ENVIRONMENTAL TAX REFORM:
THE EUROPEAN EXPERIENCE

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CENTER FOR A SUSTAINABLE ECONOMY

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EXECUTIVE SUMMARY

This paper surveys the experience of environmental tax reform (ETR) in Europe. When the revenue from taxes on pollution or natural resource depletion is used to lower taxes on valuable economic activities, such as employment or investment, we refer to this as "environmental tax reform" (ETR). We describe in detail the reforms enacted in the eight nations to adopt such reforms (Denmark, Finland, Germany, Italy, the Netherlands, Norway, Sweden, and the United Kingdom) and other nations that have announced that they will adopt such reforms or have adopted elements of such reforms (Austria and Belgium).

Several observations can be made about the ETR packages that have been adopted in the eight European countries that have carried out some form of explicit ETR. (See table at end of Executive Summary.)
(1) Explicit ETR is a recent political phenomenon: all ETRs enacted have occurred in the past decade.
(2) The Nordic countries were the pioneers of the movement, but larger economies in western and southern Europe have since followed suit.
(3) ETR packages have tended to reduce the tax burden placed on labor, primarily by cutting non-wage labor costs in the form of social security contributions paid by employers.
(4) ETR packages have tended to focus on the energy sector as the locus of new or higher green taxes. This is mainly owed to the need for curbing the risk of global climate change induced by greenhouse gases emitted upon combustion of fossil fuels, as well as the revenue potential of energy taxes compared to other green taxes.
(5) The financial magnitude of ETR packages varies from small in Italy and the United Kingdom to significant in Denmark. The magnitude shown for these ETRs, however, underestimates the importance of environmental taxes in Europe. European countries have enacted many environmental taxes that do not fall within the definition of explicit environmental tax reform because the revenues from those taxes are not recycled to the economy through reductions in other taxes. If these are included, the magnitude of environmental taxes as a percentage of total tax revenues or of GDP is actually quite substantial. For instance, in the Netherlands, the revenue from all green taxes together constituted over 9% of total tax revenues in 1997, but the revenue of only a few of those taxes—0.5% of total tax revenues--is explicitly recycled through the reduction of taxes on labor or capital.[1]

In addition to describing the reforms, the paper comprehensively surveys the literature assessing the economic impact of such reforms. Based on 44 studies containing 104 distinct simulations of environmental tax reform, we found when the revenues of environmental taxes are used to reduce other distorting taxes, the economic outcome is better than if those revenues are not so distributed, in terms of impacts on both employment and GDP.

Seventy-eight percent of the simulations predict that ETR will create employment. The best results in terms of employment are obtained when recycling occurs through cuts in social

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[1] European Environment Agency (EEA), 2000. Environmental Taxes: Recent Developments. EEA, Copenhagen. http://org.eea.eu.int/documents/presentation_en.pdf

security contributions, with 86% showing positive employment results, as opposed to, *e.g.*, 35% positive results for income tax cuts.

One hundred and four simulations return quantified results of the impact of ETR on gross domestic product (GDP). These range between +2.5% and – 5%. (See figure below, based on 100 simulations excluding one negative and two positive outliers.) Almost three-quarters of the simulations predict an impact of +0.5% to – 0.5 of GDP, *i.e.*, a change of less than 0.5% of GDP by the end of the period modeled, relative to the reference scenario. Thus it appears that the impact of ETR on GDP, whether negative or positive, is likely to be small.

Predicted Impact of ETR on GDP

Over two-thirds of the simulations returning a positive impact on output assume recycling through cuts in employers' social security contributions. In our sample of simulation results, 35% of the ETR simulations based on cuts in payroll taxes (social security contributions) resulted in net GDP losses, while 65% showed net gains or no net impact. This contrasts with simulations returning eco-tax revenue through personal income tax cuts, where 75% of the simulations showed net GDP losses. Value-added tax cuts and lump-sum transfers of the revenue to households showed intermediate results.

