greenhouse gas emissions in relation to total demand for energy are also quite low. The fairly low emission intensity is partly explained by the relatively low contribution made by fossil fuels to total energy supply. However, the growing demand for energy is bound to increase emissions during the next few years.

Economic instruments are discussed in chapter 4. Finland has been more willing than other EU countries to use these as a means of achieving environmental targets. The role of energy taxes differs from country to country and efforts to harmonize them in the EU have made little progress. Thus, chapter 4 also discusses other ways of reducing greenhouse gases, such as emissions trading and other Kyoto mechanisms.

One of the most important tasks of the working group was to assess the total economic impact of environmental taxes. Environmental protection involves making compromises between many conflicting targets. Employment and prosperity require economic growth, which is in turn conditional on production and use of energy; however, this will result in more carbon dioxide emissions. Thus, reducing environmental emissions is also linked to international competitiveness, economic growth and employment. Chapter 5 also discusses the connection between environmental protection and employment from the point of view of 'double dividend', and the impact environmental taxation can have on income distribution.

2. CLIMATE CHANGE AS AN ENVIRONMENTAL PROBLEM

2.1 Climate change

Climate change is a phenomenon in which air temperature rises, especially as a result of human activity. The rise is caused by the greenhouse effect, in which vapour in the atmosphere and certain gases occurring in small concentrations (mainly carbon dioxide) act like a glass wall in a greenhouse. They let solar radiation in but prevent thermal radiation from reflecting and thus raise the earth's temperature. The greenhouse effect is a natural phenomenon. After all, it enables mankind to enjoy favourable living conditions, as otherwise the temperature on earth would be more than 30 degrees lower than at present. However, the emissions resulting from the burning of fossil fuels and other human activity are speeding up the greenhouse effect and may lead to an excessive rise in air temperature.

Climate change is a global problem, but affects various parts of the earth differently. It is predicted that northern areas of the globe will become warmer and more rainy while some major grain-producing areas (midwestern states of the USA, southern Russia and Ukraine) will get considerably less rain. As the earth's climate becomes warmer, areas now covered by snow and ice will shrink and sea levels will rise. As a result, the population will have to move away from coastal areas, and the phenomenon may also threaten the existence of a number of island states. For Finland, the crucial factor is the future behaviour of ocean currents, especially the Gulf Stream, which keeps temperatures relatively warm in the north of Europe. If the many climatic models predicting a weakening of the Gulf Stream prove accurate, the climate in this part of the world will probably become colder.

According to the international research community, human activity is already having an impact on the earth's climate and causing temperatures to rise (IPCC, 1996). In Finland, the changes are not clear-cut, however. Though the temperatures at observation points in different parts of the country vary considerably, records show that between 1901 and 1995 there was a rise of about 0.5 degrees. According to the middle scenario prepared for the Finnish research programme on climate change, the rise would be 2.4 degrees by 2050 and 4.4 degrees by 2100. This means that in 2050, average temperatures in Rovaniemi would equal the present average in Jyväskylä, while 50 years later they would be on a par with the present average in Turku.

Carbon dioxide (CO_2) is by far the most important greenhouse gas. Other gases contributing to the phenomenon are methane (CH_4) and nitrous oxide (N_2O). Carbon dioxide, methane and nitrogen oxides are released to the atmosphere from nature and as a result of human activity. Greenhouse gases resulting solely from human activity include partly and fully fluorinated hydrocarbons (HFCs and PFCs, respectively) and sulphur hexafluoride (SF_6). Other halogenated hydrocarbons are also having an impact on the radiation balance of the atmosphere.

The climatic impact of a gas depends on the amount in the atmosphere and its natural ability to absorb thermal radiation. It is estimated that 60 per cent of all warming of the climate caused by human activity is a result of carbon dioxide emissions, while halogenated hydrocarbons account for 10 per cent and nitrous oxides for 6 per cent (IPCC, 1996).

Greenhouse gases are characterized by longevity, which means that they are easily absorbed into the whole atmosphere. The location of the emission source does not have any impact on the rate of climate change and the same goes for any action taken by an individual country. Thus, even if Finland were able to abolish all its greenhouse gas emissions, global climate change would continue at the present rate[1]. The problem is therefore being combated with internationally coordinated measures based on the UN Convention on Climate Change signed in Rio de Janeiro in 1992[2].

2.2 Origin of greenhouse gas emissions in Finland and future prospects

Carbon dioxide emissions originating from the use of fossil fuels and peat[3] account for 75 per cent of all greenhouse gas emissions in Finland. Use of fossil fuels and peat also causes other greenhouse gas emissions, which account for 3 per cent of the total produced in Finland. In 1998 the energy sector accounted for 40 per cent, industry and construction for 25 per cent, transport for 21 per cent and other sources for 14 per cent of emissions resulting from the use of fossil fuels and peat[4].

---

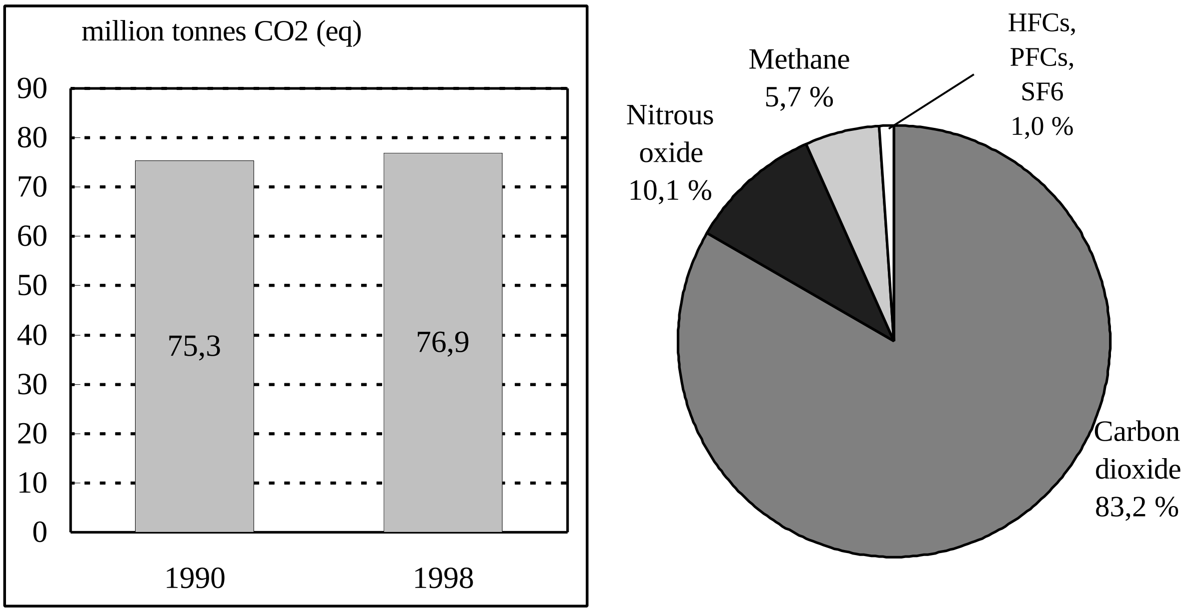
1 On the other hand, measures involving climate policy implemented in Finland and adjoining areas will contribute to the reduction of other emissions.

2 The Convention and the related Kyoto Protocol are discussed in more detail in the section 'Conventions restricting greenhouse gas emissions'.

3 Fossil fuels include oil products, coal and natural gas. Their use comprises combustion and evaporation and emissions from peat production.

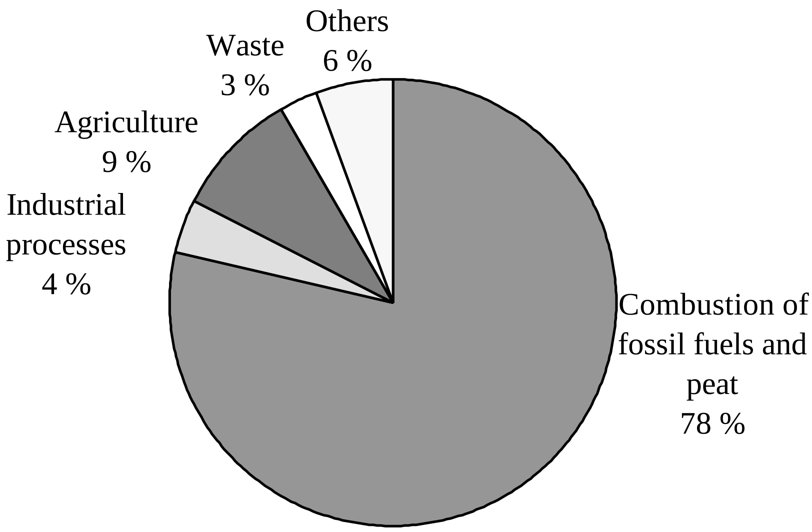
4 The category 'energy sector' includes the production of electricity and heat for general use and 'industry' units at production plants that generate electricity and heat for the industry. 'Others' includes such sources as households, services, agriculture, machinery (excl. machinery used for construction).

Figure 2.1 Emissions of greenhouse gases in Finland in 1990 and 1998 and the percentage of the various gases of the total emissions in 1998



Sources: Finnish Ministry of the Environment, Statistics Finland.

Figure 2.2 Greenhouse gas emissions in 1998 by emission source



Sources: Finnish Ministry of the Environment, Statistics Finland.

Various industrial processes, agricultural production and waste management are other significant emission sources, accounting for 16 per cent of all greenhouse gas emissions. Agricultural emissions consist of methane and nitrogen originating from cattle farming and the treatment of manure and agricultural land. Emissions from waste management comprise methane and nitrous oxide, which are released as waste decomposes. Waste management accounts for almost 50 per cent of all methane emissions in Finland, and 3 per cent of all greenhouse gas emissions.

In 1998, greenhouse gas emissions in Finland totalled 76.9 million tonnes (Figure 2.1), or 1.6 million tonnes more than in 1990, which is the reference year for the reduction of emissions in the Kyoto Protocol. If no additional measures are taken, greenhouse gas emissions will probably grow still further. The Finnish Ministry of Trade and Industry predicts that in 2010 annual carbon dioxide emissions from fossil fuels and peat will amount to about 70 million tonnes, compared with 57 million tonnes in 1998. This means that in 2010 total emissions of greenhouse gases in Finland will probably be about 90 million tonnes[5].

There are considerable annual fluctuations in carbon dioxide emissions in Finland as a result of factors such as water levels in Nordic lakes and rivers and related changes in the electricity production structure. In the longer run, the estimated growth in overall greenhouse gas emissions depends greatly on the rise in total energy consumption. Changes in the structure of the energy supply would have a major impact on emissions, as there are considerable variations in emissions per energy unit in the case of various energy types. For example, in a modern natural gas plant, carbon dioxide emissions may only be half those produced by a coal-fired condensing power plant with similar output. On the other hand, in areas such as the transport sector the use of low-emission fuel has not made much progress.

Making our energy production more efficient will have only a limited impact on emissions, because compared with many other countries, the Finnish energy system can claim a high utilization rate. This is partly because a lot of the energy needed is produced in CHP plants.

The progress of climate change will depend on both gross emissions and the earth's ability to absorb greenhouse gases. Carbon sinks are natural sites that absorb more carbon dioxide than they release during a specific period of time, which means that the amount of carbon in them gradually increases. For example, the trees in Finland's forests absorb more carbon dioxide from the atmosphere than is released in timber felling. In 1990, forest growth absorbed 24 million tonnes and in 1998 about 10 million tonnes of carbon dioxide. Forest growth has remained fairly stable, but timber felling has increased. In 1998, the carbon sink of Finnish forests accounted for 12 per cent of all greenhouse gas emissions in Finland.

Mires are also potential carbon sinks. It is estimated that a total of 6,300 million tonnes of carbon is stored in them. They absorb carbon but also release methane as 'bog gas'. As mires are drained for peat production, forestry or agriculture, their impact on the greenhouse effect will change, though not much is known about the effect of drainage on climate change. However, the question is important because three fifths of the original mire-covered area of Finland has been drained, mostly for forestry.

---

[5] Provided that greenhouse gas emissions originating from sources other than the combustion of fossil fuels and peat remain roughly at their present levels.

2.3 Targets for greenhouse gas emissions

An agreement on the reduction of greenhouse gases was reached at the Kyoto Climate Conference in December 1997. The Kyoto Protocol sets out targets for reducing greenhouse gases for each 'Annex B' country (nearly all OECD countries[6] and a number of transition economies, including Russia). Annex B countries should lower their emissions by an average of 5 per cent between 2008 and 2012, compared with 1990 levels[7]. It is estimated that this would result in emissions that are 20-40 per cent lower than would be achieved if no additional measures were taken (OECD, 1999c). Different countries and groups of countries were assigned their own reduction targets. The most stringent targets were set out for the EU (8%), the USA (7%) and Canada, Hungary, Japan and Poland (6% each).

Soon after the Kyoto Conference, EU environment ministers agreed on a burden-sharing arrangement for the individual Member States. Finland made a commitment to reduce its greenhouse gas emissions to 1990 levels by 2008-2012. This is actually less than originally envisaged, but in relation to reduction costs, is still one of the most demanding in the EU.

As stated before, there are considerable annual variations in Finnish emissions, depending on among others potential for hydropower supply and the consequent structure of electricity production. Thus, in 1998, Finnish emissions were only 2.1 per cent above the Kyoto reference year of 1990, but in 1997, the figure was 5.2 per cent. Should the above-mentioned annual emission estimate of 90 million tonnes by 2010 become a reality, Finland would have to cut its emissions by about 15 per cent on 1990 levels. However, the estimates of reduction needs are not based on the most recent material and incorporate several uncertainties.

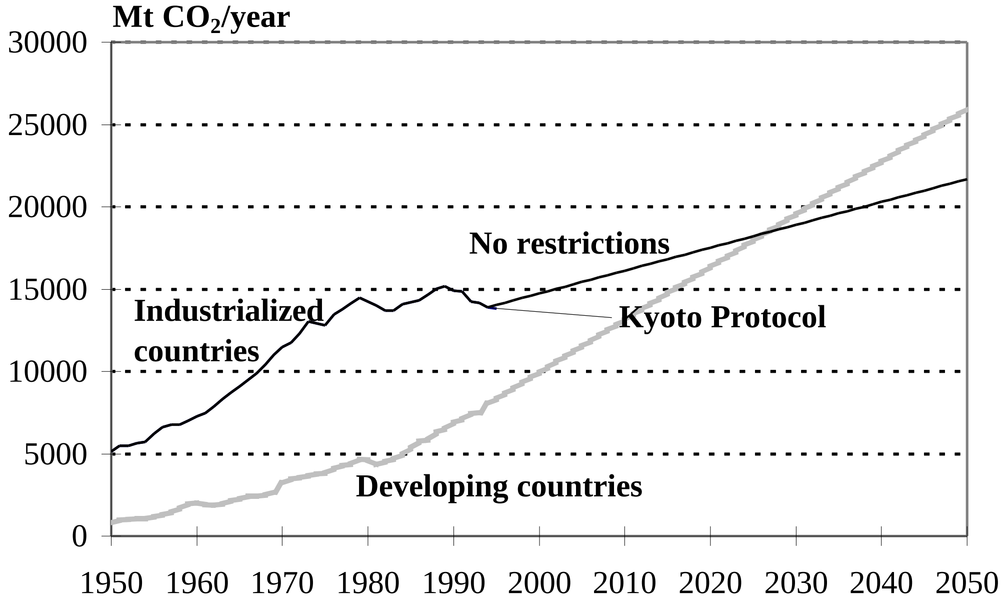
The Kyoto Protocol was the first step towards the reduction of greenhouse gases on a global scale. However, the commitments incorporated in the Protocol are too modest and will not stop the growth of atmospheric greenhouse gases. Thus, emissions will have to be cut further after 2012. The growing emissions of developing countries not included in Annex B are a major problem. As Figure 2.3 shows, emissions by developing countries are expected to surpass the emissions of industrialized nations in the course of the next few decades. Thus, to ensure progress in the future, developing countries also have to commit themselves to reducing their emissions. At the moment, they are merely required to calculate their greenhouse gas emissions, report on them and make general contributions to the fight against climate change.

---

6 Mexico, South Korea and Turkey are the only OECD countries not included in Annex B.

7 To be precise, the target applies to average annual emissions in 2008-2012.

Figure 2.3 Actual and predicted rise in carbon dioxide emissions originating from fossil fuels, in industrialized and developing countries, 1950-2050



Source: Korhonen & Savolainen, 1999.

Implementing the emission restrictions entails substantial economic costs. According to the OECD, it will slow down the annual growth of real income in its member countries by 0.25-1 per cent if transitional costs are not taken into account (OECD, 1999c). The problem is that the country-specific quotas agreed on in Kyoto and those assigned to individual EU Member States do not reflect the actual costs of combating emissions, but are rather an indication of the individual countries' negotiating power (Table 2). As a result, the marginal costs of reducing emissions vary from country to country and cost-effectiveness will not be achieved. The problem can be partly solved by using the mechanisms referred to in the Protocol, such as emissions trading and joint implementation (see section 4.4.1). Decisions concerning the use and content of the mechanisms are to be made in the Hague in autumn 2000. In the EU's view, the mechanisms should not account for more than half of the emission reductions.

Like the mechanisms, the question of sinks remains unresolved and no agreement has been reached on their definition or calculation. The inclusion of sinks in the greenhouse gas emission values of the Climate Convention is to be discussed at the Hague meeting in autumn 2000.

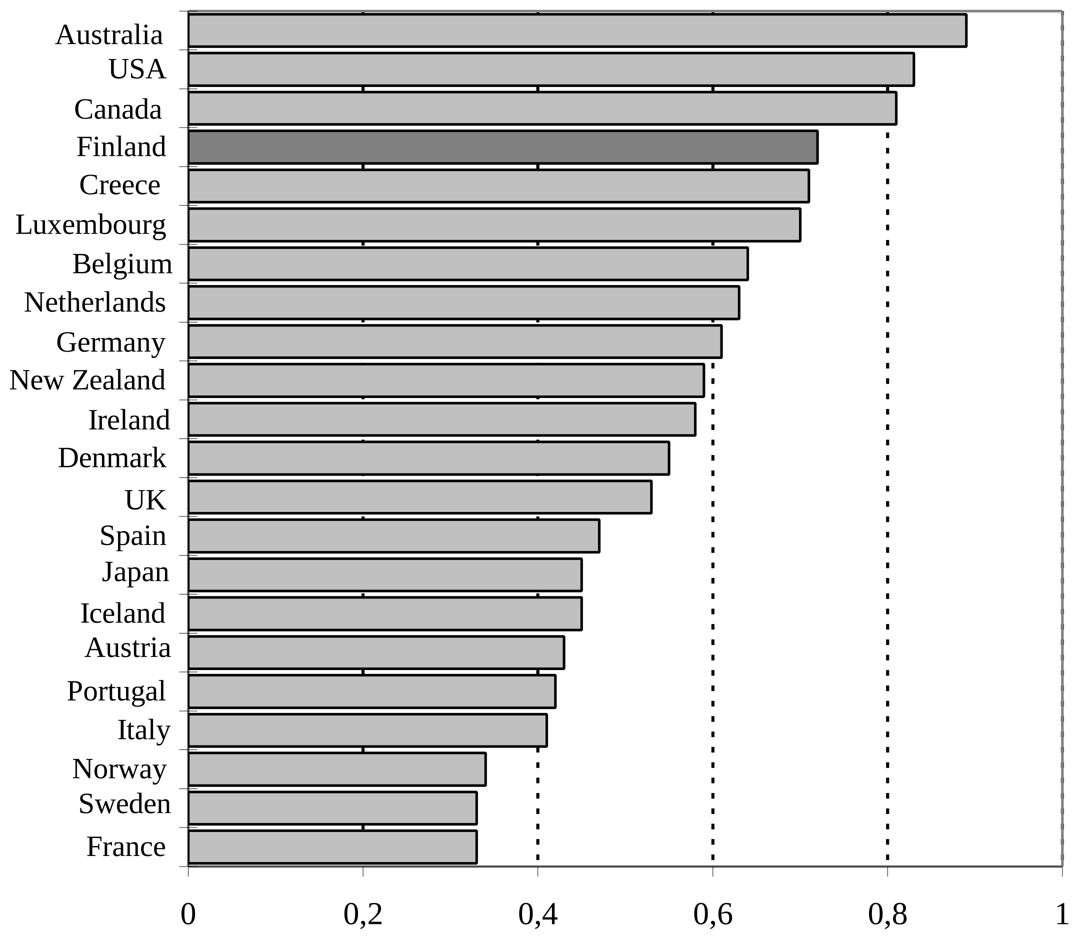
Table 2.1 Greenhouse gas emissions of EU Member States as carbon dioxide equivalents, and the projected burden sharing by 2008-2012

	Emissions in 1990, million tonnes	**Percentage of all EU emissions**	**Burden-sharing target (%)**
Luxembourg	14	0.3	-28.0
Germany	1,201	27.7	-21.0
Denmark	72	1.7	-21.0
Austria	74	1.7	-13.0
Belgium	139	3.2	-7.5
The Netherlands	208	4.8	-6.0
UK	775	17.9	-12.5
Italy	542	12.5	-6.5
France	637	14.7	0.0
Finland	**75**	**1.7**	**0.0**
Sweden	69	1.6	4.0
Ireland	57	1.3	13.0
Spain	301	7.0	15.0
Greece	104	2.4	25.0
Portugal	69	1.6	27.0
Total	**4,334**	**100.0**	**-8.0**

Source: Commission of the European Union.

Achieving the greenhouse gas reduction targets that Finland is committed to will be a major challenge. Unlike the case in some other countries, they cannot be achieved with measures already agreed on but require additional action. Carbon dioxide emissions relative to GDP are very high in Finland (Figure 2.4) and as we use energy quite efficiently, the reduction costs will be fairly high (see e.g. Gielen et al., 1998). Thus, Finland should try to make full use of the Kyoto mechanisms.

Figure 2.4 Carbon dioxide emissions relative to gross domestic product in 1997, kg/USD (PPP)



Source: IEA/OECD.

2.4 Summary

Climate change caused by greenhouse gases will be the most important environmental problem requiring further action during the next few decades. As greenhouse gases can spread freely in the atmosphere, unilateral measures will be useless. Though the UN Convention on Climate Change is an important step in getting the problem under control, the present scope of the Convention will be insufficient in the long run, and it is essential to get developing countries, the source of the fastest rise in emissions, committed to the restrictions.

The international Climate Convention has now reached a stage where the Kyoto Protocol on country-specific controls on greenhouse gas emissions is ready to be ratified. If the Protocol comes into force, Finland, too, must be prepared to take substantial additional measures with a medium-term impact. Achieving the greenhouse gas emission targets the country is committed to will be a major challenge. After all, it is predicted that in 2010 our emissions would be 15 per cent above the targeted level if no additional action were taken. However, these estimates involve many uncertainties, partly because there are major annual fluctuations in emissions.

Carbon dioxide accounts for 83 per cent of greenhouse gas emissions in Finland. Most originates from the energy and transport sectors. Carbon dioxide emissions relative to GDP are among the highest in Europe. Another important greenhouse gas is methane, which originates from sources such as landfills. Though it accounts for only a small percentage of the total, reducing these emissions could provide an easy way of implementing some of the required cuts. The generation of waste can be reduced by applying economic instruments and broadening the liability of the producer. In fact, the waste tax has already proved an effective environmental incentive.

3. ENERGY SUPPLY AND DEMAND IN FINLAND

3.1 Use of energy in Finland - present structure and future prospects

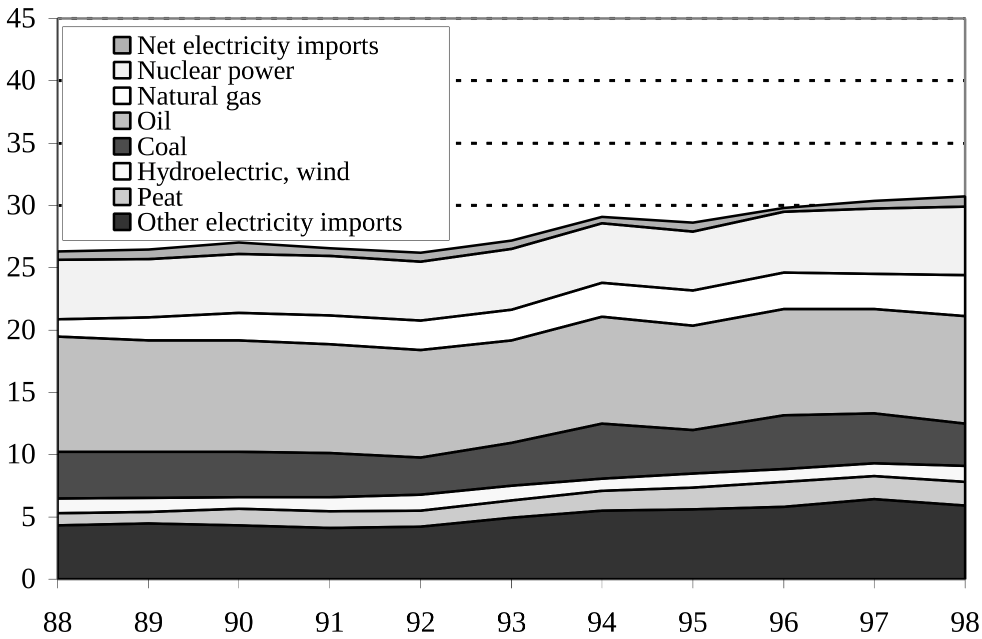
Most of Finland's greenhouse gas emissions are the result of burning fossil fuels and peat in energy production and transportation. Before we assess ways of restricting emissions and their impact on the economy, it is essential to be well acquainted with the structure and functioning of the energy sector. The following reviews the structures of energy production and consumption and the carbon dioxide emissions resulting from the use of energy.

Supply and demand of primary energy

It is easier to get a comprehensive picture of the environmental impact of the production and use of energy if the processes are divided into primary and secondary sectors. Primary energy comprises actual energy sources, such as crude oil, peat and hydroelectric and nuclear power. Most primary energy is processed or converted into other forms before end use. This converted energy (electricity and heat) is called secondary energy.

In 1998, primary energy consumption in Finland totalled about 32 million tonnes of oil equivalent (Figure 3.1). Oil, which is the most important individual source of primary energy, accounts for more than a quarter of total consumption. Fossil fuels and peat account for 60 per cent, and hydroelectric and nuclear power together for almost 20 per cent. Other domestic sources and net electricity imports account for only 2-3 per cent of total supply (Statistics Finland, 1999).

Figure 3.1 Primary energy supply in 1988-1998 by source, in million tonnes of oil equivalent



Source: Finnish Ministry of Trade and Industry.

Finland can rely on a broadly-based energy production structure, and compared with other countries, is not too dependent on any single energy source. Wood is more important than in many other countries, mainly because our forest industry makes wide use of surplus wood in its energy production. Five per cent of Finnish energy is produced with peat, another fuel characteristic of the country. The structure of energy supply has remained unchanged for many years, though the 1990s saw a slight increase in the role played by natural gas, wood and peat. More wood is used than before, largely because forest industry output has gone up, but taxation that provides incentives for the use of wood, natural gas and peat has also played a role.

About half of the primary energy is converted into electricity and district heating before end use. All nuclear power and hydropower is used to generate electricity in power plants. Most of the coal is also used for that purpose or for generating district heating. About half of the natural gas also goes to generating secondary energy, mostly in combined heat and power production. The rest goes directly to industrial end consumption. More than half of recycled and wood fuel is consumed by industry and households.

Crude oil is processed into oil products, most of which go to end consumption. The most important end user is the transport sector, which consumes more than half of all the energy in oil products, mostly as petrol and diesel oil[8]. Most of the remaining oil products are used in the form of light and heavy heating oil in industrial production and for heating households. Raw materials not related to energy production account for good 10 per cent of the total consumption of oil products.

Total demand for primary energy in Finland has been growing at roughly the same rate as the economy, and is expected to increase still further, though at a lower rate than before. The Finnish Ministry of Trade and Industry predicts that demand for primary energy will grow at an annual rate of 1.5 per cent in the early decades of the 21st century. This would mean that in 2010 Finnish energy consumption would be 40 Mtoe, or about 25 per cent, above present levels (MTI, 1997)[9].

Secondary energy and fuels used in the transport sector

Electricity

Electricity accounts for about a quarter of the energy end consumption, and more than half of that amount is used by industry. Electricity consumption is expected to grow at a faster rate than that of other energy sources. The Ministry of Trade and Industry predicts that electricity consumption will reach about 96 TWh in 2010, compared with 76 TWh in 1998 (MTI, 1997). Finnish industry, which already accounts for more than half of total consumption, will specifically need more electricity (Figure 3.2). As

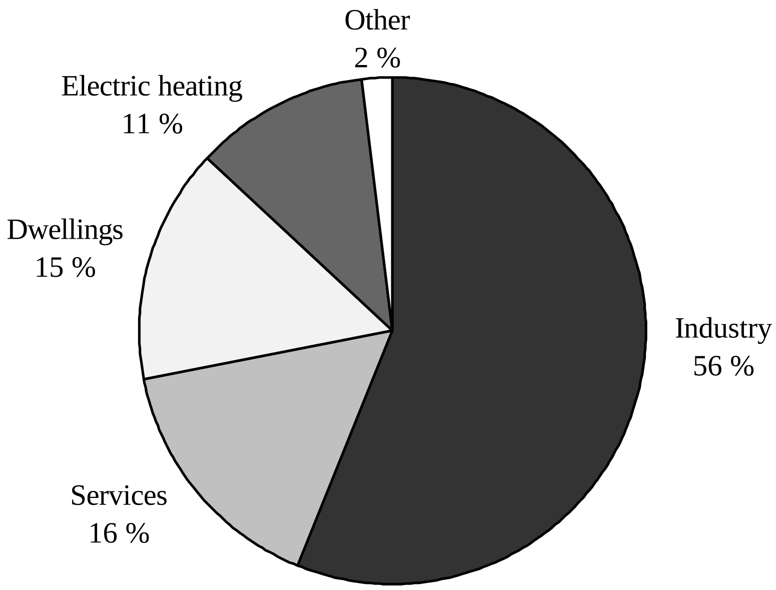
---

8 A remarkable part of the oil products are exported and roughly an equal amount of oil products is imported. Measured by energy content, raw material use account for about 20 per cent of the total oil product consumption.

9 This scenario is based on the assumption that the average annual economic growth is 2.5 per cent and that there are no major changes in either the world market prices for energy or energy policy.

electricity in itself is a clean form of energy, the way this additional demand is met is essential from the environmental point of view.

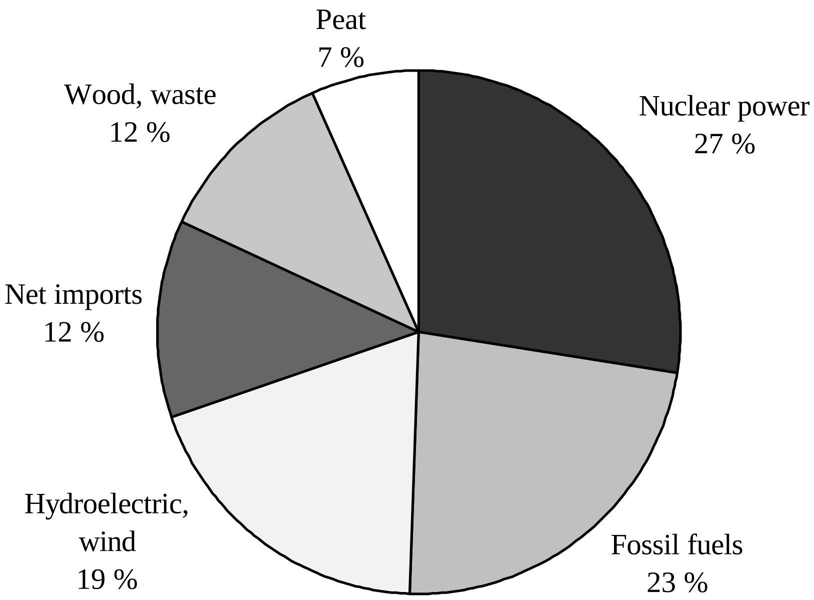
Figure 3.2 Electricity consumption in 1998, by use



Source: Finnish Ministry of Trade and Industry.

Finland can rely on a fairly versatile supply of primary sources of electricity (Figure 3.3). The most important is nuclear power, which accounted for a quarter of all electricity used in 1998. The combined contribution of fossil fuels and peat was almost a quarter, while hydropower accounted for almost a fifth and biofuels (wood and waste) and imported electricity for 12 per cent each.

Figure 3.3 Sources of electricity production in 1998



Source: Finnish Ministry of Trade and Industry.

When we are assessing the environmental impact of growing electricity consumption, it should be kept in mind that deregulation of the electricity market has made electricity a freely-moving commodity between the Nordic countries. In the 1990s, annual Finnish electricity imports exceeded exports by an average of 7 terawatt hours, which equals the annual output of a 1,000 megawatt nuclear power plant. In the next few years, parts of Continental and Russian networks will be more closely integrated with the Nordic network (see Box 1). The connection with the Russian network will be via Finland.

On an open market, fluctuations in domestic demand will not necessarily have any direct impact on domestic production, because the demand can be met with net electricity imports. If the additional demand for electricity can be satisfied with more imports, Finnish emissions will not grow at all. On the other hand, restricting domestic demand using means such as tax incentives will not necessarily lead to any similar reduction in domestic production if electricity can be generated in Finland at prices that are competitive compared with other Nordic countries.

Box 1 : Electricity markets open to Europe

Up to now, only primary energy sources, mostly fossil fuels, have been traded on the international energy market, and the need for electricity and heat has been satisfied with domestic production. In the Nordic area, however, electricity has been traded across national boundaries for many years, and the deregulation introduced at the end of the 1990s simply removed the remaining obstacles to free electricity trade. Finland, Sweden, Norway and Denmark now form a single electricity market, with a total consumption of almost 400 TWh.

The transmission capacity available may limit cross-border electricity trade, though it is increasing. Electricity is transmitted from one country to another over transmission systems which between Finland and Sweden partly take the form of sea-bed cables. At the moment, the transmission capacity between Finland and Sweden amounts to about 2,000 megawatts, and so far this has been sufficient to carry all the electricity traded between Finland and other Nordic countries.

Nordic electricity integration suits the needs of the four countries involved because they have complementary electricity production structures. Norway relies almost totally on hydropower, whereas Denmark is dependent on fossil fuels. Sweden, on the other hand, produces both hydroelectric and nuclear power, while Finland has the most versatile electricity generating structure among the Nordic countries. More than half of all the electricity in the Nordic area is produced by hydroelectric power plants. Denmark and Norway, which rely on a narrowly-based electricity production structure, can benefit particularly from the flexibility provided by the Nordic network.

Opening-up of the market and domestic deregulation have also meant more competition. Fewer long-term electricity supply agreements are concluded, and more and more electricity is sold in electricity exchanges and under short-term contracts. More competition has also led to rethinking in the area of self-sufficiency. For example, Stora Enso, the Nordic forest industry giant, has already outsourced its electricity production.

The Nordic electricity market area is already linked to the Continental distribution network through Denmark and Sweden. The EU's electricity market directive calls for an open market in Member States, and Germany is one of the countries that is in the process of adopting the Nordic model. From the point of view of emission restrictions, the German situation is interesting, as most of the electricity there is generated with fossil fuels. On the other hand, France, which so far has been reluctant to open up its markets, is a leading producer of nuclear electricity. Poland, which is the most important user of electricity among the transition economies seeking EU membership, relies almost solely on fossil fuels.

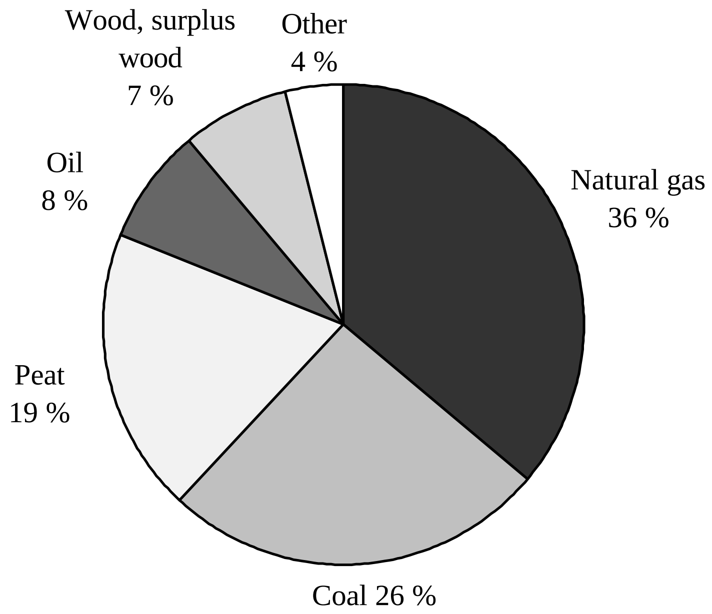
District heating

District heating accounts for about half of the heating energy used in Finland and about 10 per cent of energy end consumption. Most district heating (80 per cent) is produced in CHP backpressure power plants.

As most district heating is produced with fossil fuels, it is highly emission-intensive. Fossil fuels and peat account for about 90 per cent of the district heating produced, natural gas being the most important single type of fuel (36 per cent in 1999). Wood accounts for 7 per cent, but the figure has been on the increase, mainly because of tax incentives (Figures 3 and 4).

District heating is supplied to both households and corporations, and more than half is used to heat dwellings. In 1999, the system provided heat to one million homes with 2.3 million inhabitants. A good third is used to heat other buildings, such as business and public premises, while about 10 per cent goes to industry.

Figure 3.4 Fuels used for district heating and related electricity production in 1999



Source: Finnish District Heating Association.

Fuels used by the transport sector

The transport sector accounts for about 15 per cent of total energy use. Measured by energy content, petrol accounts for about half and diesel oil for 40 per cent of the fuels consumed by the Finnish transport sector. The rest are special fuels used in aviation, shipping and rail traffic.

The 1990s witnessed a slight decline in petrol consumption. In 1999, total consumption was about 7 per cent below the 1990 figures. Consumption of diesel oil, which went down during the recession in the early 1990s, has since recovered and is now about 10 per cent above the level in the early years of that decade. In fact, so far the consumption of diesel oil has closely followed fluctuations in economic activity and consequent changes in transport performance.

This trend is expected to continue. In 1998, the Technical Research Centre of Finland (VTT) estimated that fuel consumption by cars will drop by almost 2 per cent during the next 10 years, even though car traffic will increase up at the same time. The estimate is based on the assumption that old cars will gradually be replaced by new vehicles and that, as a result, average consumption will steadily decrease. In the heavy road transport sector, no such technological developments are foreseen, but consumption is expected to increase by almost a quarter during the next 10 years, roughly at the same rate as traffic performance.

Energy use and emissions

The energy sector is a major source of greenhouse gas emissions. In Finland, most result from the use of fossil fuels and peat in energy production and transportation[10]. These activities account for about 90 per cent of all carbon dioxide emissions in Finland. The combined share of industrial energy and heat production is about 40 per cent, and that of electricity production and transportation about 20 per cent each (Finergy, 1997).

The Finnish Ministry of Trade and Industry predicts that in 2010 our energy consumption will be about 25 per cent higher than at the moment. Provided that there are no changes in the structure of energy supply, carbon dioxide emissions will grow at a similar rate. This would be in clear conflict with the Kyoto targets Finland is committed to. Adjustment to longer-term emission targets will inevitably require reductions in emissions resulting from the use of energy.

Finnish emissions of greenhouse gases in relation to total demand for energy are low by international standards. Our emissions of carbon dioxide per primary energy unit amount to 1.9 CO_2/toe. Among the Nordic countries, Norway and Sweden have slightly lower emissions, while the figure for Denmark, 3.0 CO^2/toe, is higher. The low emission intensity of Finland, Norway and Sweden is explained by the relatively small

[10] Even though wood and recycled fuels also cause major emissions, there are no plans to incorporate them into the international Climate Convention.

contribution made by fossil fuels to total energy supply in these countries, while Denmark relies heavily on fossil fuels and therefore has higher emissions.

Table 3.1 Average emissions relative to total energy supply in the Nordic countries and EU in 1995, as CO_2 tonnes/toe

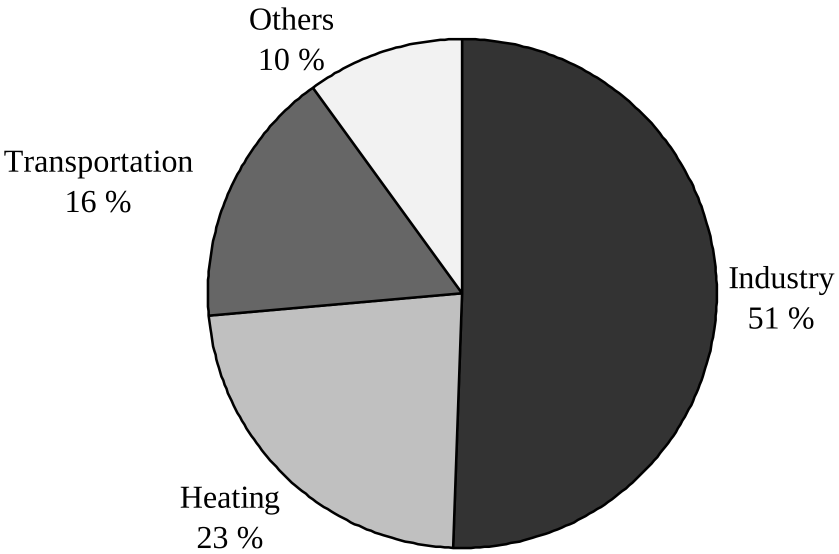
Denmark	3.0
Finland	1.9
Sweden	1.1
Norway	1.5
EU	2.3

Source: IAEA, 1999.