Virtually all nations that have adopted ETR have also adopted measures to promote new clean energy technologies at the same time. Austria, Denmark, Germany, the Netherlands, Norway, and Sweden explicitly included tax incentives for efficiency technologies in their ETR packages, and other nations have included exemptions from their carbon or energy taxes for efficient technologies such as district heating or super-efficient electrical plants. Studies on the impact of hybrid packages including both ETR and tax or non-tax measures to promote efficiency technologies -- from Austria, Denmark, and the U.K., and a multinational study using the Hermes model -- all found that the net economic effect of such packages was both positive and preferable to ETR alone. An older Belgian study, also using the Hermes model, found that using 30% of the revenue to fund energy efficiency slightly reduced the GDP gain but greatly increased the emissions savings. Our survey suggests that policy packages that include the use of a portion of the environmental tax revenues to finance energy efficiency or renewable energy improvements are more likely to result in positive employment and GDP impacts. The study also surveys results on sectoral and income distribution impacts, and a variety of implementation issues.

Synopsis of Explicit ETR Packages

Country	Taxes cut or items funded	Taxes raised on	Magnitude
Sweden (1990)	• PIT • Energy taxes on agriculture [2] • Continuous education	• CO_2 • SO_2 • Various	2.4% of total tax revenue
Denmark (1994)	• PIT • SSC	• Various (gasoline, electricity, water, waste, cars) • CO_2 • SO_2 • Capital gains	Around 3% of GDP by 2002, or over 6% of total tax revenue
Netherlands (1996)	• CPT • PIT • SSC	• CO_2	0.3% of GDP in 1996, or around 0.5% of total tax revenue
United Kingdom (1996)	• SSC	• Landfill	Around 0.1% of total tax revenues in 1999
Finland (1997)	• PIT • SSC	• CO_2 • Landfill • Corporate profits	0.3% of GDP as of March 1999, or around 0.5% of total tax revenue
Norway (1999)	• PIT	• CO_2 • SO_2 • Diesel oil	0.2% of total tax revenue in 1999
Germany (1999)	• SSC • Renewable energy	• Petroleum products	Around 1% of total tax revenue in 1999
Italy (1999)	• SSC	• Petroleum products	Less than 0.1% of total tax revenue in 1999

Sources of the data for financial magnitude of the tax shifts:

OECD, *Revenue Statistics 1965-1997* (Paris: OECD, 1998), and Denmark: Mr. Jens Holger Helbo Hansen, Danish Ministry of Taxation, communication with author, February 9, 1999; Finland: Mr. Timo Parkkinen, Finnish Ministry of the Environment, communication with author, February 15, 1999; Germany: Mr. Kai Schlegelmilch, German Ministry for the Environment, Nature Conservation and Nuclear Safety, communication with author, February 25, 1999; Italy: "Carbon Tax Boosts Italian Fossil Fuel Prices" *ENDS Daily* (London: January 19, 1999); Netherlands: Mr. Jacob van der Vaart, Dutch Ministry of Finance, communication with author, February 15, 1999; Vermeend, Willem, and Jacob van der Vaart, *Greening Taxes: the Dutch Model* (Deventer, Netherlands: Kluwer, 1998), p.27; Norway: a representative from the Royal Norwegian Ministry of Finance and Customs; Sweden: Ms. Åsa Johannesson, Swedish Ministry of Finance; Swedish Green Tax Commission, *Taxation, Environment, and Employment* (Stockholm: Fritzes, 1997), p.8; United Kingdom: Dominic Hogg, ECOTEC Research and Consulting, London, communication with author, March 15, 1999.

Abbreviations: CPT=Corporate profit tax; GDP=Gross domestic product; PIT=Personal income tax; SSC=Social security contributions; CO_2=Carbon dioxide; SO_2=Sulphur dioxide.

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[2] Sweden's year 2000 step towards ETR raised several energy taxes on industry and recycled the funds to reduce energy taxes on agriculture and finance continuous education of the workforce.