Because of its high-tech energy sector, Finland should focus on promoting low-emission energy production when efforts are made to stabilize emissions in the medium range. This could be achieved by increasing the proportion of wood use and replacing oil and coal with natural gas. As electric energy accounts for most of the growth in energy consumption, additional nuclear power and more electricity imports should also be seriously considered.

Industry accounts for more than half of all energy consumption in Finland (Figure 3.5). If emissions are to be kept under control, the question of how much energy is consumed by different sectors of the economy is important, because the effectiveness of the instruments can vary, depending on the target. If, for example, industry is in a better position to replace its existing energy sources with low-emission fuels than the transport sector is, the environmental impact will be greater if the instruments are targeted at industry. Oil refining, the forest industry, the basic metal industry and transportation are the biggest sources of carbon dioxide emissions. They also have the highest emission intensity, which means that their emissions are high relative to added value (Mäenpää, 1998).

Figure 3.5 Energy end use by sector, 1998



Source: Finnish Ministry of Trade and Industry.

Emissions cannot be kept in check by controlling the prices of secondary energy (electricity and heat consumption), because price controls do not provide any incentives for changing the energy production structure or for reducing emissions per energy unit produced. For example, electricity tax can only limit emissions by reducing the pollution resulting from a drop in the total demand for electricity. Besides, should the tax result in electricity being replaced by more use of fossil fuels in heating, for example, there would be even less impact on emissions. Tax exemptions for fuels used for electricity production are problematic if emissions are to be kept under control. For maximum effectiveness, taxes or other similar instruments should be focused on primary sources of energy and staggered in accordance with their emission content. Because of the situation on the electricity market discussed in Box 1, it is very difficult for Finland to change its taxation structure unilaterally.

The transport sector relies almost solely on fossil fuels and its contribution to carbon dioxide emissions is well above its share of total energy consumption. Vehicles using alternative fuels are being tested, but few commercial applications are on the market. So far, the transport sector has only been able to cut its emissions by focusing on higher energy efficiency, which is gradually becoming a reality as older cars are replaced with new vehicles. Other emissions by road traffic have been cut by developing lower-emission fuels and technology for engines and catalytic converters.

In 1998 VTT predicted that in 2010 carbon dioxide emissions from car traffic would be 8 per cent below the 1990 level. Emissions by heavy transport, on the other hand, were expected be 40 per cent higher. If this scenario becomes a reality, total emissions from road traffic in 2010 thus would be almost 8 per cent above the 1990 level.

3.2 Summary

As things stand, total demand for energy in Finland will continue to grow at a fairly rapid rate, with the rising demand for electricity in Finnish industry accounting for most of the increase. The predicted rise in energy demand means that, with the existing production structure and technology, Finland will exceed its emission targets by a wide margin.

Energy production in Finland is not particularly emission-intensive because we can draw on a multiple of primary energy sources and because the energy used by industry and households is produced efficiently**.** If Finland is to cut its emissions, the structure of primary sources has to be changed so as to achieve an even smaller share of fossil fuels in total demand. In recent years there have been encouraging signs of such a trend, such as an increase in the role played by wood. However, as the scope for increasing the use of wood as a primary source of energy is limited, additional nuclear power and more electricity imports should also be seriously considered. Replacing coal and oil with cleaner fossil fuels such as natural gas would also lead to a reduction in emissions.

Imposing an electricity tax on energy consumption will not provide any incentives for introducing lower-emission electricity production structures. However, because of the present situation on the electricity market, it is very difficult for Finland to change its tax system unilaterally. The electricity market is in a transitional stage, and expanding from the Nordic area into Europe. Thus, the emergence of a European-wide electricity market may in the future prompt some reassessment of electricity taxes.

Fuel consumption and, consequently, carbon dioxide emissions from cars are on the decrease, and tax incentives directed at fuels have probably contributed to this positive development. Whether the trend will continue depends on how quickly old cars are replaced by new vehicles with lower average consumption. In heavy road transport, however, fuel consumption and emissions are expected to grow at roughly the same rate as the economy, which means that total emissions from traffic will probably rise still further.

4. ECONOMIC INSTRUMENTS FOR ENVIRONMENTAL CONTROL

4.1 Economic instruments in the OECD countries

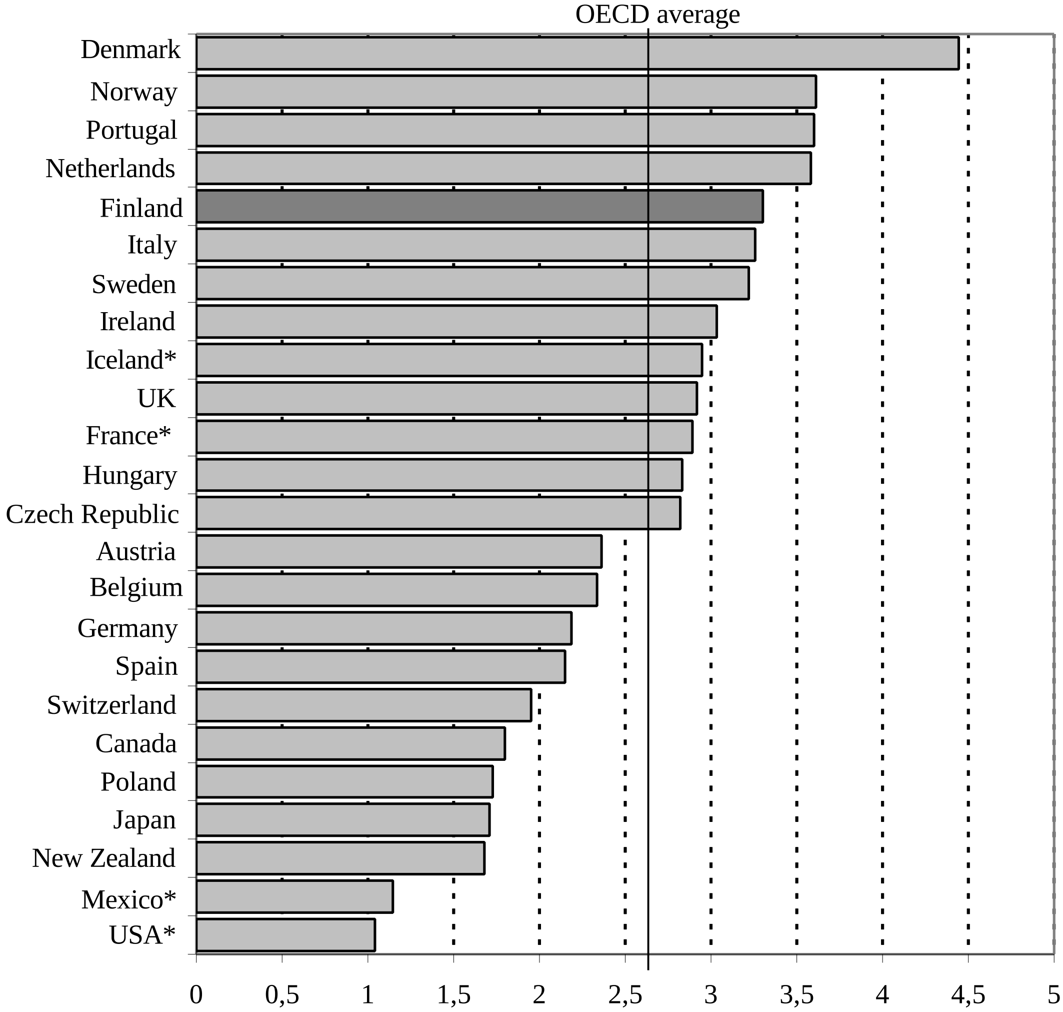
The action taken to deal with environmental problems can be divided into administrative measures and economic instruments. The first methods adopted were administrative (e.g. regulations on wastewater treatment), but from the '70s onwards various economic instruments such as taxes and subsidies gradually became more common. The OECD, for instance, has vigorously recommended the more widespread use of economic instruments in member countries. The following surveys trends in economic controls and looks at the present situation in the main OECD countries.

According to the information gathered by the OECD, member countries use a wide range of economic instruments. Nearly all employ at least some kind of emission charge. Returnable deposit systems and various subsidies are fairly common, and some countries also charge penalties for failure to meet commitments, as well as contributions to environmental insurance funds. On the other hand, emission quota trading is still fairly rare. Guarantee payments to encourage compliance with regulations are also used rather infrequently.

Economic instruments are also used in quite a wide range of sectors. Methods related to natural resources are nearly as common as those designed to regulate emissions and discharges. Various charges for use of water resources are quite common. Charges and subsidy systems often form part of policy concerning cultivated resources, fishing and forest resources. However, few countries have so far assessed the effectiveness of their actions. The OECD nonetheless judges that the information available indicates positive results on the whole.

By far the most common economic instrument used in the OECD countries is environmental tax. In 1997 such taxes accounted for an average of nearly seven per cent of total tax revenues. Figure 4.1 shows income from environmental taxes as a percentage of GDP in OECD countries in 1997. The significance of environmental taxes varies considerably from country to country. The Nordic countries all come well above average in use of these taxes. Other countries that employ environmental taxes on quite a large scale include Portugal, the Netherlands and Italy. Outside Europe, the proportion is much lower. In Finland, environmental taxes accounted for 3.4 per cent of total revenues in 1999.

Figure 4.1 Environmental taxes as a percentage of GDP in OECD countries, 1997



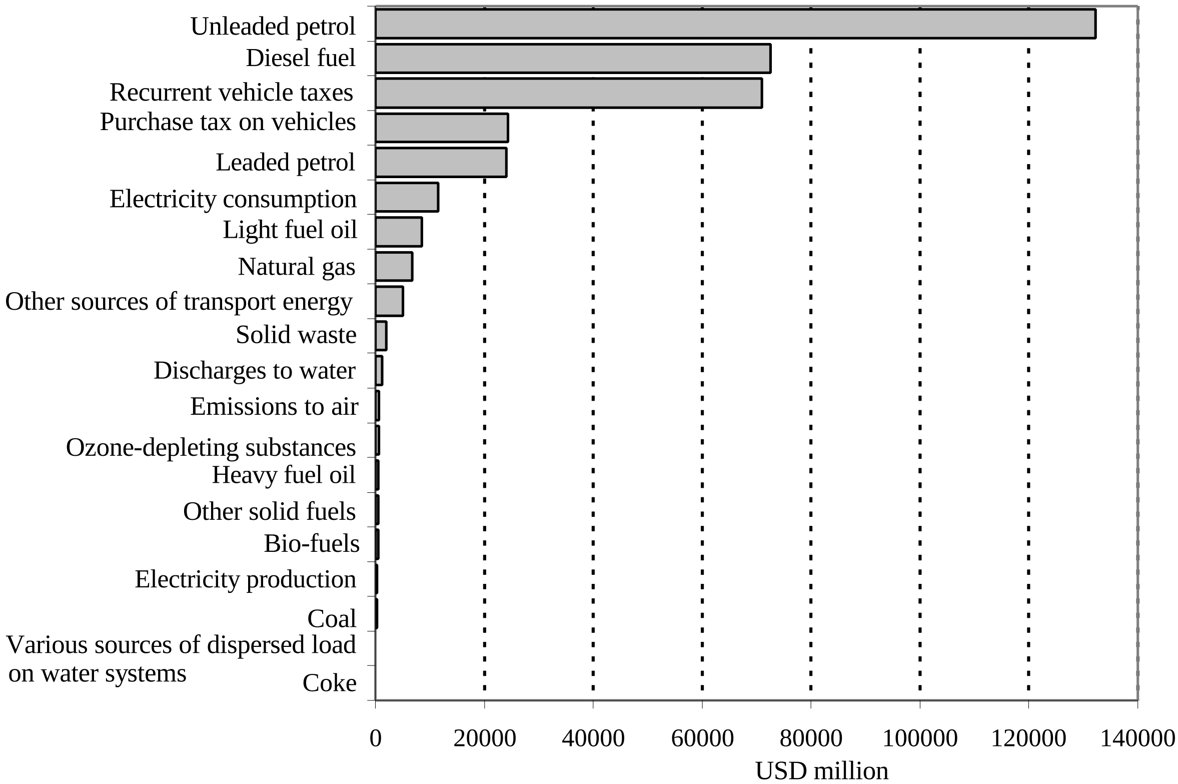
* 1995 figures
Source: OECD; OECD/EU Database on Environmentally Related Taxes.

Figure 4.2 shows total tax revenues from various environmental taxes in twenty OECD countries, by tax type. By far the largest proportion of environmental taxes relate to the transport sector. The biggest revenue item is from unleaded petrol. Leaded petrol is probably insignificant in this respect because many countries have already ceased to use it. Other important sources of revenue are diesel oil, and the initial purchase tax and annual tax on vehicles. Taxes related to transport account for over 90 per cent of total revenues from environmental taxes.

Transport taxes and charges are being used increasingly in EU countries as an instrument of transport and environment policy. The White Paper on transport pricing and the follow-up to it aim at pricing policy that is fair and economically efficient. The 'polluter pays' principle is followed, i.e. pricing based on marginal costs. Social marginal costs include what are called 'external costs' that also cover detrimental effects on the environment (emissions and discharges, noise).

The other tax bases in Figure 4.2 generating quite considerable revenues are electricity consumption, light fuel oil and natural gas. By contrast, coal and coke, and heavy fuel oil, all of which cause problems for the environment, are hardly taxed at all. Some countries even pay a subsidy on coal.

Figure 4.2 Total tax revenues from environmentally related taxes in 21 OECD countries in 1995, USD million



Source: OECD; OECD/EU Database on Environmentally Related Taxes.

As yet, no general estimates have been released on how far the environmentally related taxes introduced up to now have helped to achieve environmental goals. Differential taxation on traffic fuels has greatly contributed to eliminating leaded and other ordinary grades off the market. The new specification of Austrian car registration tax on the basis of fuel consumption has done a great deal to focus the purchase of new cars on diesel models with low consumption. In Sweden, the sulphur tax and earmarked charge on nitrogen oxides is estimated to have substantially reduced acidifying emissions.

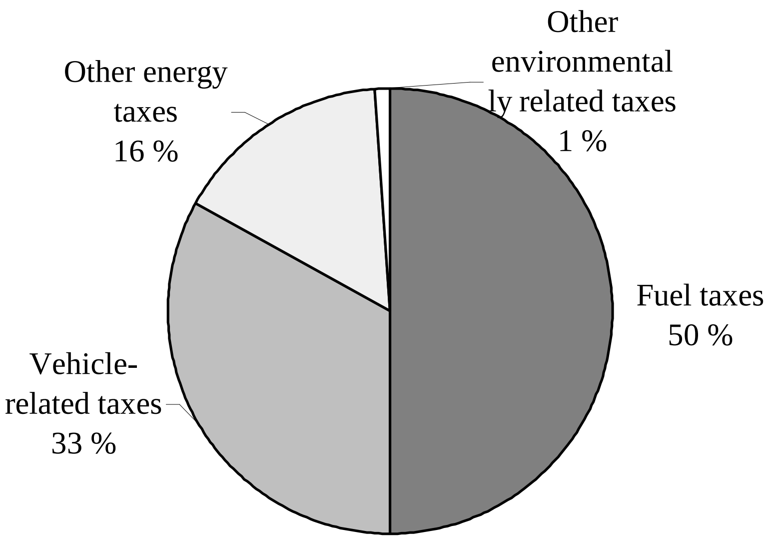
4.2 Economic instruments in Finland

General

Increasing economic control in environmental protection was an aim of all Finnish Government Programmes in the '90s. In fact, Finland employs quite a wide range of economic instruments, environmentally related taxes having by far the widest impact. In terms of number, however, other economic instruments outstrip taxes.

The structure of environmentally related taxation in Finland reveals some similarities with other OECD countries, but also some distinct differences. One similarity is that taxes on transport play a central role in terms of revenues. One difference is that energy taxation also targets other forms of energy in Finland, and not just traffic fuels. As a result, revenues from taxes on the transport sector are some ten percentage points lower in Finland than the OECD average (Figure 4.3). There are only three types of tax on or related to areas other than energy and transport: the waste tax and the supplementary taxes on alcoholic beverages and soft drinks.

Figure 4.3 Revenues from environmentally related taxes in Finland in 1998, %



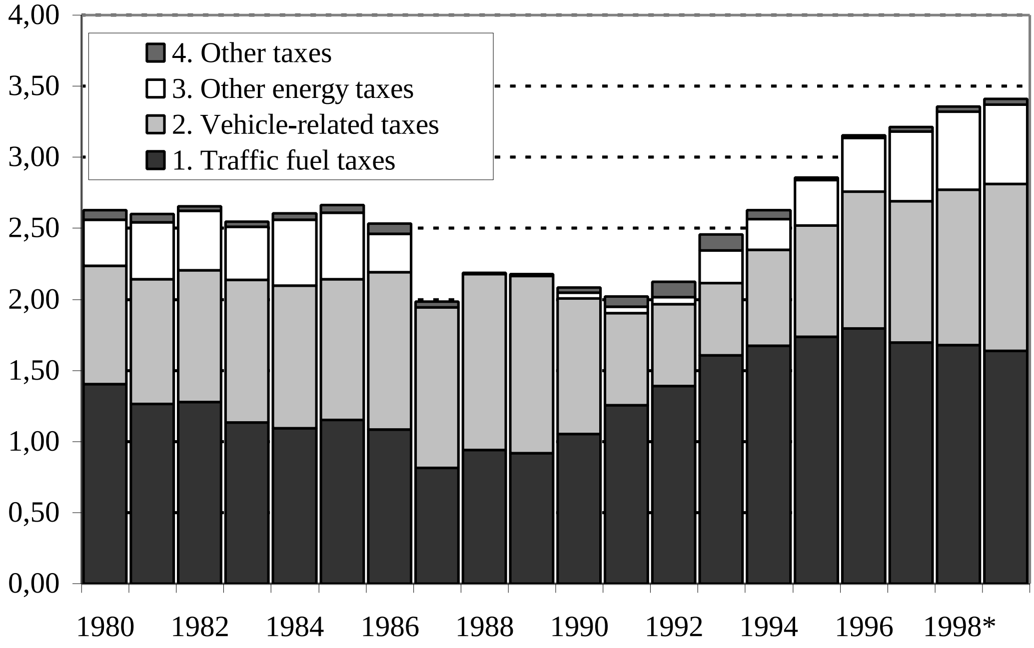
Source: Statistics Finland.

In the '80s[11] the percentage of GDP accounted for by environmentally related taxes was quite stable (Figure 4.4), but from the early '90s onwards the figure has been rising. The recession sharply reduced revenues from the initial purchase tax on vehicles, but from 1993 onwards nominal revenues in all three groups rose. The percentage of GDP represented by environmentally related taxes rose by one and a half percentage points during the '90s.

---

[11] In 1986 energy products were made subject to turnover tax, and at the same time the fuel taxes on them (incl. electricity tax) were abolished or reduced, resulting in the shift in level shown in the figure.

Figure 4.4 Environmentally related taxes as a percentage of GDP, 1980-1999



Source: Statistics Finland.

During Prime Minister Paavo Lipponen's first Government, taxes on earned income were reduced by a good FIM 13 billion altogether. At the same time (in 1996-1999), however, energy taxation was increased by a total of FIM 3.5 billion. Energy taxation, brought in over FIM 11.5 billion in 1995. The estimate in the 2000 budget is a good FIM 17 billion.

The present energy tax system came into force in 1997. Compared with the earlier system, its main features are that the environmental aspect was eliminated in electricity production but increased somewhat in heat production as far as carbon dioxide emissions are concerned. Admittedly, right from the start a subsidy procedure was incorporated into the system for small-scale electricity production based on renewable energy sources and for combined heat and power production. The scope of the subsidies has since been expanded substantially and they currently amount to over FIM 200 million a year.

A differential electricity tax is used in the revised energy taxation system as a way of reducing detrimental effects on competitiveness. For the wood-processing industry, the subsidy granted in electricity taxation from 1998 to renewable sources of energy is also important, and has brought the industry's tax burden down to a level closer to that in other countries. From the beginning of 1999, energy-intensive companies were granted the right to a rebate after exceeding a given tax ceiling percentage. Another procedure that promotes competitiveness and is in line with tax practices in other countries is that metal and engineering companies are granted tax exemption on electricity generation using waste gases from their processes.

In 1996 a waste tax on public land-fills was introduced. Its effect on the environment is not absolutely clear, because it could encourage people to dump waste in places other than priced land-fills and thus to act quite contrary to the aims. Other taxes related to waste policy in Finland are the excise taxes collected on disposable beer and soft drink packaging. If the packaging is recycled for raw material, the tax basis is lower than normal. The following studies mainly taxes on energy and motor vehicles, environmentally related charges and other economic instruments in Finland.

Energy taxation in Finland

The energy taxation practice currently followed in Finland derives from the '70s and the first oil crisis. The taxation on forms of energy has also taken shape over the years amid the crosscurrents of various fiscal, market-based and environmental considerations.

After the first oil crisis, in 1974, when the price of oil and other fuels rose sharply, fuels were exempted from turnover tax and made subject to an excise tax. A tax on electricity was first levied in 1976. In 1986, the fuel tax on electricity and all other fuels, except traffic fuels was abolished, and all energy was again made subject to turnover tax.

In 1990 a general environmental tax on fossil fuels was introduced (called the carbon dioxide tax) in the form of a supplement to the fuel tax. The grounds for this tax on other than liquid traffic fuels was FIM 24.5 per tonne of carbon (FIM 6.7/tCO_2). In the case of petrol, the additional tax was staggered: no tax at all was paid on unleaded, and the full amount was paid on leaded petrol. Imposition of the tax was justified by arguing that it would restrain rising energy consumption and reduce detrimental effects on the environment.

In 1993, the supplementary tax on liquid traffic fuels was staggered on environmental grounds, in that the tax on reformulated gasoline and desulphurized diesel oil was lower than on standard grades. At the same time, a separate electricity tax was also introduced, justified on purely fiscal grounds. Energy-intensive industry was entitled to an equivalent rebate.

From the beginning of 1994 a tax fixed according to energy content was levied on all primary energy sources. However, this was not levied on wood, wind power and waste fuel. In addition, a tax was levied on fossil fuels, dependent on their carbon content. This was collected as a supplement to the fuel tax; 60 per cent of revenues came from the carbon dioxide component and 40 per cent from the energy component. A basic tax was also collected on nuclear and hydropower and on imported electricity.

In 1995, after Finland joined the EU, the fuel taxes were converted into excise taxes, and taxation of oil products was brought into line with EU directives on mineral oils. At the same time, the primary-production deduction on peat and the import price deduction on natural gas were both abolished, being replaced by a temporary exemption from carbon dioxide tax for peat and a 50 per cent tax relief for natural gas.

With the opening-up of Nordic electricity markets and the development of electricity exchange, it became clear that Finland's exceptional electricity taxation system was a serious threat to the competitiveness of production. It was therefore decided in 1997 to adopt the present tax system, the main change being that electricity is taxed at the consumer end rather than as a primary form of energy. The tax remained on fuels used for heat production, but the amount depends solely on the carbon dioxide content, i.e. the energy component in the supplementary tax was abolished. This compensates for the weakening in environmental control resulting from exempting electricity production fuels from tax.

With the introduction of tax on electricity consumption, production based on renewable energy sources, especially, got into difficulties because it forfeited the advantage it had enjoyed from being tax-exempt. Tax subsidies have therefore been gradually introduced in order to improve the standing of renewable energy sources. These include a subsidy to small power plants (peat, wind power, small-scale hydropower), for electricity generated using wood and for electricity generated with waste gases from the metallurgical industry. To safeguard industrial competitiveness, the electricity tax on industry is lower than on other consumers, and energy-intensive industry can claim a rebate on the electricity tax it pays, on certain conditions.

The present system has proved rather complicated administratively and somewhat difficult for taxpayers to understand, as a result of the various subsidies and procedures related to combined heat and power production. Tax subsidies are also a difficult issue in terms of long-term tax policy, because they require approval from the European Commission. Even if the Commission approves the subsidies, the approval is only for a fixed period, usually a maximum of three years.

Table 4.1 shows the tax tables that came into force in Finland on September 1, 1998. The basis for levying the supplementary tax on fuels is their carbon content, the tax being FIM 102 per tonne of carbon dioxide. The exception here is natural gas, which enjoys 50 per cent tax relief, and peat, where the tax is specified separately. The supplementary tax on electricity is not linked to the carbon dioxide tax, either.

An electricity producer that generates electricity using wood or peat in a heating plant under 40 MVA, in a small-scale hydropower plant (under 1 MVA) or using waste gas from metallurgical processes, is entitled to tax subsidy equivalent to electricity tax class II. Producers using wind power are paid subsidy according to tax class I.

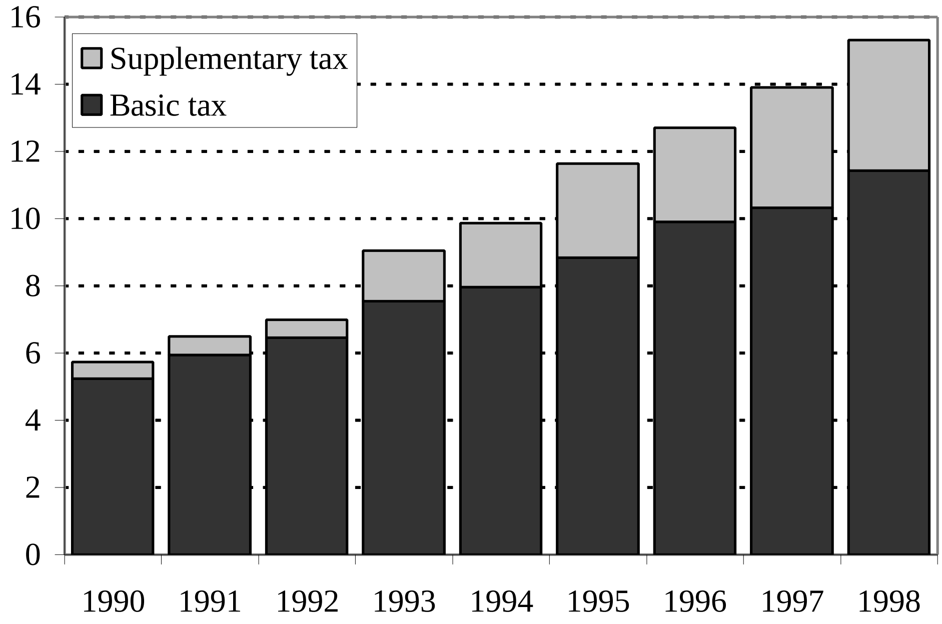
Table 4.1 Energy taxes in Finland as of September 1, 1998

	Basic tax	Supp. Tax	Total	FIM/MWh
Unleaded petrol p/l				
- basic grade	309.4	23.9	333.3	
- reformulated	304.4	23.9	328.3	
Leaded petrol p/l				
- basic grade	354.4	23.9	378.3	
- reformulated	349.4	23.9	373.3	
Blended petrol p/l				
- basic grade	331.9	23.9	355.8	
- reformulated	326.9	23.9	350.8	
Diesel oil p/l				
- basic grade	166.6	26.9	193.5	
- desulphurized	151.6	26.9	178.5	
Light fuel oil p/l	10.9	27.0	37.9	37.9
Heavy fuel oil p/kg		32.1	32.1	28.4
Coal FIM/t		246.0	246.0	35.2
Natural gas p/nm3		10.3	10.3	10.3
Peat FIM/MWh		9.0	9.0	9.0
Pine oil p/kg	32.1		32.1	
Electricity p/kWh				
- tax class I		4.1	4.1	41.0
- tax class II (industry)		2.5	2.5	41.0

The increase in total energy tax revenues in the '90s derived both from the rise in tax levels and from the increase in energy consumption (Figure 4.5). Estimated revenues in 1999 were around FIM 16 billion, with the basic tax accounting for around FIM 11 billion and the supplementary tax for around FIM 5 billion. About FIM 3 billion of the supplementary tax total is from fuels and around FIM 2 billion from electricity tax.

Examined by sectors of consumption, the tax revenue breakdown is as follows: transport FIM 11.8 billion, industry FIM 1.5 billion, household heating and electricity FIM 1.7 billion, and heating and electricity for services around FIM 1 billion.

Figure 4.5 Energy tax revenues in 1990-1998 at nominal prices, in FIM billion



Taxation on motor vehicles

There are three taxes on motor vehicles in Finland: a tax on initial purchase, an annual vehicle tax collected from the owner or user, and an annual motor vehicle tax levied on vehicles powered by other than petrol. In fiscal terms, the most important of these is the tax on initial purchase. The revenues are given in Table 4.2.

Table 4.2 Tax revenues from motor vehicles in Finland in 1990 and 1995-1999, in FIM million

	1990	1995	1996	1997	1998*	1999E
Purchase tax	4 143	2 685	3 611	4 210	5 259	6 082
Vehicle tax		1 046	1 110	1 129	1 198	1 240
Motor vehicle tax	883	668	929	979	1 042	1 100
TOTAL	4 976	4 399	5 650	6 318	7 499	8 422

The tax on initial purchase is levied on passenger cars, vans, other motor vehicles under 1,875 kg in weight, and motorcycles. The tax has to be paid before the vehicle is registered or taken onto the road in Finland. The tax on a passenger car is its taxable value less FIM 4,600, and that on a van 35 per cent of the taxable value. There is an additional reduction of FIM 4,500 on vehicles with a low-emission engine and this is currently granted to all cars with petrol engines. The tax on motor cycles is based on their engine displacement. A fixed scale of reductions is used in fixing the tax on used cars imported into Finland. The initial purchase tax took on its present form in 1993, when the rate was reduced from 122 per cent to the present 100 per cent.

Vehicle tax is levied annually on all cars and vans, and on special vehicles with an aggregate weight of up to 3,500 kg. The tax was introduced in 1994 to compensate for the above-mentioned reduction in the initial purchase tax. The tax was initially FIM 500 on new vehicles registered in 1994 and FIM 300 on older vehicles. In 1995 the tax was raised to FIM 700 and 500 respectively.

Motor vehicle tax is levied annually on all motor vehicles without a petrol engine. The aim of the tax is to compensate primarily for the lower excise tax on diesel oil. The tax on passenger cars and vans is decided by weight. On a car it is FIM 1,500 per tonne and on vans FIM 270 per tonne. In the case of lorries and other heavy vehicles, the tax is also determined by the number of axles and the bogie structure, ranging between FIM 270 and 630 per tonne.

As it stands, the current taxation on motor vehicles does not incorporate any environmentally-related features. In order to limit emissions, the taxes would have to be formulated so as to encourage the adoption of more environmentally friendly technology.

Environmentally-related charges in Finland

In addition to taxes Finland uses a number of charges related to the environment. The feature common to them all is that the income is used for a purpose specified when the system was set up. The total sum of environmentally-related charges, FIM 5.3 billion, was 0.8 per cent of GDP in 1998. Total revenues are shown in Table 4.3.

The main group of charges comprise water and wastewater charges, and waste management charges on waste collection. These are local user charges which are fixed by the municipalities concerned on the full-cost principle, taking account not only of running costs but also of capital costs involved in water and sewage systems. Waste collection is sometimes outsourced to the private sector.

The charge on agricultural pesticides is merely administrative and brings in little income. It was designed only to cover the cost of registering new pesticides. Sweden and Denmark both have a charge that also acts as an economic instrument. If Finland needs to further restrict the use of pesticides, a study should be made of whether the best way would be controls possibly incorporated into the environmental programme for agriculture, or some kind of tax or charge. In any case, it is difficult to fix the basis for a tax or charge, because the active ingredients in pesticides and their detrimental impact vary greatly, even within one and the same product group.

Charges are levied on electricity generated using nuclear power for the State Nuclear Waste Management Fund. The money will finance the decommissioning of nuclear power plants at the end of their useful life and the final placement of the nuclear waste, which is to be buried 500-700 metres deep in the bedrock. This process is to start around 2020. Most of the estimated cost can already be covered from the fund, and decommissioning and final placement will not call for any other funding.

Table 4.3 Revenues from environmentally-related charges in Finland in 1990 and 1995-1999, in FIM million

	1990	1995	1996	1997	1998	1999*
Increase in funding contribution to the State Nuclear Waste Management Fund	388	443	408	466	800	444
Security of supply levies on energy products	257	235	251	296	288	290
Pesticide charges	7	6	6	6	9	9
Waste oil charges	26	21	20	20	20	19
Oil protection charges	40	34	29	33	33	35
Water protection charges	1	3	3	3	3	3
Water charges	1 331	1 491	1 669	1 629	1 564	1 583
Wastewater charges	1 428	1 847	2 058	2 008	2 065	2 091
Municipal waste management charges	312	393	488	478	533	540
TOTAL	3 790	4 473	4 932	4 939	5 315	5 014

Source: Statistics Finland.

Security of supply levies are collected in a special fund on a number of commodities that would be strategically important in a crisis. A similar charge is also collected on all energy products, including electricity. These have the same impact on prices as energy taxes proper. Oil protection and water protection charges are collected mainly to cover the costs of any future accident or environmental catastrophe. The waste oil charge is used to finance the collection, handling and storage of used lubricants.

Other economic instruments in Finland

Other economic instruments used in Finland comprise returnable deposit schemes, voluntary agreements and various kinds of direct subsidy. The bottle return scheme has been comprehensive for a long time now. A similar system for drink cans has been in effect since 1995. For both schemes, the return rate is high. The Ministry of the Environment has also signed two voluntary agreements designed to increase recycling and re-use, one with the packaging industry, in 1995, and the other with the vehicle tyre industry[12], in 1996.

The Ministry of Trade and Industry has made a number of voluntary energy conservation agreements with various sectors on arrangements valid mainly up to 2005. So far no evaluations have been made of the effects of these agreements, but their coverage is extremely broad by international standards. The system includes government subsidy for energy surveys and analyses and for certain energy-saving investments. In 1998, the value of the subsidy was a good FIM 11 million. The OECD criticized the subsidy aspect of the system in its Economic Survey on Finland for 1999. The European Commission has also expressed some doubts about voluntary

[12] This scheme includes a charge levied on the consumer which is used by Suomen Rengaskierrätys Oy, a recycling company made up of constituent groups in the industry, to cover the costs of recycling, collection and handling.

agreements, e.g. in its most recent Communication on the Kyoto issues. The Finnish agreements do, however, provide some interesting practical experiences of the functioning of the method, which enjoys broad support in the private sector.

In the last few years, the government has spent roughly FIM 4-4.5 billion a year on the environment. At least half of this comprises support for the running and capital costs of various environmental projects. The biggest single area is subsidies for agriculture (FIM 1.5 billion), where the EU provides half. Other important areas are support for transport and energy projects.

In future, the main economic instruments will probably be the 'Kyoto mechanisms', which are dealt with in more detail in section 4.4. Finland already has experience of the funding and implementation of projects with environmental benefits through its cooperation programme with neighbouring areas in Russia and eastern Europe.

Effect of energy taxation on carbon dioxide emissions in the '90s

Some major changes were made in energy taxation in Finland in the '90s and these have certainly had an impact on use of energy and related emissions. The following assesses the significance and scale of these effects using a simple calculation.

We will limit ourselves to examining the impact of the different level of energy taxation in 1990 and 1998 on total consumption, on the relative consumption of different fuels and energy sources, and on carbon dioxide emissions. Energy taxes are considered to comprise the basic and supplementary taxes on fuel used in 1990, and the corresponding basic and supplementary excise tax in effect in 1998. The effect of VAT is taken into account where applicable.

As far as demand for energy is concerned, the calculation estimates how much the rise in tax level between 1990 and 1998 reduced demand, in other words, how much higher consumption would have been in 1998 if the taxes had remained at the 1990 level. The impact on energy demand is calculated based on the price elasticity of demand, using figures produced in the Ministry of Trade and Industry's earlier demand analyses.

Next, changes in the role played by different fuels and energy sources in building heating and in industry are examined. An estimate is made of how much emissions would have changed if the energy consumption of the sectors concerned in 1998 had followed the fuel and energy source breakdown in 1990.

Thirdly, changes in the fuels used for energy production, and the resulting impact on emissions, are considered. Although only the fuels used to produce heat are taxed in CHP, the calculations assume that taxation affects the fuel choice of CHP overall. The result is the hypothetical change in emissions if the district heat and electricity produced in 1998 had been generated using the 1990 fuel breakdown.

Overall, study of the above-mentioned three factors reveals a roughly 4 million tonne reduction in carbon dioxide emissions in 1998. In other words, without the impact of energy taxation, emissions would have been 4 million tonnes, i.e. a good 7 per cent, higher than the 57 million tonnes actually recorded. The decrease breaks down roughly equally between end use and production. In end use, one of the most important factors is certainly the decrease in petrol consumption and the structural and consumption change in industry. Both reduced emissions by around a million tonnes.

About two thirds of the industrial decrease in emissions results from the change in proportions of fuels used, especially the replacement of coal and heavy fuel oil by natural gas and some wood. Although the price elasticity in industrial energy demand is estimated to be small, the decrease in demand in industry is also considerable, because the tax on fossil fuels rose 7-11 fold during the period studied, depending on the fuel. In the case of petrol, the large decline in consumption and emissions is explained both by the price elasticity, which is estimated to be substantial, and the fact that the tax on petrol, which was already high in 1990, more than doubled.

There are some uncertainties attached to the findings. Estimates concerning changes in consumption naturally depend greatly on the flexibility assumptions made. In particular, demonstrated changes in the proportions of different fuels used are affected by factors other than merely taxation. Domestic fuels are also subsidized by other government means, such as investment subsidy and technology development support. Similarly, it is probably not realistic to put down the higher market share of natural gas solely to taxation, as gas has other advantages over competing fuels. Thus the findings can mainly be viewed as maximum estimates of the impact of taxation, though this clearly has a substantial effect on the use of energy and carbon dioxide emissions.

4.3 Harmonization of energy taxation within the EU

General

One important consideration that affects national energy taxation is the need to maintain the country's international competitiveness. It is difficult for a single country to change its taxation on environmental grounds, for instance, if its trade rivals do not do the same. Without international collaboration, the result is competitive taxation systems in which national authorities have no room for manoeuvre. On an integrating market, some degree of harmonization, at least at EU level, is a precondition for any important changes in energy and environment taxes. The following surveys harmonization trends and the present situation in the EU and compares price levels for key energy products in various EU countries.

In 1991 and 1992, the Council of Ministers approved a number of directives that harmonized the excise taxation on oil products, for instance, to a considerable degree. Three of the directives concern excise tax on mineral oils, dealing with the overall system for products subject to the tax, the movement of products, the tax structure and minimum tax levels. Finnish mineral oil tax levels are well above the minimums laid down by the EU.

The basic premise is that all mineral oils used as engine fuels and for heating should be taxed. In addition, in the case of engine fuels, all replacement fuels such as liquid bio-fuel should be taxed in the same way as petrol and diesel oil. Mineral oils used for other purposes are tax-exempt. Taxing fuels used in air and sea traffic (except for private use) is also prohibited.

The general rule is that reduced tax levels are not permitted. However, Member States can request permission to allow exceptions, tax exemptions or reductions, following a set procedure. The exceptions concerned require unanimous approval by all the Member States, and several dozen are currently in force.

The EU has also long been working towards tax harmonization for all energy products, including electricity. As early as 1992 the Commission proposed a mandatory carbon dioxide and energy tax on members of the Community which was supposed to take effect at the beginning of 1993. Half of the tax on the crude oil that was used as the reference product was to be collected on the basis of carbon content and half on energy content. The taxes on other sources of energy were to be based on unit tax components specified in this way. Initially the tax level proposed was 3 dollars a barrel, rising to 10 dollars by 2000. However, the Commission's proposal did not win unanimous approval.

At the Council's request, the Commission issued a new draft directive in spring 1997, which is still being discussed. This rejects the carbon dioxide/energy tax model, instead proposing minimum tax levels on all energy products, including electricity and heat.

The draft directive calls for a staggered introduction of minimum tax levels, the first coming into effect in 1998, the second in 2000 and the third in 2002. With the exception of diesel fuel, Finland's current taxes already exceed the minimum levels in the proposal. The draft directive is still being considered by the Ecofin Council and a working group, which look unlikely to achieve unanimity at least within the next 1-2 years.