1   INTRODUCTION

Over the last decade, the advanced economies of the West have increasingly turned toward market-based approaches to environmental control.[3] These new approaches allow private individuals or companies greater flexibility in deciding where, when, how or to what extent to cut pollution emissions, thereby reducing the cost to the economy and increasing personal freedom. These approaches range from regulatory "bubbles," which set the aggregate emissions allowed from large manufacturing facilities rather than setting emissions on a source-by-source basis within the facility, through various state and regional trading and incentive systems, all the way up to national pollution, energy and natural resource taxes or tradable permit systems. If properly designed,[4] such national market-based systems allow reductions of total national pollution emissions with greater flexibility and with lower cost than with less flexible and comprehensive approaches. National systems are most likely to be workable for pollutants that are widely disseminated through the atmosphere and do not have strongly localized effects, such as greenhouse gases or chemicals that deplete stratospheric ozone.

In addition to achieving emission reductions at lower cost and with greater flexibility, pollution taxes and auctioned permit systems have been justified on the basis of the "polluter pays" principle. This principle has been formally adopted by all OECD nations including the United States.[5] It states that polluting households and firms should pay for the damage that their emissions cause to others (sometimes called "external costs" or "externalities") as part of the cost of production. It has been well known since 1920 when A.C. Pigou first published *The Economics of Welfare*[6] that externalities cause economic inefficiency. Charging the full social cost of pollution gives firms and individuals the incentive to pollute less when the cost of pollution abatement is less than the social cost of pollution.

One way of internalizing external costs is through environmental taxes. Such taxes cause polluters or resource users to pay for the environmental resources they use, just as they pay for capital and labor. When firms pay the cost of pollution or resource depletion, normal profit-seeking motives will encourage them to adjust their behavior so as to avoid paying the tax. Either they will scale back the production of pollution-intensive goods, or they will adopt methods that ameliorate the environmental harm or prevent it altogether.

With rare exceptions, taxes discourage the taxed activity. Therefore it makes sense that at least part of the revenue for essential public purposes should be raised from socially undesirable activities that we wish to discourage, such as pollution and natural resource consumption. When

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[3] Organization for Economic Cooperation and Development (OECD), *Economic Instruments for Pollution Control and Natural Resources Management in OECD Countries: a Survey* (Paris: OECD, 1999); European Environment Agency, *Environmental Taxes: Implementation and Environmental Effectiveness* (Copenhagen: Office for Official Publications of the European Communities, 1996).

[4] A good design might include policies to adjust for local or regional effects, if necessary, ancillary policies to promote fundamental research on clean technologies and eliminate barriers to their adoption, policies to deal with distributional and competitiveness issues, and the like.

[5] Organization for Economic Cooperation and Development (OECD), *Recommendation of the Council on Implementation of the Polluter-Pays Principle, Recommendation C(74)223,* adopted Nov. 14, 1974, reprinted in 14 ILM 234 (1975); see also Sanford E. Gaines, "The Polluter-Pays Principle: From Economic Equity to Environmental Ethos," *Texas International Law Journal* 26 (1991): 463-96, 476.

[6] A.C. Pigou, *The Economics of Welfare* (London: Macmillan, 1960).

the revenue from environmental taxes is used to lower taxes on socially valuable economic activities that we wish to encourage, such as employment or investment, we will refer to this as environmental tax reform (ETR). ETR is typically designed to be revenue-neutral, *i.e.*, all the revenue from the environmental tax is returned to the economy through cuts in other taxes. However, this need not be the case. Depending on the fiscal needs of a nation, ETR can be designed to cut or raise the total tax burden.

The most significant environmental taxes in revenue terms are the broad-based taxes on energy and fossil fuels. Many environmental problems, including the bulk of local air pollution, are associated with the consumption of fossil fuels. Burning fossil fuels also releases carbon dioxide (CO_2), the most important of the greenhouse gases that cause global climate change.

ETR can provide two benefits: the *environmental* benefit from charging the full cost of environmental resources, and the *economic* benefit from the reduction in other taxes.[7] ETR is thus said to offer the possibility of a "double dividend:" it would help not only the environment but also the economy. This double dividend hypothesis has been the subject of intense academic and political debate in recent years. Goulder distinguishes three forms of the double dividend hypothesis: weak, intermediate, and strong.[8] The weak double dividend hypothesis states that revenue recycling through cuts in distortionary taxes is welfare-improving relative to recycling through lump-sum payments that do not reduce distortion. In this form, the double-dividend hypothesis is uncontroversially true. The intermediate form states that one can identify one or more distortionary taxes such that a revenue-neutral substitution of an environmental tax for this tax involves zero or negative gross welfare cost. ("Gross" means that the welfare value of the environmental benefit is not included in the welfare cost calculation.) The strong form says that substitution of an environmental tax for a typical or representative distorting tax will necessarily improve gross welfare. Environmentalists, following Weizsäcker and Jesinghaus, originally claimed the strong double dividend hypothesis, but subsequent economic research contested it.