Energy prices and taxes in some countries

The following examines energy price levels and the tax component in Finland and ten other countries in western and northern Europe. The information has been assembled from various sources. The energy price data are based on information collected by the Finnish Oil and Gas Federation (oil products) and Statistics Finland (natural gas, electricity), in addition to which IEA and European Commission material on energy taxes was used.

In the case of petrol, the consumer price level in Finland and the tax included in the price are both somewhat above the average for the countries studied (Figure 4.7). Petrol is by ar the most expensive in the UK and Norway, and cheapest in Austria.

The differences are partly due to taxation; prices before tax range within 50 pennies, while the consumer price range is just over FIM 2. It should be noted that prices and taxation in southern Europe are much lower than in the countries studied. The price of petrol in southern Europe averages FIM 4.5 per litre, with tax accounting for FIM 1.7.

The overall picture is the same for diesel oil. Because of high taxation, diesel oil is by far the most expensive in the UK and Norway, while Finland comes somewhere below average. The tax range for diesel oil is much broader than for petrol, at around FIM 3.5 per litre. In some countries public transport is granted diesel tax relief.

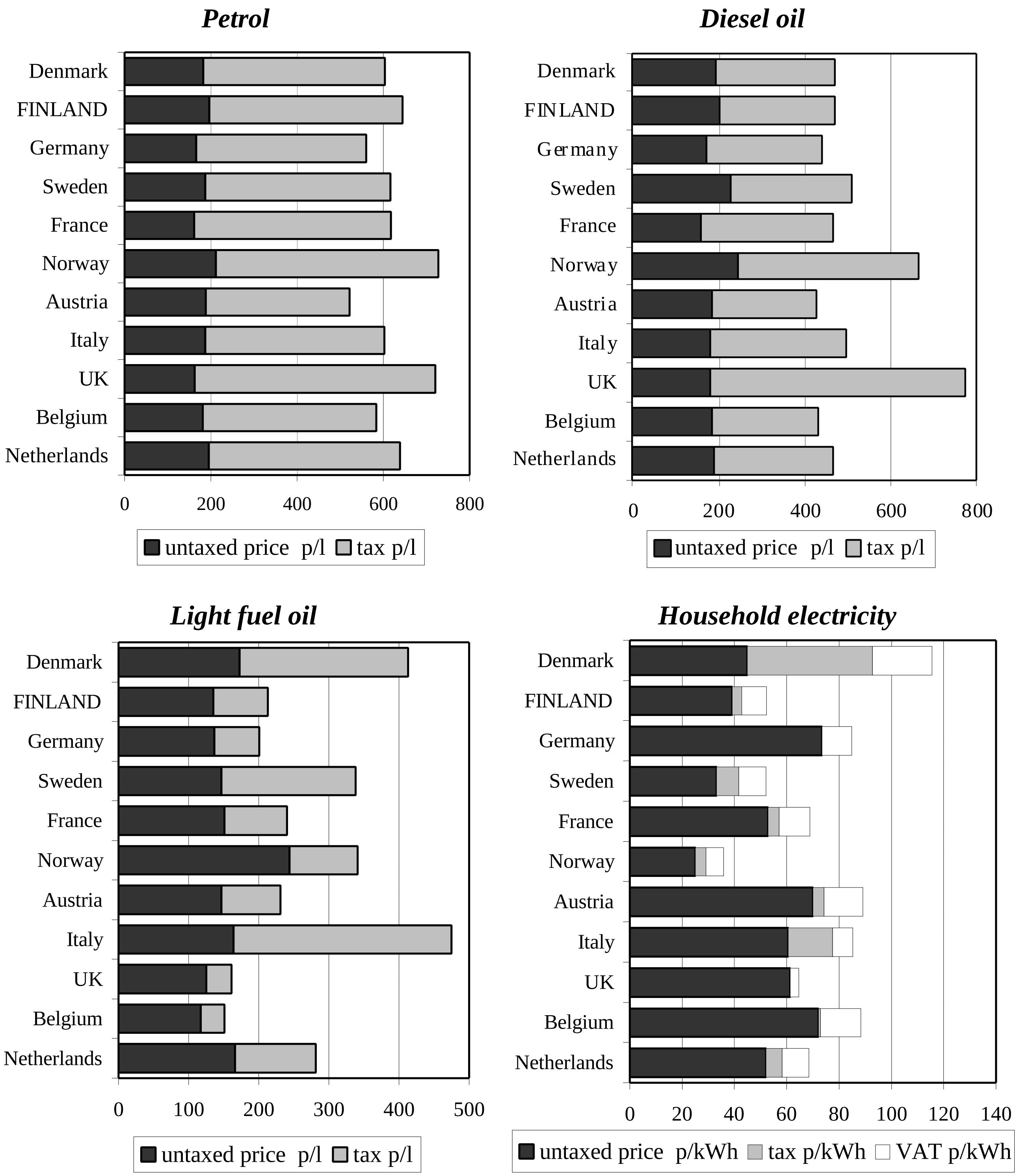
There is great variation in the consumer prices and taxation of light fuel oil. In Italy, the price is over three times that in the cheapest country, Belgium. In Finland, the price of light fuel oil and the tax on it are well below the average. However, no general conclusions should be drawn on this basis concerning the tax burden on heating energy, as the energy sources used for heating vary greatly from country to country.

The price of the electricity used by households, even before tax, varies much more than that of oil products. In countries where electricity is expensive, such as Germany, the price before tax is nearly three times that in the cheapest country, Norway. Electricity prices before tax are by far the lowest in the Nordic countries, and also after tax, with the exception of Denmark. Two countries, Germany and the UK, did not levy any energy tax at all on electricity in the comparison year. Since then, Germany has decided to introduce an electricity tax of around FIM 0.06 per kWh. On average, tax accounts for a much smaller proportion of the price of electricity than of oil products, Denmark being the sole exception in this respect. It should be noted that fuels used for producing electricity are taxed in some countries, and this is included in the untaxed price used in this comparison.

In the case of industrial fuels and electricity, the taxation practice varies depending on the fuel, and comparison is therefore difficult. Many countries do not release such price information at all, and what information is given does not necessarily illustrate the price paid by, for instance, big energy consumers. Most countries also grant a variety of tax reliefs to the whole of manufacturing or its energy-intensive sectors.

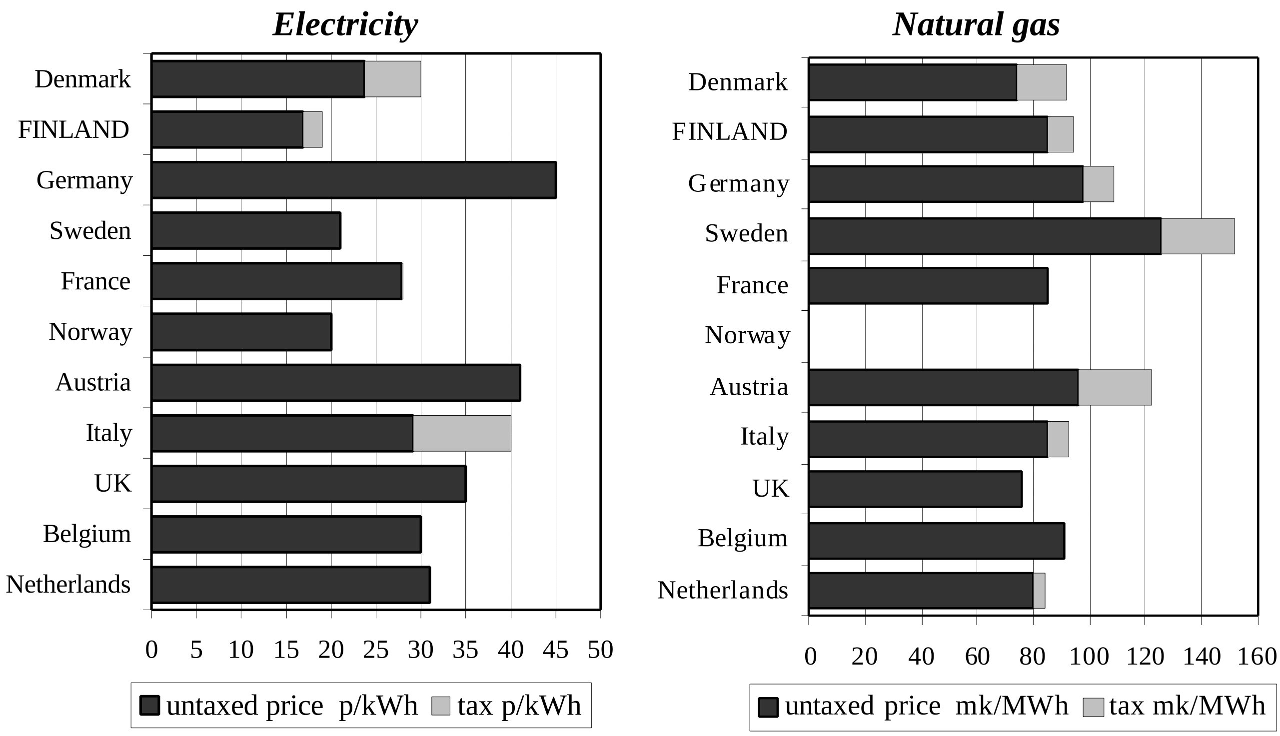
Generally speaking, industrial coal is only taxed in the Nordic countries and the Netherlands, and electricity is in effect completely or almost tax-exempt to manufacturing in at least Belgium, the UK, Norway, France, Sweden and Germany. On the other hand, oil products and natural gas are widely taxed, and natural gas is tax-exempt only in the UK, Norway and France. Figure 4.8 shows prices and taxes for industrial electricity and natural gas (mainly average price levels or those paid by medium-sized industry). In the case of energy-intensive manufacturing, prices generally seem to be far lower, though no reliable statistics are available since prices are usually confidential.

Figure 4.6 Consumer prices of petrol, diesel oil and light fuel oil, and tax component (incl. VAT) in December 1999, and the price of household electricity in 1998.



Sources: Finnish Oil and Gas Federation, IEA Energy Prices and Taxes

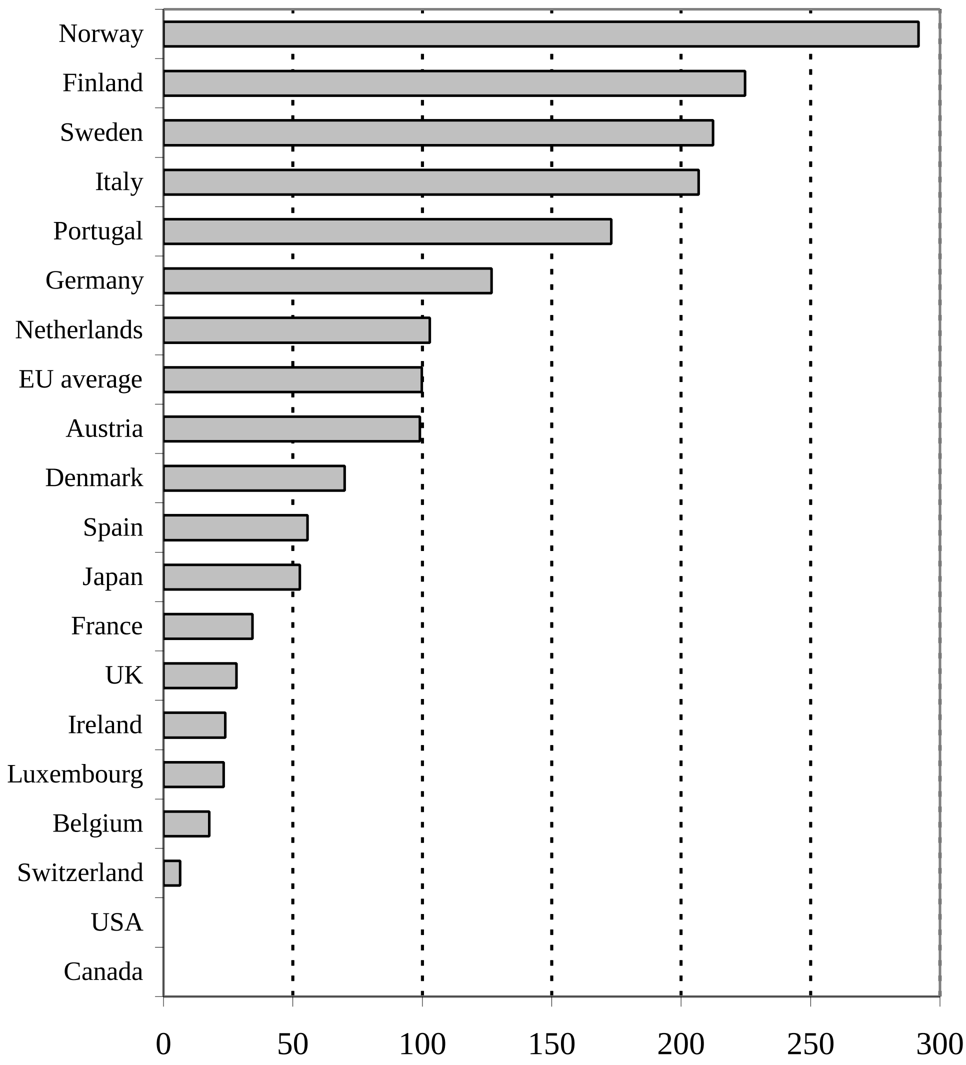
Figure 4.7 Prices of electricity (50 GWh p.a.) and natural gas and taxes in manufacturing, 1998



Sources: Statistics Finland, IEA, EU

The Confederation of Finnish Industry and Employers has produced a study estimating the effect of energy tax on industry in various countries in 1997. This concludes that energy taxes relative to the value added of industrial production vary greatly within the EU (Figure 4.9). The heaviest tax burden seems to be borne by the three Nordic countries, at around one per cent. On the other hand, there are great differences between sectors. Among energy-intensive sectors, the tax burden on the forest industry in Finland is shown to be the highest of all, at nearly five times the EU average. In the basic metal industry, the tax burden in Finland is only just above the EU average.

Figure 4.8 Total burden of energy tax on industry relative to value added, 1997 (index, EU average=100)



Source: Confederation of Finnish Industry and Employers

Although the information in the comparison is fairly recent, it does not necessarily give the right picture of the situation, because changes in energy taxation are going on, or are already in effect, in many countries. Germany has instituted an 'ecological tax reform' and at least the UK has plans for expanding energy taxation to industry. Sweden, in turn, has set up a working group to consider changes in energy taxation. Since the date of the comparison, Finland, too, has introduced certain tax subsidies and reliefs for manufacturing which will lighten its burden. These include a subsidy for electricity generated using wood and waste sludge in the forest industry, and a tax rebate to energy-intensive industries.

4.4 Emissions trading and the Kyoto mechanisms

So far, emissions trading has not become a common economic instrument outside the USA. However, as a result of the UN Climate Convention, emissions trading and comparable mechanisms are coming strongly to the forefront. As things look now, it is clear that their significance will also grow in future in other industrial countries. The eventual form these instruments take is still very much an open question, however. What follows surveys the present stage of preparation and experimentation in Finland and elsewhere.

The Kyoto mechanisms and international preparations

The parties to the Kyoto Protocol can employ what are called 'Kyoto mechanisms' laid down in the Protocol in order to fulfil their commitments. These are intended to supplement the quantified emission limitation and reduction commitments.[13] Reducing emissions is usually cheaper in developing countries and transition economies than in the industrialized countries covered by Annex B. Use of the mechanisms can be thought of as changing the permitted emission levels in the countries employing them. The mechanisms mentioned in the Kyoto Protocol are as follows:

A) Emissions trading (ET) between Annex B countries, in which some of the permitted emissions of one party are transferred to another party to increase its maximum permitted emissions.

B) Joint implementation (JI) of projects, in which two or more Annex B countries implement an individual project aimed at emissions reduction in the area of some other Annex B country. The reduction achieved as a result of the project, or part of it, can be divided among the parties involved in the project as they jointly agree. The reduction must supplement what would be achieved otherwise.

C) The clean development mechanism (CDM), which aims to help developing countries achieve sustainable development. The CDM permits joint implementation of individual projects or some closely related activity between an Annex B country and an outside country, i.e. primarily a developing country. The same kind of rules apply to CDM as to JI. Sinks are not mentioned separately. The emission reduction achieved can be divided among the participating countries, though it can only be counted as a benefit to Annex B countries with an emission limit.

The actual decisions about practical implementation of these mechanisms and the rules concerning them are to be made at the COP6 Conference of the Parties to the Climate Convention, possibly in autumn 2000. Finland counts as part of the EU at international conferences and will thus contribute mainly through joint EU positions. The Commission has produced various documents on implementation of the Kyoto

---

[13] One of the key issues in climate negotiations is how to interpret the concept supplementarity. The EU advocates a 50 per cent ceiling on use of the Kyoto mechanisms, i.e. at least half of the deduction in emissions agreed on for each country should be achieved using internal, national measures.

Protocol, and a Green Paper is expected this spring on emissions trading inside Member States.

It is still impossible to say with any certainty whether an international market in emission permits will take shape. However, research findings indicate that this could substantially reduce the costs of achieving the emission reductions called for in the Protocol. According to a recent Commission estimate, emissions trading could cut costs by as much as a third at Community level.

An experimental phase regarding JI and CDMs is currently under way. The EU is aiming at the most flexible possible change-over from this experimental stage to actual implementation of the project mechanisms. One issue involved here is how emission reductions achieved by JI projects before the commitment period (2008-2012) begins can be taken into account. Approval of sinks, i.e. afforestation and reforestation, as CDM projects is an important issue for many international companies, the developing countries, and Finland.

Box 2: World Bank Carbon Fund

In July 1999, the Board of Governors of the World Bank decided to set up a special Prototype Carbon Fund, or PCF. The Fund started to make preparations in January 2000. The Fund aims to reduce greenhouse gases through JI projects aimed at transition economies and CDM projects aimed at developing countries. In order to get these projects approved by the Parties to the UN Climate Convention, independent experts will be used to select and certify projects. Another aim is to collect and disseminate information. A third is to enhance cooperation between the public and private sectors in combating climate change and gathering related resources.

According to the head of the Carbon Fund, developing countries have plenty of potential for reducing emissions at a cost of between 5 and 15 dollars per carbon tonne, only a fraction of the costs in industrial countries. The Carbon Fund also aims to act as a kind of 'broker' seeking to find a reasonable price for projects which is acceptable to both parties, and thus to set a price for emission reductions. According to the head of the Fund, the level aimed at is 20 dollars per carbon tonne, which would also cover administrative costs. Twenty countries have already expressed interest in getting Carbon Fund projects.

Finland, the Netherlands, Norway and Sweden are members of the Carbon Fund. The companies that have so far joined are mainly Japanese. The Norwegian companies Statoil and Norsk Hydro are considering joining. As yet, no Finnish companies are involved in the Fund's activities. By January 2000, USD 85 million had been invested in the Fund.

The Fund is intended as a pilot project. It will not compete on the emissions market, its equity will not be raised above USD 150 million and it will stop operating in 2012. Half of the investments will be in transition economies and half in developing countries. The Fund will itself invest directly in projects, but also aims to help target countries to set up similar funds for themselves. The main focus of the projects will be on renewable energy.

One project can account for between 2 and 10 per cent of the Fund's resources. One host country's contribution to the value of investments may not exceed 20 per cent. Only a quarter of all investments can promote the same technology. No more than 10 per cent of Fund assets can be invested in forestation. Such projects may likewise not be set up in developing countries before agreement is reached on this in the climate negotiations. Projects must fulfil the criteria of the UN Climate Convention and the Kyoto Protocol.

National preparations

Planning, application and adoption of national emissions trading is at a highly dynamic stage worldwide. The matter is being widely studied in Anglo-Saxon countries where there are several voluntary systems. At the beginning of 2000, British Petroleum Amoco began voluntary greenhouse gas emissions trading based on a reduction target for the company's own emissions decided on by the Group's central administration. This has been divided up among the profit centres, which can trade between themselves with emissions quotas.

Preparations for trading under the law have made most progress in the Nordic countries. In Denmark a new act on the matter will probably take effect at the beginning of 2001. It includes a fast-falling quota of carbon dioxide emissions aimed at electricity producers, and allows for emissions trading to alleviate the cost burden involved. In other Nordic countries, including Finland, the matter is at the committee stage.

A committee set up by the Finnish Ministry of Trade and Industry has the brief of drawing up a proposal for ways of using the Kyoto mechanisms as part of a national plan to reduce greenhouse gases, and to consider issues related to the Kyoto mechanisms that come up in the international negotiating process. Another of the committee's tasks is to study national application of the Kyoto mechanisms within the international context and the organization of any national emissions trading.