In addition to the ongoing theoretical debate about the double dividend, there is a growing body of practical experience and empirical modeling of ETR proposals enacted or planned in Europe. This paper will survey the European experience with explicit ETR to date, both actual ETR initiatives that have been announced or enacted, and economic models of such initiatives. Its primary focus will be ETR packages increasing taxes on energy or fossil fuels and decreasing other taxes. These have been the main ETR initiatives studied and passed to date. The case of the British ETR-*cum*-landfill tax, and elements of ETR in other countries, will also be discussed. Our attention will focus on the intermediate form of the double dividend, in roughly Goulder's sense, *i.e.*, we will be asking if there are ETR proposals that offer economic benefits even when the environmental benefit is ignored. However, we will not be looking primarily at monetized

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[7] Carlo Carraro, and Domenico Siniscalco, eds., *Environmental Fiscal Reform and Unemployment* (Dordrecht, Netherlands: Kluwer Academic Publishers, 1996); Lawrence H. Goulder, "Environmental Taxation and the Double Dividend: A Reader's Guide," *International Tax and Public Finance* 2, no. 2 (1995): 157-83; M. Jeff Hamond, et al., *Tax Waste, Not Work: How Changing What We Tax Can Lead to a Stronger Economy and a Cleaner Environment* (San Francisco: Redefining Progress, 1997); Organization for Economic Cooperation and Development (OECD), *Environmental Taxes and Green Tax Reform* (Paris: OECD, 1997); Ernst U. Von Weizsäcker and Jochen Jesinghaus, *Ecological Tax Reform* (London: Zed Books, 1992).

[8] CGE models generally attempt to test the "strong double dividend" hypothesis, which posits that "the revenue-neutral substitution of the environmental tax for *typical* or *representative* distortionary taxes [on labor and capital] involves a zero or a negative gross cost." See Lawrence H. Goulder, "Environmental Taxation and the Double Dividend: A Reader's Guide," *International Tax and Public Finance* 2, no. 2 (1995): 159.

welfare changes, but rather at a range of macroeconomic indicators, most notably GDP growth, employment, and price effects, which are more concrete and measurable concepts. We will also examine more briefly the evidence on environmental effectiveness and social and sectoral impact.

The present study is mainly justified by the realization that in its intermediate or strong form the "double dividend" controversy cannot be solved by simplified theoretical models alone. Much of the existing theoretical literature about ETR is based on simplified policy packages which are not consonant with the actual ETRs undertaken by European countries. The goal of this study is to catch up with the reality of ETR on the ground. Tax reform takes place in a complex policy environment with many macroeconomic structural rigidities, pre-existing market distortions, and a complex and idiosyncratic tax system already in place in every nation. Thus it is desirable to consult the full range of empirical CGE and macroeconomic models in assessing the impact of such a reform. Whether ETR achieves environmental and economic dividends in this complex policy context is an empirical matter that should be the topic of empirical research with the full range of tools of the economics profession. It is precisely this type of research that this study endeavors to review. This study complements prior work by providing an extensive description of the "real-world" experience of ETR, together with the evidence of a large number of simulation studies conducted in preparation for actual ETR but so far not widely distributed.

The literature contains several prior reviews that pursued the same goal, including those by the European Commission, Goulder, Mors, INFRAS and ECOPLAN, Majocchi, the European Environmental Agency, the OECD, and Baranzini, Glodemberg and Speck.[9] There is also an excellent database on environmental taxation that has been assembled by the OECD.[10] The present study will build on, complement and in some cases update these prior reviews so as to characterize, as closely as possible, the state of the knowledge on the question at hand. Our review is unique in combining detailed descriptions of the enacted reforms, the most comprehensive compilation of European modeling results done to date, and tabulations of GDP and employment impacts by choice of tax policy instrument, modeling approach, and various other factors. We focus primarily on ETR studies that include revenue recycling.

The sections are ordered as follows: section 3 describes the various explicit ETR packages that have taken place so far, section 4 discusses two examples of important initiatives that contain

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[9] European Commission, *The Economics of Limiting CO₂ Emissions*, Special Edition no.1 (Brussels: European Commission, Directorate-General II, 1992); Lawrence H. Goulder, "Environmental Taxation and the Double Dividend: A Reader's Guide," *International Tax and Public Finance* 2, no. 2 (1995): 17; Matthias Mors, "Employment, Revenues and Resource Taxes: Genuine Link or Spurious Coalition?" *International Journal of Environment and Pollution* 5, nos.2-3 (1995): 118-34; INFRAS and ECOPLAN, *Economic Impact Analysis of Ecotax Proposals: Comparative Analysis of Modeling Results* (Brussels: European Commission, Directorate-General XII, November 1996); European Environment Agency (EEA), *Environmental Taxes: Implementation and Environmental Effectiveness*, EEA (Copenhagen, 1996); Alberto Majocchi, "Green Fiscal Reform and Employment: A Survey," *Environmental and Resource Economics* no. 8 (1996): 375-97; OECD, *Environmental Taxes and Green Tax Reform*, OECD (Paris: 1997); OECD, *Evaluating Economic Instruments for Environmental Policy*, OECD, (Paris: 1997); OECD, *Economic Instruments for Pollution Control and Natural Resources Management in OECD Countries: A Survey*, OECD, (Paris: 1999); A. Baranzini, J. Goldemberg, and S. Speck, "A Future for Carbon Taxes," *Ecological Economics, 32, 3* (2000): 395-412, on the web at http://www.elsevier.nl/cas/tree/store/ecolec/sub/2000/32/3/1013.pdf.; European Commission, *Database on Environmental Taxes in the European Union Member States, Plus Norway and Switzerland: Evaluation of Environmental Effects of Environmental Taxes*, 2000, on the web at http://europa.eu.int/comm/environment/enveco/env_database/database.htm

[10] OECD, Nils-Axel Braathen, ed., *Database on Environmentally Related Taxation* (1997). http://www.oecd.org/env/policies/taxes/index.htm. This database is still being maintained and updated.

elements of ETR without fully fitting our definition, section 5 summarizes and categorizes the initiatives of sections 3 and 4, section 6 reviews the empirical evidence on economic and environmental impact of ETR on a country-by-country basis, section 7 summarizes the results of section 6 and outlines some policy lessons, and section 8 concludes. The appendix provides tables of the abbreviations used, unit conversions, and currency conversions.

2   COUNTRIES HAVING IMPLEMENTED EXPLICIT ETR PACKAGES

So far eight countries have carried out some form of explicit ETR. They are: Denmark, Finland, Germany, Italy, the Netherlands, Norway, Sweden and the United Kingdom. Table 2.1 indicates the time at which reforms became effective, the tax increased and the tax reduced, as well as an order of financial magnitude for each of these ETR packages.

Table 2.1-a synopsis of these packages-conveys several messages. First, explicit ETR is a recent political phenomenon: all ETRs enacted have occurred in the past decade. Second, the Nordic countries were the pioneers of the movement, but larger economies in western and southern Europe have since followed suit. Third, ETR packages have tended to reduce the tax burden placed on labor, primarily by cutting non-wage labor costs in the form of social security contributions paid by employers. Fourth, ETR packages have tended to focus on the energy sector as the locus of new or higher green taxes. This is mainly owed to the need for curbing the risk of global climate change induced by greenhouse gases emitted upon combustion of fossil fuels, as well as the revenue potential of energy taxes compared to other green taxes. Fifth, the financial magnitude of ETR packages varies from small in Italy and the United Kingdom to significant in Denmark.