One key issue in arrangements for domestic emissions trading will be choosing between producer trading and user trading. In the former, emission quotas are allotted to the producers and importers of products, which in the case of greenhouse gases could be limited to importers and to producers of fossil fuels. In user trading, the quotas are allotted to users, which in the case of greenhouse gases could be limited to energy producers above a certain size, for example. In many cases the number of parties, and thus the working of the market, will depend essentially on which alternative is chosen.

In neighbouring areas close to Finland and in developing countries, the Kyoto mechanism pilot stage is just being launched. Energy ministers from the Baltic region and the EU decided in October 1999 on guidelines for energy cooperation in the area in 2000-2003. One of the subgroups is a working group on climate affairs, which is planning a 'Testing Ground for the Kyoto Mechanisms' in the Baltic.

4.5 Summary

The OECD countries use a huge range of economic instruments in environmental protection, and comparison between them is often difficult. Use of economic instruments probably has a good effect in reducing detrimental environmental impact. Systematic analysis of the environmental effects of each approach used is methodologically difficult, and none has been carried out in Finland or in any other OECD country.

A key instrument of control is environmentally-related taxation, where revenues account for a growing proportion GDP in the OECD countries. In Finland the share of environmentally-related taxes of GDP is somewhat above the OECD average. By far the most important environmental taxes are energy taxes, where Finland, too, has achieved improvements in the last decade in the form of an environmentally-based differential tax system.

Finland's present energy tax system has taken shape slowly amid fiscal, market-based and environmental cross-currents. It has proved rather complex administratively and to some extent difficult for those taxed to understand, partly because of tax subsidies and the complicated procedures involved in combined heat and power production. Tax subsidies are a problem for long-term tax policy because they have to be approved by the EU Commission.

The consumer prices of oil products and their taxation are fairly uniform throughout northern and western Europe, where Finnish practices lie around the average. Price and tax levels in the case of liquid transport fuels, in particular, vary rather little from country to country. There are large differences in the untaxed price of electricity to households, and in electricity taxes, however. In Finland the household electricity tax is around the average, but the consumer price of electricity well below it.

In the case of manufacturing industries, it is difficult to make reliable price and tax comparisons. Finnish manufacturing would seem to face a higher energy tax burden than the average in the comparison countries. Comparison is complicated by the fact that it is also impossible to work out the real prices of energy in industry and effective tax rates from international statistics. In addition, energy taxes have been changed very recently in many countries. Finland, for instance, has lightened the energy tax burden on manufacturing by increasing subsidies and reliefs, while at the same time raising taxes generally. However, the comparisons made indicate that the price paid by the Finnish manufacturing for its electricity is fairly reasonable.

So far, the taxation of motor vehicles in Finland incorporates no features directly related to the environment. In practice, its controlling effect could be increased so as to reduce detrimental effects on the environment in the long term. Preliminary work on this matter should be launched, also taking overall taxation of liquid fuels into account.

Harmonization of energy taxation at the European Community level has not made as much progress as originally expected and the creation of a harmonized energy tax system looks far from certain. The Commission's present proposal is based on minimum tax levels which are mainly below those currently in force in Finland.

The slow progress made towards an internationally harmonized tax solution underlines the importance of using Kyoto mechanisms in achieving greenhouse gas reduction targets. It is in Finland's interests to strive to promote the widest possible acceptance of Kyoto mechanisms and to reduce the costs of emission-cutting measures in this way. The practical aspects of the mechanisms, especially emissions trading, are still being worked out and many related issues call for urgent clarification.

5. THE ECONOMIC IMPACT OF ENVIRONMENTAL TAXATION

There are always some economic costs involved in environmental protection, whatever form it takes. The costs of reducing harmful emissions, for instance, comprise the expense of treating emissions, the costs of developing and investing in less polluting technology, and any penalties, taxes or the price of emission permits. Some cases of environmental protection actually have direct economic benefits in, for instance, the form of lower energy consumption, and may prove viable even in strictly economic terms.

Most benefits, at least those of environmental protection projects, usually take the form of a better-quality environment. Environmental values are difficult to measure and put a price to. If, for instance, the greenhouse effect spreads and raises the earth's mean temperature, it would be very difficult to assess the consequences in economic terms. The benefits of a cleaner environment are also typically divided between a large group of people that is hard to specify, and the winners and losers can rarely be reliably identified. There are also no mechanisms for transfers between states.

Because of the lack of a common means of measurement, it is resonable to examine the economic costs of environmental protection separately from its benefits. We then have to establish the cost of achieving a given environmental target, such as a 10 per cent reduction in emissions. In itself, there is no reason to evaluate emissions reduction here in economic terms. Such analysis offers a cost-based way of 'pricing' environmental values via the costs of achieving them and thus make it easier to formulate environmental policy. A comparison of economic costs in achieving one and the same target is a key criterion when choices are made between different instruments.

As well as the costs, there are often also considerable problems with allocation when environmental policy is made stricter. The widely accepted 'polluter pays' principle is based on the idea that the source of emissions carries primary responsibility for the costs of environmental protection. Thus any reforms proposed usually affect various sectors of production in various ways. The same applies to households, in that various types of household have to sacrifice a varying proportion of their income to improving the quality of the environment.

This section examines the overall economic impact of environmental protection and particularly taxation, and the related costs. The assessment of impact concentrates on three component areas which have been given special attention in connection with environmental control: competitiveness, employment and income distribution between households.

5.1 Environmental protection, competitiveness and employment

An important obstacle to more extensive use of economic instruments in industrial countries has been the need to watch over national competitiveness. In EU Member States, for instance, this has resulted in the slow progress made with the Commission's proposed energy tax and the fact that it has been watered down substantially amid various pressures (European Commission, 1999). The consequence is that the proposed measures will obviously be ineffectual in terms of achieving their environmental objectives. How far is concern about lower competitiveness as a result of tax changes justified? The following discusses some important considerations in the relationship between competitiveness and environmental protection.

Though economic competitiveness is a well known concept, defining it precisely is not very easy, as the definition will vary from case to case. Most commonly, perhaps, 'national competitiveness' is used to mean the success enjoyed by some country's products on the export and home markets. This is influenced not only by relative costs and prices but also by what is called 'real competitiveness', meaning the qualitative superiority of the products concerned, including the services associated with their use.

On the other hand, competitiveness can also mean how attractive a country is as a location for production. It is then affected by factors such as the tax level, the infrastructure, and the availability, quality and pay levels of labour. These two meanings of competitiveness obviously overlap to some extent, and they should be viewed as mutually supplementary, rather than as options (Thompson, 1999).

Effect of environmental policy on competitiveness

The premise for making a link between environmental protection and competitiveness is that measures to protect the environment involve companies in costs which are transferred to prices and thus cut at export prospects and demand, or business interest in investing in the country in question. Of course, the innovative nature of environmental investments can also be underlined, and stricter environmental standards viewed as a competitive asset that results in more advanced technology and a competitive edge on world markets. Empirical research has not on the whole found any strong evidence for either view, however (Palmer et al., 1995, Grossman & Grueger, 1994, OECD, 1996).

These different approaches can be considered to give rise to two alternative national strategies in implementing environmental policy: a country afraid of becoming less competitive will bring its environmental legislation into line with the international minimum after a short time lag, rather than immediately; a country taking the more positive view will strive to predict trends in environmental standards and to win a technological advantage by following a policy stricter than the minimum level.

The approach emphasizing the strategic advantages of environmental protection has also won support among businesses in recent years. Witness the voluntary environmental standards in excess of the minimum demand adopted by companies, such as environmental certificates and internal emissions quota trading between big companies. This progressive position is founded on the desire to use environmental friendliness as an element in marketing.

There is particularly strong opposition to environmental taxes, because they are seen to reduce competitiveness, constituting a permanent cost item for companies. This view contradicts the cost effectiveness argument speaking for use of taxes. The reason for the dichotomy derives at least partly from the different points of view taken: it is important to make a distinction between the competitiveness of the individual company - or possibly industry - and that of the economy as a whole. Basically, environmental protection, for instance in the form of taxes, causes costs for companies which generate pollution. If the resulting tax revenues make it possible for taxes on, say, labour to be reduced, the result is cost savings specifically for labour-intensive industries. In this case, the competitiveness of the polluting production declines, but the competitiveness of labour-intensive production improves. The impact on the economy overall depends on considerations such as the structure of the economy and its reactions to tax changes, and ultimately calls for empirical analysis.

The above simplified example brings out a key feature of the whole competitiveness question: the issue is often one of a rise in costs and the relative position of different sectors, rather than of a general rise in costs. In the case of environmentally related taxes, the cost burden is borne by energy-intensive production, transport and to some extent agriculture. The weighting of these sectors is relatively great, so their interests are taken comprehensively into account in solutions. The benefits of taxes related to the environment are often to some degree uncertain and are difficult to quantify, and the beneficiaries are a highly heterogeneous group.

If those paying for environmental protection comprise a large proportion of the export industry, as in Finland, a decline in the competitiveness of polluting industry is reflected in problems with the external balance of the economy and with employment,[14] at least initially. If the price elasticity of exports is high, the production losses in export industries are greater than the production gains in other sectors benefiting from tax reliefs. Total output then falls, too. In the Netherlands, for instance, where exports are highly energy-intensive, researchers have come to conclusions like these (Koopmans, 1998). In the UK, on the other hand, where energy-intensive industry contributes far less to exports, the competitiveness of the whole economy is expected to improve as a result of such changes (Ekins & Speck, 1999).

Measures to support competitiveness

The imbalances connected with the introduction of stricter environmental standards - such as unemployment and insufficient use or premature outdating of capital stock may result in major adjustment costs on a scale difficult to assess. Taxes and other forms of regulation should therefore be introduced gradually and in a predictable manner. The new standards can then be accounted for in companies' investment plans, for instance.

---

[14] Lower labour cost due to tax recycling will alleviate the problem by improving competitiveness of domestic products at home market. In the longer perspective even the export sector may become more labour intensive.

Another way of spreading out the costs of adjustment is to channel revenues from emission taxes back to the payer sectors in some way or other. One example could be to refund the tax based on carbon dioxide emissions that heating power plants have to pay, in relation to the usable energy generated. With an arrangement like this, the overall competitiveness of heating power plants would not suffer as much as when the revenues are used as tax relief on labour. And yet the incentive to reduce emissions within the sector would remain. A similar method has been used for nitrogen oxide emissions in Sweden, for instance (see Box 3).

Box 3: Sweden's NO_x tax

In 1992 Sweden introduced a tax on nitrogen oxide emissions from electricity plants. All plants producing a minimum of 25 GWh of electricity a year were liable for a tax of SEK 40 per kilo of emission, based on actual measured volumes.

The special feature of the system is that the tax revenues are returned to the power plants concerned in proportion to the amount of electricity they generate. The system thus encourages them to reduce their No_x emissions without weakening the 'competitiveness' of their electricity generation at the sectoral level.

The system seems to have worked very well, because it was extended in 1997 to include smaller plants (the original minimum size was 50 GWh). It is estimated that the tax contributed crucially to Sweden's success in halving its nitrogen oxide emissions in the early '90s (Nordic Council of Ministers, 1999).

The main problem in competitiveness over business location is that companies made liable for emission tax may move to countries with less strict environmental standards. However, the costs of environmental protection are only one factor among many in a company's decisions on location. Position relative to markets and raw materials, infrastructure, and labour costs and availability are the main factors influencing location. In any case, several calculations indicate that there is a possibility of this kind of 'leakage' and that it can appreciably weaken an individual country's potential for raising the level of its environmental taxation unilaterally without any negative effects on production.

One cure proposed for such leakage is international harmonization of environmental taxes, with standards laid down at roughly the same level in all countries, thus eliminating the incentive for companies to move from one country to another.[15] If it is to work perfectly, harmonization should in principle be global, but in practice even small 'conglomerates' would be important, depending on the sector. Other obstacles to harmonization, apart from the national income distribution issues mentioned earlier, include the different sectoral breakdown in various countries and their particular susceptibility to the effects of emissions: a country with an energy-intensive production structure causes heavy emissions, but it may suffer less than average from their impact because of its location, and it will not then be willing to submit to the standards that countries producing less emissions but suffering more from them wish to impose.

[15] International cooperation is also argued for by the fact that carbon dioxide mixes freely into the global atmosphere. Relocation may keep carbon dioxide emissions unchanged, or even increase them, despite local limitation measures.

Environmental protection and employment

Where lower competitiveness is viewed as an obstacle to a stricter unilateral environment policy, a high level of employment has been a key economic reason for shifting the focus of taxation over to environmental taxes. The guiding principle is that the revenues from higher environmental taxes could be used to reduce the taxes on labour. At best, the result would be a 'double dividend' - a simultaneous improvement in both the quality of the environment and the level of employment (e.g. European Economy, 1994, OECD, 1997).[16]

Europe has been plagued by serious unemployment in recent years, and a great deal of attention has been given to the high tax burden on labour. Such high taxes are thought to contribute to alarming unemployment rates by raising the relative price of labour. This has prompted a need to seek alternative tax bases that do less harm to employment. As those concerned over the state of the environment have at the same time demanded more extensive introduction of environmentally-related taxes, it is not surprising that the idea of replacing labour taxes with environmental taxes has come to be a popular subject for research.

Thus, the same kind of tax reform can be justified from two rather different points of view: if the objective is to promote employment by lightening the taxes on labour, environmental taxes offer one alternative tax base for funding public expenditure. On the other hand, if the objective is to look after the state of the environment, for instance by raising emission taxes, reducing labour taxes offers a potential channel for returning surplus tax revenues to economic agents. The approach followed in this presentation is primarily the latter.

It should be emphasized that environmental taxes do not in themselves promote employment any more than other taxes do. The positive employment impact often associated with environmental taxation is a consequence specifically of 'recyling' revenues from environmental taxes, i.e. of the fact that one integral feature of the reforms is that they reduce indirect labour costs. If the same tax revenues can be collected with environmental tax, and with lower job losses, than with labour tax, employment improves as a result. Reliable verification of this calls for case-by-case calculations, but in principle it is possible that taxes on fossil fuels, for instance, have a better effect on employment than those targeted directly at labour input.[17] This view is also supported by most of the empirical calculations made in various countries on the effects of such a change in the tax structure, though impact on employment is usually rather minimal.

---

[16] 'Double dividend' refers either to improvement in the quality of the environment and *employment* or in the quality of the environment and higher general *efficiency*. We restrict ourselves here primarily to assessing impact on employment. 'Double dividend' can also be used to describe better environmental quality if the same policy achieves a reduction in e.g. both carbon dioxide and acidifying emissions.

[17] The extensive literature on the double dividend hypothesis deals more with the effects of a change in the tax structure on general efficiency, which is a rather more complicated question (see e.g. Goulder, 1999). There is reason to remember that increasing employment at the expense of, say, investment is not necessary desirable in terms of general well-being.

There are various practical aspects related to the employment impact of a reform focusing on taxes related to the environment. Firstly, revenues from most of the environmental taxes discussed so far have been rather small compared with revenues from labour taxes. Consequently, the labour taxes levied could only be reduced slightly, and the impact on employment would then also be minimal. In principle, this problem could be circumvented by targeting tax reliefs or income transfers at a narrower target group, for instance in low-paid sectors. However, there is a fundamental observation to be made on this approach: over the long term, at least, a tax with effective environmental impact will not bring in the very large revenues that would be needed if any effect was to be had on employment. Thus a choice has to be made between the environment and employment: if environmental goals are given priority, employment targets inevitably have to be compromised, and vice versa.

Secondly, there are always adjustment costs involved in extensive changes to tax systems that affect the structure of the economy and the distribution of resources. These costs may take the form of a rise in unemployment in the sectors primarily affected by emission taxes. The level and duration of this unemployment will depend largely on the adaptability and flexibility of the labour market. As noted earlier, adjustment costs can be alleviated, for instance by compensating the sectors producing the pollution for the costs of emission taxes. From the employment viewpoint, such compensation could take the form of a reduction in social security contributions. Alternatively, tax revenues could be used to support the retraining of labour and transfers to other fields. It is quite difficult to evaluate the costs of such adjustment during the transition period, so most calculations give the matter little attention.

Thirdly, the main question as far as employment is concerned is whether the reform causes a reduction in the producer price of labour and thereby increases labour demand. The key issue then is how pay formation reacts to the tax change. If an increase in environmental taxes is reflected only partly in pay levels, and employees are, for instance, willing to compromise over pay increases in the name of a cleaner environment, the chances of improving employment grow. Other important factors are the mobility of production factors and the market force of foreign trade. Capital mobility in turn affects how far the tax burden can be transferred to other production factors. The market force of foreign trade in turn decides how far the tax on imported energy, for example, is passed on for foreign economic agents to pay as a result of lower world market prices (cf. Box 4).

Box 4: One tax up, another down - how about employment?

The taxes nominally levied on labour, income taxes and social security contributions tend to reduce the employee's real wage and to raise the employer's labour costs. The result is that the tax wedge grows and employment declines. In a 'green tax reform', revenues from environmental taxes are used specifically to reduce these labour taxes. So why does employment not necessarily rise as a result?

The problem is simply that many taxes other than those nominally affecting labour - including environmental taxes - widen the tax wedge and have a detrimental effect on employment. Thus the reform's net impact on employment is less than that of the tax relief in itself and may in principle even be negative.

The precondition for improving employment is that changing the tax structure reduces the tax burden on labour. Because someone always bears the cost of a tax, environmental tax must shift at least part of the tax burden to other parties. The main options are energy producers, shareholders, foreign economic agents, and non-working consumers.

Bovenberg (1995) analyses the situation rather pessimistically from the viewpoint of a small open economy: in so far as the prices of energy and capital inputs and export commodities are fixed on world markets, the only parties left able to share the tax burden are non-working consumers, such as the unemployed and pensioners. They can be made to bear the tax burden by shifting it from labour taxes to taxes on consumption. Bovenberg does not consider this option advisable for income distribution reasons.

The small open economy model is a theoretic simplification, however, and does not illustrate the real situation. Firstly, some energy input is usually of domestic origin and thus unable to 'escape' the tax burden. In the short term, capital stock is not completely mobile and thus bears part of the burden of, for instance, emission taxes. Even rather small countries may have an impact on export markets through either a large market share or product differentiation. In such a situation, environmental taxes up to a certain amount can be transferred to prices and thus passed on abroad. In addition, if a harmonized tax reform comes into being, for instance through the EU, some of the emission tax burden can be passed on to oil producers in the form of lower world market prices. However, this possibility is made more complicated by the fact that oil producers are organized within OPEC.

Research findings

Because existing tax systems are complicated, estimating impact on competitiveness and employment ultimately calls for empirical calculations on a case-by-case basis. Several calculations have been made of the impact of environmental and energy taxes which aim to elucidate their overall economic impact.[18] In most of them, the growing revenues from environmentally-related taxes are reimbursed in some form to companies and households. The forms of compensation used most commonly in research, following the 'double dividend' hypothesis, are cuts in wage-earners' income taxes and ancillary labour costs.

Most of the calculations made draw positive conclusions about the long-term impact on employment if revenues from energy taxes are used to reduce taxes on labour. Employment improves particularly markedly in calculations illustrating how the economy adjusts in the longer term and which take account of involuntary

[18] Similar comprehensive calculations have also been used to estimate the marginal costs of achieving the Kyoto emission targets. These calculations are dealt with in Annex 2 of this report.

unemployment. Calculations illustrating short-term adjustment, however, indicate that a reduction in energy-intensive production results in a temporary rise in unemployment. The following presents the findings of research considered to be particularly important for Finland.

International calculations

Studies by Bayar (1996) and Capros et al analyse the impact of environmental taxes on employment within the European Union. The assume that revenues from higher energy and environmental taxes when revenues are 'used' to reduce social security contributions. Bayar uses a carbon dioxide emission tax of USD 10 per tonne. His conclusion is that the tax would reduce an unemployment rate of 11 per cent to 10 per cent. He does not make any calculations for individual countries. Carpos et al. come to similar conclusions, calculating the impact of the same energy tax (USD 10 per oil barrel equivalent) in 12 EU countries. Both studies judge that the tax would also have a favourable impact on GDP.

Up to the mid '90s environmental tax committees existed in the Nordic countries which pondered the broader introduction of environmental taxes, mainly with an emphasis on the employment angle. A number of broader calculations of impact were also commissioned by these committees. There were calculations in the Norwegian committee report (NOU, 1996) on the effect of a general carbon dioxide tax, for example, based on a tax of NOK 220 per tonne of carbon dioxide and reimbursement in the form of lower social security contributions or income tax. In both options, employment rose half a per cent, though the social security contribution option was slightly better in this respect.

The official target in Denmark is to reduce carbon dioxide emissions by 20 per cent on the 1988 level by 2005. Hauch & Mortensen (1999) present calculations based on a 25 per cent reduction on the present level, using various background assumptions. In the basic scenario, Denmark would unilaterally levy a DKK 300 per tonne carbon dioxide tax on use of energy by households and industry. The increase would not be compensated by reducing other taxes. Over the long term, the effects on total output would be slightly negative: GDP would fall 0.7 per cent. In the calculations, employment would remain unchanged, partly as a result of wage flexibility. Over the short term, with fixed wages and more limited mutual compensability of production inputs, GDP would fall more and employment would decline.

In the calculations made by the Swedish committee (SOU, 1997), the basic scenario would be to double the carbon dioxide tax on the 1995 level (SEK 83 per tonne in industry and SEK 340 in other sectors). The increase in revenues would be used for either a general or a specific reduction in social security contributions. The calculations show the impact on economic well-being to be negative. The committee did not make any actual calculations on employment impact, but estimated that if social security contribution cuts were targeted at sectors with considerable price elasticity in the demand for labour, employment might actually improve. On the other hand, the committee points out that in the short term the policy could raise adjustment costs and increase unemployment.

Calculations on Finland

The Finnish Environmental Economics Committee interim report (1993) also estimates the impact of energy taxes on employment using Finnish material. The committee had calculations made on the effects of the energy tax proposed by the EU (USD 10 per oil barrel equivalent) using two model frameworks. The assumption made was that Finland would levy the tax unilaterally and that revenues would be reimbursed in the form of lower social security contributions. According to the KESSU IV model showing shorter-term adjustment, employment would fall by about half a per cent. The FMS model illustrating longer-term impact showed the effect on employment to be slightly positive.

One of the studies using Finnish material incorporating calculations comparable with the work of the Nordic committees is by Alatalo (1998). She uses a general tax of FIM 185 per tonne of carbon dioxide, which he calculates is enough to stabilize emissions at the 1990 level. If the increase in revenues were used to reduce social security contributions, both production and employment would rise somewhat, by 0.2-0.4 per cent. If it were used to reduce income or commodity taxes, the positive impact on production and employment would be slightly lower. Honkatukia (1997) produced similar results using a somewhat different calculation model. Tossavainen (1998) used elasticities calculated from industry level data, estimating that replacing social security contributions with energy tax could improve employment to some degree.

Honkatukia (2000) examines the effects of raising the supplementary tax on fuels, based on carbon dioxide content. His calculations assume an increase in the supplementary tax from the present FIM 102 per tonne to FIM 200. The study considers two alternative scenarios, with the tax increase imposed either unilaterally or internationally. Also, various structural options in which the tax increase is either targeted solely at fuels or also levied on electricity consumption are examined.

Honkatukia's findings show that raising the tax within the present tax system would reduce the overall volume of carbon dioxide emissions rather little, about 4 per cent in 2010. If electricity tax were raised by the same proportion at the same time, emissions would decrease somewhat more, a good 5 per cent. If revenues were reimbursed by reducing income taxes, employment would remain more or less unchanged in the unilateral scenario and increase slightly if the tax were international. The effect on GDP would be slightly negative, around half a per cent. The main negative effects would relate to falls in exports and production in energy-intensive sectors, especially if the tax were raised unilaterally. There could also be substantial adjustment costs involved in this kind of change in the production structure that the calculations are unable to take into account. Earlier model calculations indicate that costs would rise sharply in the case of a higher carbon dioxide tax hike. More detailed results of the calculations are given in Annex 1.

5.2 Environmental taxes and income distribution - will low-income groups suffer?

Economic study of environmental and energy taxes has largely concentrated on their impact on efficiency, competitiveness and employment. Households are usually dealt with as a group, without taking the differences between them into account. In reality, however, households differ in terms of income and consumer behaviour, so we need to assess how environmentally-related taxes affect their relative standing. This is an important issue because energy taxes, for instance, are usually regressive, i.e. take more from low-income groups than from high-income groups. If, too, they are used to replace the present progressive scale of income taxation, the reform overall could greatly reduce the ability of the tax system to equalize after-tax incomes.

The following studies the impact of environmental taxes, especially energy taxes, on the income distribution of households. Initially, we survey the general principles behind the effect of environmental taxes on income distribution, and the findings of empirical studies. Finally, we present an estimate of the impact of environmental and energy taxes on the relative standing of various types of household in Finland.

How do environmental taxes affect income distribution?

Environmental and income taxes affect household expenditure and consumption both directly and indirectly. Direct impact means taxes aimed at a household's own energy consumption, such as petrol tax and more recently electricity tax. Indirect impact means energy taxes on the intermediate products involved in a household's other consumption, such as the fuel taxes paid by industry. When the price of intermediate product inputs is raised, the energy taxes paid by industry are transferred at least partly to consumer prices and thus ultimately to the consumer.

Perhaps the most typical new tax related to the environment proposed as part of recent tax reforms is the carbon dioxide tax, which is designed to limit carbon dioxide emissions into the atmosphere. For practical reasons, carbon dioxide tax would usually be levied on fossil fuels, staggered according to carbon content. This is a justified approach in that most carbon dioxide emissions derive from fossil fuels and the amount of carbon dioxide released on combustion is directly proportional to the carbon content of the fuel.

The impact of tax based on carbon dioxide content on income distribution19 can be estimated directly by calculating the carbon content of the various consumption items of households using national input/output accounting. When the principle for determining the tax is known, the taxes on various consumer items can be calculated. Using material on household incomes and consumption structures, it is then possible to define, say, the carbon dioxide taxes paid by various income groups. The justice of the new tax can then be estimated using various indicators, e.g. by relating the tax

[19] Income distribution is used here to mean specifically the way annual after-tax income or consumption potential is spread among households. The approach is thus static. Income distribution can also be examined dynamically, making a comparison between lifetime incomes and different generations (e.g. Bull et al., 1994; Bovenberg & Heijdra, 1998).

increases in each group to income, or by comparing welfare indicators calculated before and after the innovation, and their distribution. Similarly, it is also possible to study differences between age groups, types of family or regions, or combinations of them, instead of income groups.

In practice, assessing impact on income distribution is complicated for instance by the fact that taxes are not always transferred to prices in full, and some taxes fall to companies to pay, being passed on to households in the form of lower primary factor compensations, for instance. Over time, bigger tax changes also result in changes in the structure of production and consumption. These may well produce a systematic bias in the income distribution impact if, for instance, high-income groups have a better chance of adjusting to rising energy prices than low-income groups.

Research findings

Estimating the income distribution impact of tax changes always calls for empirical calculations. The following surveys research on the impact of environmental and energy taxes, with consideration for the above-mentioned factors. Some of the calculations apply solely to the effects of an increase in taxes related to the environment, while others also estimate the effects of compensatory tax cuts on income distribution.

International calculations

Symons et al. (1994) studied the effect of carbon dioxide tax on income distribution in the UK. The tax is USD 411 per carbon tonne and is levied on fossil fuels in production and consumption. Their findings show that the tax increases income differentials between households. Cornwell and Creedy (1996) assessed the income distribution impact of carbon tax, using Australian material. In the basic scenario, the tax is USD 306 per carbon tonne, and the impact on household income distribution is distinctly regressive. The authors assume that the structure of consumption changes as a result of the new tax, but not the structure of production. Carbon dioxide emissions decrease 20 per cent as a result of the tax. Cornwell and Creedy estimate that the same emission level could be achieved with a USD 200 tax, assuming moderate flexibility in the production structure. They also point out that growing inequality between households could be controlled by using tax revenues to raise the level of basic security, for example.

Metcalf (1998) used US material to study the income distribution impact of a 'green tax reform'. This involves increasing certain environmental taxes, e.g. a carbon dioxide tax similar to the above (USD 40 per carbon tonne), so as to achieve an overall increase of 10 per cent in revenues. This increase would be compensated by reducing income taxation and social security contributions by an equivalent amount.[20] The overall

[20] As well as carbon dioxide tax, motor fuel excise tax, automobile tax and waste tax would also be increased. The income taxation cut would include a uniform reduction in income tax rates, a higher untaxed minimum on social security contributions, and an increase in certain deduction rights (see Metcalf, 1998).

impact of the reform on income distribution would be slightly regressive. Metcalf shows, however, that if the tax reliefs were made to favour low-income groups, the effect would become progressive. The calculations assume that the structure of consumption and production remains unchanged. Barker & Köhler (1998) come to much the same conclusions in their calculations, which use an econometric model covering eleven EU countries.

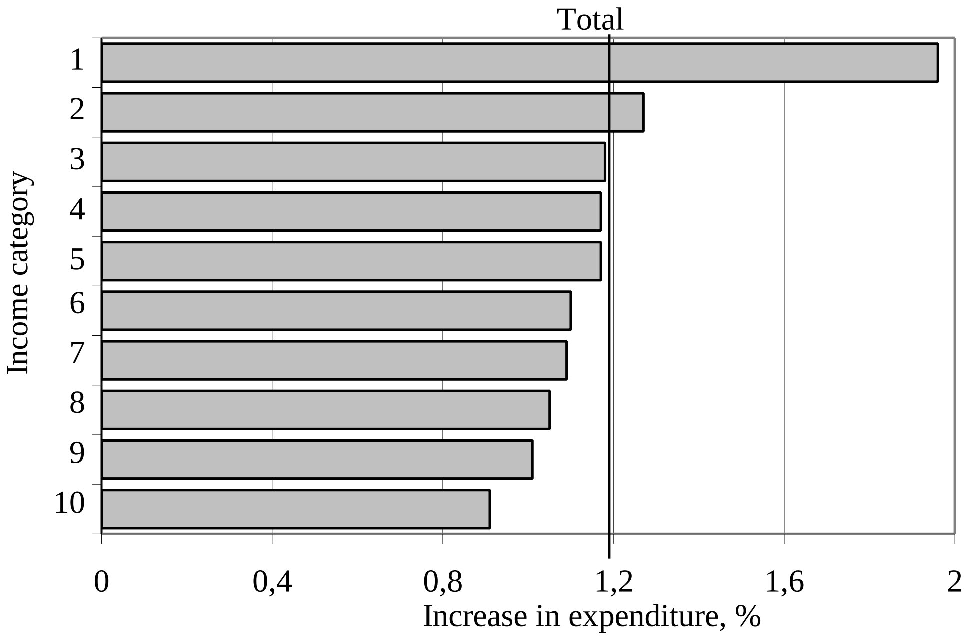
A report by the Swedish environmental tax committee also studies the impact on income distribution of doubling the carbon dioxide tax (SOU, 1997). It concludes that low-income groups spend more of their income on heating fuels, but a smaller percentage of their expenditure on petrol, than high-income groups. The former observation tends to strengthen, and the latter to weaken, the regressive character of carbon dioxide tax. According to the calculations in the report, the change would cause the biggest losses to Swedish families with children, as the latter make consumption more energy-intensive, partly because more transport is needed.

Finnish calculations

In Finland, the impact of carbon dioxide tax on income distribution was dealt with in the 1991 report of the Carbon Dioxide Tax Committee. Its findings are mainly in line with international calculations. They show that a carbon dioxide tax of FIM 150 per tonne would be distinctly regressive with respect to the disposable incomes of households in the 1988 material used.

The calculations made in Finland in recent years do not assess the effects of climate policy on income distribution. To get a picture of the effects of environmental and energy taxes, however, the working group had calculations made which were designed to take account of this impact (see Annex 2). The structure of the calculations was formulated to correspond as closely as possible to the calculations on the whole economy being made at the same time.

Figure 5.1 Additional expenditure caused by raising the tax based on carbon dioxide content, by household income category. The assumed tax increase is FIM 100 per CO_2 tonne. The calculations are based on the 1994-1996 consumption structure. Income category 1 is the lowest disposable income decile



The calculations examined the impact of both a general tax based on carbon dioxide content and the present taxes on traffic fuels on household expenditure by income category, socioeconomic status and place of residence. Both the carbon dioxide tax and the present tax on traffic fuels have the strongest relative impact on households in the lowest income categories. The effect of carbon dioxide tax on the income distribution of households, by income category, is shown in Figure 5.1. The regional distribution of the tax burden is also to some extent uneven. The tax on traffic fuels, specifically, has above-average impact on households in sparsely populated areas. More detailed results of the calculations are given in Annex 2.

5.3 Summary

However it is carried out, environmental protection invariably generates economic costs. In most of the cases, the benefits of environmental protection are achieved in the form of a better-quality environment. Because they are not mutually compatible, it makes sense to examine the economic costs of environmental protection separately from the environmental benefits it confers. The main question then is the cost of a given environmental objective in terms of lower economic growth, loss of employment, and ultimately poorer consumption potential.

As well as the costs, however, stricter environmental policy often has considerable distributional effects, too. Environmental and energy taxes affect different sectors of production in different ways. The same is also true of households: if environmental and energy taxes are raised, different types of household have to sacrifice varying shares of their income to improving the quality of the environment.

In practice, stricter environmental taxes and standards have most effect on the relative position of different sectors. In this respect, the issue involves a reallocation of resources, which gives rise to conflicts of interest and thus makes it more difficult for policy to be carried out. The impact on the competitive standing of the whole economy depends on its structures, e.g. the energy intensiveness of the open sector, and the time span concerned. In this respect, Finland is in quite a difficult position, because a large proportion of the export industry is highly energy-intensive. There may be substantial adjustment costs in the transition stage, felt in the form of losses in total output. These costs can be alleviated by compensating for the rise in costs to the parties paying out, by introducing the higher taxes, etc. gradually and by striving for the broadest possible joint implementation internationally.

Broader use of environmental taxes is often justified by appealing to the positive effect on employment. Actually, the taxes in themselves do not promote employment, but in so far as raising them makes it possible to reduce taxes levied more directly on labour, changing the tax structure in principle results in a better employment balance. In practice, the situation is not so simple, however. Firstly, most taxes, including energy taxes, are levied partly on the labour input and thus reduce the positive effects of any tax reliefs on employment. Secondly, because the base for labour taxes is large, a substantial reduction in labour taxes calls either for appreciable increases in energy taxes or has to be targeted at a relatively narrow sector only. Thirdly, because someone always ends up paying the taxes, better employment presupposes that the tax burden can be transferred to other parties, e.g. shareholders, foreign economic agents or pensioners.

Because existing tax systems are complicated, assessing impact on competitiveness and employment ultimately calls for empirical calculations on a case-by-case basis. Most calculations show positive, though small, long-term effects on employment if energy tax revenues are used to reduce the taxes on labour input. The main negative effects would be a decline in exports and production in energy-intensive sectors, especially if the tax increase were unilateral. There could well be substantial adjustment costs attached to such a change in the production structure, and most calculations do not take these into account. Calculations on short-term adjustment suggest that unemployment would increase because of a decline in energy-intensive industry. Available data indicate that Finland's targets for carbon dioxide emissions are quite strict by international standards. If taxes were to be used as a key instrument in attaining the targets incorporated in the EU's burden-sharing agreement, taxation would have to be made much stricter. The costs involved in the tax change would then also rise to quite a high level.

Environmental taxes, especially those on use of energy, are usually regressive, i.e. affect low-income groups relatively more than high-income groups. This is because low-income households spend a higher share of their income on energy-intensive products. Empirical calculations using Finnish material support this finding. Both a tax based on carbon dioxide content and the present tax on traffic fuels affect low-income households more than high-income ones. Also the regional breakdown of the tax burden is uneven to some extent. The tax on traffic fuels, especially, is more of a burden on households in sparsely populated areas.

In the light of the results outlined here, it appears that if the main focus of taxation were moved from the present income tax system to environmental and energy taxes, the tax system's effectiveness in levelling out income differentials would suffer. This could be counterbalanced to some extent by tax reliefs and income transfers aimed at low-income groups. However, because use of energy and thus the burden of energy and environmental taxation varies greatly even between households with the same level of income, it is in practice difficult to compensate for the income losses caused by higher taxes.

REFERENCE

Alatalo (1998): Hiilidioksidiveron kaksoishyötyvaikutus, ETLA series B 141.

Barker & Köhler (1998): Equity and Ecotax Reform in the EU: Achieving a 10 per cent Reduction in CO_2 Emissions Using Excise Duties, Fiscal Studies, Vol. 19, No. 4.

Bovenberg (1995): Environmental Taxation and Environment, De Economist 143, No. 2.

Bovenberg & Heijdra (1998): Environmental Tax Policy and Intergenerational Distribution, Journal of Public Economics 67.

Bull, Hassett & Metcalf (1994): Who Pays Broad-Based Energy Taxes? Computing Lifetime and Regional Incidence, The Energy Journal, 15.

Böhringer & Rutherford (1997): Carbon Taxes with Exemptions in an Open Economy: a General Equilibrium Analysis of the German Tax Initiative, Journal of Environmental Economics and Management, 32.

Cornwell & Creedy (1996): Carbon Taxation, Prices and Inequality in Australia, Fiscal Studies, Vol. 17, No. 3.

Ekins & Speck (1998): The Impacts of Environmental Policy on Competitiveness: Theory and Evidence in Barker & Köhler (eds): International Competitiveness and Environmental Policies, Edward Elgar.

European Commission (1999): Compromising the Energy Tax Proposal? Background Paper for ENVECO Meeting, European Commission, DG ECFIN, 11 October.

European Economy (1994): Taxation, Employment and Environment: Fiscal Reform for Reducing Unemployment, Annual Economic Report, No.56.

Finergy (1997): Sähkömarkkinat 2010; Sähkön käytön ja hankinnan kehitysnäkymiä, research report no 3.

Gielen, Koutstaal, Kram & van Rooijen (1998): Effects on the Climate Policy of the European Union, ECN Report C-98-040.

Goulder (1999): Green Tax Reform: Theoretical Issues, Empirical Results, and Future Challenges in Bränlund & Gren (eds.): Green Taxes – Economic Theory and Empirical Evidence from Scandinavia, Edward Elgar.

Grossman & Grueger (1994): Economic Growth and the Environment, NBER Working Paper 4634.

Hiilidioksiditoimikunnan mietintö (1991): Committee report 1991:21, Ministry of Environment.

Honkatukia (1997): Are there Double Dividends in Finland? The Swedish Green Tax Commission Simulations for Finland, research report B:5, HKKK.

Honkatukia (1998): Ympäristöverot ja työllisyys – Katsauksia tutkimustuloksiin ja toimenpiteisiin pohjoismaissa ja Hollannissa, Suomen ympäristö 1999, Ministry of Environment.

Honkatukia (2000): Energiaverotuksen uudistamisen taloudelliset vaikutukset Suomessa, unpublished report to Economic Council secretariat.

IPCC (1996): Climate Change 1995. The Science of Climate Change. Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press 1996. 572 pp.

Koopmans (1998): Effects of National, OECD-wide and World -wide Energy Taxes on Environment and on Competitiveness in Barker & Köhler (eds.): International Competitiveness and Environmental Policies, Edward Elgar.

Korhonen & Savolainen: Contribution of industrial and developing countries to the atmospheric CO_2 concentrations - Impact of the Kyoto Protocol. Environmental Science and Policy, Vol.2, 1999, Nos 4-5, pp. 381-388.

Koskela & Schöb (1999): Alleviating unemployment, European Economic Review (43)9, pp. 1723-1746

Koskela, Schöb & Sinn (1998): Pollution, Factor Taxation and Unemployment, International Tax and Public Finance, 5, pp. 379-396.

Kristensen (1996): Environmental Taxes, Tax Reform and the Internal Market – Some Danish Experiences and Possible Community Initiatives in Environmental Taxes and Charges: National Experiences and Plans, European Foundation for the Improvement of Living and Working Conditions, Dublin, and Office for Official Publications of the European Communities, Luxembourg.

Lucas, Wheeler & Hettige (1992): Economic Development, Environmental Regulation and the International Migration of Toxic Industrial Pollution 1960-88 in Low (ed.), International Trade and the Environment, World Bank Discussion Paper 159, Washington DC.

Metcalf (1998): A Distributional Analysis of an Environmental Tax Shift, NBER Working Paper 6546.

Ministry of Trade and Industry (1997): Energiatalous 2025 –Skenaariotarkasteluja, publications 7/1997.

Ministry of Trade and Industry (1999): Kioton mekanismit ja Suomi, Ministry of Trade and Industry working group and committee reports 4/1999.

Mortensen & Hauch (1999): Governmental Commissions on Green Taxes in Denmark in Bränlund & Gren (eds.): Green Taxes – Economic Theory and Empirical Evidence from Scandinavia, Edward Elgar.

Mäenpää (1998): Kansantalous, energia ja päästöt, Ympäristö 1998:1, Statistics Finland.

Nordic Council of Ministers (1999): The Use of Economic Instruments in Nordic Environmental Policy 1997 – 98, TemaNord 1999:524.