It is worth noting that the magnitude shown for these ETRs underestimates the importance of environmental taxes in general tax revenues or as a percentage of GDP. For instance, in the Netherlands, all green taxes together raised over 9% of total tax revenues in 1997, but the revenue of only a few environmental taxes is explicitly recycled through the reduction of taxes on labor and capital.[11]

Table 2.3 contains background information on energy in the various countries that adopted an explicit ETR and other reference countries. The following points deserve mentioning. First, it appears that the countries with an explicit ETR have average energy efficiency by European standards. Second, taken together, these countries represent around 9% of world emissions of carbon.

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[11] European Environment Agency (EEA), 2000. Environmental Taxes: Recent Developments. EEA, Copenhagen. http://org.eea.eu.int/documents/presentation_en.pdf

Table 2.1: Synopsis of Explicit ETR Packages

Country	Taxes cut or items funded	Taxes raised on	Magnitude
Sweden (1990)	• PIT • Energy taxes on agriculture [12] • Continuous education	• CO_2 • SO_2 • Various	2.4% of total tax revenue
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Abbreviations: CPT=Corporate profit tax; GDP=Gross domestic product; PIT=Personal income tax; SSC=Social security contributions; CO_2=Carbon dioxide; SO_2=Sulphur dioxide.

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[12] Sweden's year 2000 step towards ETR raised several energy taxes on industry and recycled the funds to reduce energy taxes on agriculture and finance continuous education of the workforce.

Table 2.2: Energy Efficiency, CO$_2$ Emissions, Greenhouse Gas (GHG) Emissions, and Kyoto Targets

(countries with explicit environmental tax reform are in bold)

	Energy intensity: Energy supply/ GDP [a]	Energy intensity: Energy supply/ population [b]	CO$_2$ emissions per capita (MtC per capita) 1996 [c]	National CO$_2$ emissions relative to world emissions 1996	GHG Emissions (Mt CO$_2$e) 2010 [d]	GHG Emissions (Mt CO$_2$e) 1990 [d]	GHG Emissions (Mt CO$_2$e) Kyoto target [d]	Difference in emissions needed to meet Kyoto target [d]
Austria	0.15	3.37	2.00	0.25%	80.93	77.81	67.70	-13.0%
Belgium	0.27	5.55	2.85	0.44%	n.a.	138.94	128.52	-7.5%
Denmark	**0.16**	**4.35**	**2.95**	**0.24%**	**60.94**	**71.66**	**56.61**	**-21.0%**
Finland	**0.23**	**6.14**	**3.15**	**0.25%**	**76.30**	**64.65**	**64.65**	**0.0%**
Germany	**0.19**	**4.27**	**2.87**	**3.61%**	**1,248.00**	**1,207.00**	**954.00**	**-21.0%**
Italy	**0.14**	**2.80**	**1.92**	**1.69%**	*475.59*	*532.92*	*498.28*	*-6.5%*
Japan	0.15	4.05	2.54	4.89%	1,424.81	1,190.25	1,118.84	-6.0%
Netherlands	**0.23**	**4.88**	**2.72**	**0.65%**	*269.64*	*215.36*	*202.43*	*-6.0%*
Norway	**0.16**	**5.28**	**4.20**	**0.28%**	*68.00*	*55.00*	*56.00*	*1.8%*
Russia	4.17	1.80	2.91	6.61%	2,911.80	3,040.33	3,040.33	0.0%
Sweden	**0.22**	**5.91**	**1.68**	**0.23%**	**73.74**	**65.10**	**67.71**	**4.0%**
United Kingdom	**0.22**	**3.99**	**2.59**	**2.33%**	**695.63**	**713.88**	**624.64**	**-12.5%**
United States	0.34	8.04	5.37	22.20%	*7,134.04*	*5,801.40*	*5,395.30*	*-7.0%*
World	n.a.	n.a.	1.13	n.a.	n.a.	n.a.	n.a.	n.a.

a) Total primary energy supply per GDP (toe per thousand U.S. dollar).
b) Total primary energy supply per capita (toe per capita).
c) MtC = megaton (1 million tons) of carbon.
d) Predicted emissions of GHG between 2008 and 2012, to conform with the Kyoto target. GHGs including 3 gases (CO$_2$, CH$_4$ and N$_2$O). Numbers in italics are for 6 GHG (CO$_2$, CH$_4$, N$_2$O, SF$_6$, HFCs and PFCs); Mt CO$_2$e = megaton (1 million tons) of CO$_2$ equivalent.
   n.a. = not applicable