NOU(1996): Grönne skatter – en politikk for bedremiljö og höj sysselsetting, Statens forvaltningestjeneste, 1996:11, Statens trykning, Oslo.

OECD (1997): Environmental Taxes and Green Tax Reform, OECD Paris.

OECD (1998a): OECD Work on Climate Change: Economic Theory and Policy Implementation, OECD Paris.

OECD (1998b): Evaluating Economic Instruments for Environmental Policy, OECD Paris.

OECD (1999a): Economic Instruments for Pollution Control and Natural Resources Management in OECD Countries: A Survey, OECD Paris.

OECD (1999b): Taking Action Against Climate Change: The Kyoto Protocol, OECD Paris.

Oliveira-Martins, Burniaux & Martin (1992): Trade and Effectiveness of Unilateral CO_2 - abatement Policies: Evidence from Green, OECD Economic Studies 19.

OECD (1999c): Action Against Climate Change: The Kyoto Protocol and Beyond, OECD Paris.

Palmer, Oates & Portney (1995): Tightening Environmental Standards: the Benefit-Cost or the No-Cost Paradigm? Journal of Economic Perspectives, 9(4), Fall.

Porter (1990): The Competitive Advantage of Nations, The Free Press, New York.

Sinko (1999): Taxation, Employment and the Environment – General Equilibrium Analysis with Unionised Labour Markets, VATT Research Reports 54.

SOU (1997): Skatter, miljö och sysselsättning - Slutbetenkande av Skatteväxlingskommitten, Statens offentliga utredningar 1997:11, Finansdepartementet, Stockholm.

Symons, Proops & Gay (1994): Carbon Taxes, Consumer Demand and Carbon Dioxide Emissions: a Simulation Analysis for the UK, Fiscal Studies, Vol. 15, No. 2.

Tilastokeskus (1999): Energy statistics 1998.

Thompson (1998): International Competitiveness and Globalization: Frameworks for Analysis, Conections and Critiques in Barker & Köhler (eds): International Competitiveness and Environmental Policies, Edward Elgar.

Tossavainen (1998): Panosverot ja toimialoittainen työllisyys, VATT research 47.

Xepapadeas (1997): Advanced Principles in Environmental Policy, Edward Elgar, Cheltenham.

Ympäristöverotoimikunnan osamietintö (1993): Working group report I/1993, Ministry of Environment, Helsinki.

ANNEX 1: THE ECONOMIC IMPACT OF CARBON DIOXIDE-BASED TAXATION[1]

In the debate that followed the signing of the UN Convention on Climate Change, one early focus was the role of economic instruments in combating greenhouse gas emissions. The emphasis was on how to restrict emissions of carbon dioxide, the greenhouse gas with the greatest impact, with tax incentives. From the point of view of combating climate change, any tax incentives should have a direct impact on greenhouse gas emissions. As direct taxation of emissions is difficult, the tax is usually targeted at fuels and staggered in accordance with their carbon dioxide content. If such taxes are to have any cost-effective impact on global emissions, they should also be coordinated at a global level.

Finland introduced a carbon dioxide tax in the early 1990s, and was the first country to do so. It is staggered according to the carbon dioxide content of the fuel and levied as a supplementary tax of FIM 102 per tonne of CO_2, though the tax on peat and natural gas is lower. The supplementary tax on transport fuels is roughly one tenth and that on light heating oil two thirds of the excise tax while in the case of other fossil fuels, the excise tax is levied in the form of a supplementary tax. In 1999, total revenues from the supplementary tax came to about FIM 3.2 billion. In 1995 and 1996, the tax also applied to electricity production and was levied on electricity imports. This practice had to be discontinued, however, after the Court of Justice of the European Communities ruled that it was in violation of the EU's competition directives. The deregulation of the Nordic electricity market had also made the practice untenable and thus, fuels used for producing electricity are now tax-exempt. Many other European countries have since followed the Finnish example and introduced a carbon dioxide tax, though none has made any comprehensive use of it. Moreover, most countries have concluded that any unilateral levy of a comprehensive tax on CO_2 emissions is out of the question.

This Annex summarizes the calculations of the impact of the changes in Finnish energy taxation prepared by the Research Institute of the Finnish Economy for the Secretariat of the Economic Council. The Institute assessed the impact of the following two hypothetical energy tax alternatives: a) raising the taxes on different types of energy to the minimum level proposed by the EU Commission and b) raising the supplement to the fuel tax staggered according to CO_2 content to FIM 200 per tonne of carbon dioxide. An alternative in which the supplementary tax on electricity would be raised in the same proportion as the supplement to the fuel tax was also considered. EU-imposed restrictions may make these alternatives unrepresentative or even unfeasible, but they nevertheless enable comparisons to be made with calculations on similar environmentally-based taxes produced in other countries (e.g. NOU, 1996).

The study also looked at ways of channelling the increased revenues resulting from higher rates back to taxpayers so that the changes in energy taxation would not have any impact on the State budget. The following alternatives were examined: a) a rebate

[1] This Annex is based on calculations made by Juha Honkatukia.

through income transfer; b) a rebate through lower income taxes; and c) a rebate through lower employers' social security contributions.

The calculations were based on a numerical general equilibrium model developed by the Research Institute of the Finnish Economy, which is particularly well suited to assessing the impact that measures related to the energy sector have on the economy as a whole. The aim was to select model parameters that would exclude any unrealistic combinations of production factors. The parameters for export and import demand are taken from an extensive study of international trade and are also used by bodies such as the OECD. Consumption and labour supply are described using parameter estimates provided by the Government Institute for Economic Research which take better account of the conditions in Finland. It is also assumed that autonomous improvements in energy productivity are in line with the Government Institute for Economic Research estimates. However, the model does not take into account any adjustment costs involving capital and the workforce. Neither is any consideration given to the impact foreign ownership may have on Finnish industry, as the assumption is that all factor incomes remain in Finland.

Two alternative assumptions concerning the extent of the tax changes were examined: Finland raises the tax a) unilaterally or b) in co-ordination with its trading partners. In the case of the first scenario, Finnish companies would have to raise their export prices, which would make them less competitive on the international market. If, however, a large number of countries decided to introduce higher taxes, it is assumed that the ratio between the export prices charged by Finnish companies and those charged by their competitors would remain unchanged.

Table 1

Impact of a higher fuel tax supplement and a simultaneous increase in the supplement and the electricity tax (supplement+electricity) on the key economic variables in the cases of unilateral Finnish action and co-ordinated international action. Impact of higher tax revenue is neutralized by lowering household income accordingly. Figures are percentage changes relative to 2010 levels with no changes in taxation.

	Unilateral action		**International action**	
	Supplement	Supplement +electricity	Supplement	Supplement +electricity
Emissions	-3.9	-5.3	-3.0	-4.1
Exports	-1.0	-1.7	-0.3	-1.0
GDP	-0.2	-0.2	-0.2	-0.2
Employment	0.0	-0.1	0.4	0.7
Consumption	0.1	0.6	-1.0	-1.2

According to the calculations, raising the supplement to the fuel tax would result in a 4 per cent drop (almost three million tonnes) in carbon dioxide emissions by 2010, compared with a situation in which the tax remained unchanged. If other countries, too, decided to introduce similar tax increases, the reduction in emissions would be slightly lower (about 3 per cent). This is because should Finland take unilateral action, the rise in relative export prices would result in additional reductions since the forest and metal industries, the two open sectors with particularly energy-intensive production processes, would experience sharper falls in production and exports. Oil refining would also decrease considerably. In relative terms, these three sectors would also have to shoulder most of the burden imposed on the economy by the tax increase.

Both unilateral and international action would result in a drop of about 0.2 per cent in GDP, compared with a situation in which no tax increases are introduced. In both cases, a number of sectors would be particularly hard hit. The output of the energy-intensive oil refining and paper industry would go down sharply, while production in sectors with lower carbon dioxide emissions, such as the electrical and electronics industry, and services, would go up. However, the rise would be less than 1 per cent, and thus would not make up for the decline in energy-intensive sectors.

Table 2

Impact of a higher fuel tax supplement and a simultaneous increase in the supplement and the electricity tax (supplement+electricity) on the production of the different industries variables in the cases of unilateral Finnish action and co-ordinated international action. Impact of higher tax revenue is neutralized by lowering household income tax accordingly. Figures are percentage changes relative to 2010 levels with no changes in taxation.

	Unilateral action		**International action**	
	Supplement	Supplement +electricity	Supplement	Supplement +electricity
Oil refing	-7.9	-8.3	-3.3	-3.5
Production and distribution of electricity	-1.2	-5.3	-1.1	-5.1
Production of heat	-3.2	-3.6	-2.4	-2.8
Paper industry	-3.6	-6.4	-1.3	-2.2
Heavy metals industry	-1.7	-0.5	0.9	1.2
Electrical and electronics industry	0.9	0.9	0.4	0.7
Transportation	-1.3	-1.3	-0.7	-0.5
Private services	0.4	0.6	0.3	0.1

Unilateral action would have a fairly limited impact on employment and consumption, as the increased revenue would enable the government to lower income taxes. In fact, employment levels are unlikely to change at all. However, should concerted international tax increases be introduced, employment levels would go up by about half a per cent. Real wages would drop in all scenarios.

The second alternative, granting employers a rebate by channelling the increases into tax revenue to lower social security contributions, was also examined. Calculating the effect of this option also makes it possible to assess the impact of the tax change on the net tax burden of the different sectors of the economy. Table 3 shows the net change in taxes paid by some of the most important economic sectors in two alternative situations: a) the supplement to the fuel tax is raised, or b) both the supplementary and electricity taxes go up. In both cases, employers' social security contributions are reduced so as to keep government tax revenues unchanged. The paper industry and transportation would be net contributors. Should the electricity tax also go up, the metal industry, too, would lose out. The calculations also indicate that lowering social security contributions would have a more negative impact on consumers and GDP than lower income taxes.

Table 3

Impact of a higher fuel tax supplement and a simultaneous increase in the supplement and the electricity tax (supplementary+electricity) on the taxes paid by different industries. Only the effect of unilateral Finnish action is considered. Impact of higher tax revenues is neutralized by lowering employers' social security contributions. Figures are percentage changes relative to 2010 levels with no changes in taxation.

	Change in tax revenue, %	
	Supplement	Supplement+electricity tax
Paper industry	7.3	32.9
Heavy metals industry	-0.4	14.2
Electrical and electronics industry	-3.3	-5.3
Transportation	3.3	1.0
Private service	-2.7	-3.4

The impact of the environmental tax directive being drafted by the EU Commission was also examined. According to the latest proposal, the minimum taxes on fuels in 2002 would be lower than those now levied in Finland, except for the tax on diesel oil. Thus, Finland would only have to increase its diesel tax unless it decided to introduce changes in taxation at the national level. Pilot calculations indicate that increasing the diesel tax to the minimum level proposed by the Commission would not have any major impact on the economy as a whole. Transportation would be the most severely affected sector and would decline as a result. A higher tax on diesel oil would also increase the costs of goods transportation, and thus impose a heavier tax burden on trade and industry.

The calculations indicate that, if implemented as part of the existing tax system, an increase in the carbon dioxide tax would only have a minor impact on CO_2 emissions. According to the targets laid down in the Kyoto Protocol, Finland should cut its emissions by approximately 25 per cent on 1990 levels, the reference year, but with our present production structure, doubling the supplement to the fuel tax would cut emissions by only 4 per cent. Even if the electricity tax supplement were raised by the same amount, the drop would still be only 5 per cent. Earlier pilot calculations indicated that a higher rise in carbon dioxide tax would be accompanied by major cost increases.

If the carbon dioxide tax were raised, the economy level impact would be felt in the form of somewhat lower GDP. The most serious negative effect on the sectoral level would be a decline in exports and production in energy-intensive industries, especially if Finland decided to raise its taxes unilaterally. Such a change in the country's production structure could also involve major adjustment costs, which were not included in these calculations. Higher tax revenues would enable the government to lower income taxes or social security contributions, which would alleviate at least some of the impact of the higher tax rates. However, the GDP would nevertheless drop.

ANNEX 2: THE IMPACT OF ENVIRONMENTAL AND ENERGY TAXATION ON INCOME DISTRIBUTION[1]

These calculations concern the impact of raising the tax based on a product's CO_2 content. Such a tax would be similar to the existing supplementary tax based on a fuel's carbon dioxide content. However, the exemptions and reliefs incorporated into the present system have not been taken into account[2]. It is assumed that the additional tax on a tonne of carbon dioxide would be FIM 200, compared with the present FIM 102. This would push e.g. petrol prices up by approximately FIM 0.25 per litre.

The calculations are based on Mäenpää's estimates (1998) on the amount of carbon dioxide embedded in households consumpition (Figure 1) and on household consumption data in 1994-1996. The higher supplementary tax on carbon dioxide was then targeted at emissions originating from households. According to the calculations, keeping the taxes at their present level would bring in FIM 3.3 billion, which is roughly the same amount as is now collected as the supplement to the fuel tax[3]. Should the tax be raised to the level of FIM 200 per tonne of carbon dioxide, revenues would roughly double.

The impact of the tax and changes in it on income distribution were estimated by proportioning the change in tax revenue calculated above to the disposable income of different household categories. Disposable income includes earned income, capital income and income transfers received, from which income transfers paid are deducted. Of particular interest is the percentage of income different households would have to spend on a higher carbon dioxide tax. The impact of the tax on households with a different socioeconomic status and domicile is also examined.

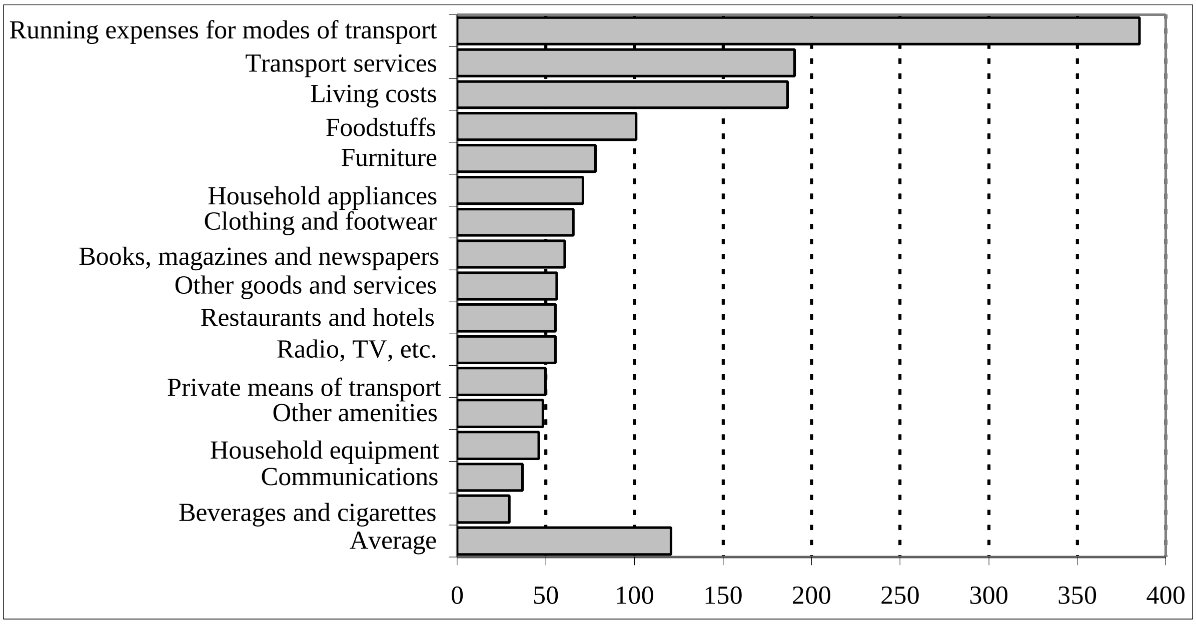
---

[1] The information in this Annex is based on calculations made by Esko Mustonen.

[2] Insofar as the tax reliefs are not systematically directed at specific household categories, they would not change the income distribution impact of the taxes between households, which the calculation primarily aims to assess.

[3] In 1999, estimated revenues from the supplementary tax based on carbon dioxide content was FIM 3.2 billion.

Figure 1 The amount of carbon dioxide embedded in household consumption categories in 1993, CO_2 tonnes/FIM million



Source: Statistics Finland.

Firstly, it is assumed that consumers would have to shoulder the impact of the tax in full[4]. Secondly, the demand structure is expected to remain unchanged even though the relative prices of different commodities would change. Thus, the calculations mainly refer to the immediate consequences of the tax change. However, as relative prices change, there will also be gradual changes in the consumption structure. As stated before, these assumptions do not necessarily have any major impact on the picture we have of the relative status of different households.

Table 1 shows the increase in expenditure in each income category resulting from tax rises, in proportion to disposable income[5]. In relative terms, the tax rise would put the heaviest burden on low-income households. If the tax went up, the lowest income category would have to increase its expenditure by about 2 per cent, in relation to disposable income. In higher income groups, the rise in expenditure would be only about 1 per cent of disposable income. These results are explained by the fact that low-income households spend a larger proportion of their income on commodities containing carbon dioxide, especially energy products.

---

[4] The accuracy of this assumption depends on the flexibility of demand and supply. Roughly speaking, the more essential the commodity, the less adjustable the price and the larger the percentage of the tax transferred to the price.

[5] The income categories are based on an equivalent scale used by the OECD, which takes the size of the household into account. The scale weighs household members as follows: 1.0 for the first adult, 0.7 for other adults and 0.5 for children under 13.

Table 1

Increase in expenditure by households resulting from a rise in tax based on CO_2 content, by income category. Presumptive tax increase FIM 100 per tonne of carbon dioxide. Calculations based on the consumption structure in 1994-1996. Income category 1 is the lowest decile of disposable income.

Income category	Increase in expenditure, %
1	1.96
2	1.27
3	1.18
4	1.17
5	1.17
6	1.10
7	1.09
8	1.05
9	1.01
10	0.91
Average	1.19

The impact of the tax on income distribution by province is examined in Table 2. The table shows that the burden is above average in the Province of Lapland, while in Åland it is lower than average. However, regional differences are fairly small and are probably explained at least partly by income differences between regions. Another reason for the low tax burden in Åland might be the fact that consumption of transport fuels is lower there than in the rest of Finland.

Table 2

Increase in expenditure resulting from a rise in the tax based on CO_2 content, as percentage of disposable income and by domicile of the household.

Province of Lapland	1.28
Province of Western Finland	1.21
Province of Eastern Finland	1.20
Province of Oulu	1.19
Province of Southern Finland	1.16
Åland	1.08
Average	1.19

The impact of the tax on income distribution, according to the socioeconomic status of the head of the household, is examined in Table 3. It shows that, in relative terms, a tax increase would put the heaviest burden on students and the unemployed, while the impact on pensioners and senior officials would be slightly below average. It seems that most of the differences in the relative tax burden are explained by income differences. However, pensioners probably have a light tax burden because they spend a relatively low proportion of their income on energy.

Table 3

Increase in expenditure resulting from a rise in a tax based on CO_2 content as a percentage of disposable income, according to the socioeconomic status of the head of the household.

Students	1.94
Long-term unemployed	1.47
Working at home	1.36
Other entrepreneurs	1.36
Farmers	1.18
Officials	1.17
Employees	1.17
Senior officials	1.07
Pensioners	1.06
Others	1.46
Average	1.19

The impact of the tax based on CO_2 content on income distribution according to the composition of the household is examined in Table 4. Children and the number of adults per dwelling are probably the two determining factors. It also seems that, in relative terms, a tax rise would put the heaviest burden on single parents. Families with two parents would also have to pay more than households with only two members.

Table 4

Increase in expenditure resulting from a rise in the tax based on CO_2 content as percentage of disposable income, according to the composition of the household.

Single parents	1.59
Those living alone	1.24
Families with children	1.14
Others	1.10
Average	1.19

For comparison, the impact of the present tax on transport fuels on different household categories was also calculated using the same method. The petrol and diesel tax were directly targeted at the same items in the 1994-1996 household survey as the higher CO_2 tax. The results are roughly similar to the above-mentioned calculations concerning the tax based on carbon dioxide content. The tax on transport fuels is, however, slightly more regressive in proportion to disposable income. It also burdens Finnish regions more unevenly so that the gap between Åland and Lapland is wider than that in the case of a higher CO_2 tax. On the other hand, the fuel tax puts a lighter burden on pensioners and those living alone than a rise in carbon dioxide tax.

Prime Minister's Office
Snellmaninkatu 1
FIN-00170 HELSINKI
FINLAND

http://www.vn.fi
ISBN: 952-5354-02-4
ISSN: 0783-1609