Sources: Carbon Dioxide Information Analysis Center (CDIAC), *Global, Regional and National CO$_2$ Emissions from Fossil-Fuel Burning, Cement Manufacture, and Gas Flaring: 1751-1996* (Oak Ridge, TE: Oak Ridge National Laboratory January 15, 1999) on the web at http://cdiac.esd.ornl.gov/ftp/ndp030/nation96.ems; International Energy Agency (IEA), *Statistics: Selected Statistics, Key Indicators per Country*, (Paris: IEA, 1998) on the web at http://www.iea.org/stat.htm; United Nations Environment Programme (UNEP) - Global Resource Information Database (GRID), *Greenhouse Gas Emissions: Graphics* (Arendal, Norway: UNEP-GRID, November 1998) on the web at http://www.grida.no/infop/collection/climatechange.

2.1 Denmark

Denmark has a long history of energy taxation. Before the "Energy Package" of the early 1990s the system promoted energy efficiency in households and provided incentives for combined heat and power (CHP) systems. However, the motive for energy taxes was still largely fiscal. The "Energy Package" established the principles that environmental quality should improve, including through the introduction of taxes, voluntary agreements, and subsidies; a green tax shift should ease social security contributions; and the international competitiveness of Danish enterprises should be preserved via exemptions for energy-intensive enterprises.[13]

The Danish system of energy taxation today consists of three instruments: (1) an energy tax on oil, coal, gas and electricity; (2) a CO_2 tax; and (3) an SO_2 tax. First, the energy tax rate is increasing stepwise from DKK 41/GJ in 1998 to DKK 51/GJ in 2002, with variations among the tax rates on the various fuels gradually decreasing. Some uses of energy are exempted from energy taxes, including fuels used for the production of electricity, energy for air and sea transport, energy for mass transport, and energy used for oil extraction in the North Sea. VAT-registered companies using energy for commercial purposes benefit from a full energy tax refund, which occurs at the same time as the refund of value added tax payments upon proof of original payment of the tax, except for gasoline and diesel, road transportation, and space heating. Refunds were justified by the need to maintain the industrial and commercial sectors' competitive advantage, but also meant that households and companies not VAT-registered (financial sector, private health care, public sector) would shoulder the bulk of taxes.[14]

The Danish ETR model is multifaceted, based as it is on a wide array of green taxes, including energy taxes, and on independent revenue recycling schemes. It is also characterized by a long phase-in period.

Second, the CO_2 tax has evolved since it was introduced in 1992. At that time it was set at DKK 100 per metric ton of CO_2, effective May 15, 1992 for households and January 1, 1993 for the industrial and commercial sectors. It covered all fuels on which there was an energy tax, apart from gasoline. The exemptions correspond to the exemptions to the energy tax mentioned above. The tax rate of DKK 100 was based not on the marginal cost of emissions, but reflected a variety of political and economic considerations. The CO_2 tax replaced a portion of existing energy taxes: at the same time as the CO_2 tax was introduced, the energy tax on heavy and light fuel oil was reduced, so that the overall tax burden on these fuels remained unchanged. This increased the tax on household use of coal and electricity and on business use of oil, coal, gas and electricity. In this way, the former inequality in the taxation of oil, electricity and coal was greatly reduced.[15]

The CO_2 tax on manufacturers was reduced from DKK 100 to DKK 50 per metric ton in order to protect the competitiveness of Danish industry. This rate of DKK 50 per ton of carbon dioxide, which represented about 40% of the proposed Europe-wide CO_2 tax proposed in 1992, was still

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[13] Gesa Clasen, "A Framework for Innovation: Corporate Responses to Applied Energy/CO_2 Taxes in Denmark," (Washington: Center for a Sustainable Economy, 1998): 10-11.

[14] Danish Ministry of Taxation, *Energy Taxes: The Danish Model* (Copenhagen: Ministry of Taxation, September 6, 1998): 1-5.

[15] Danish Ministry of Taxation, *Energy Taxes: The Danish Model* (Copenhagen: Ministry of Taxation, September 6, 1998): 15-6.

considered too high for heavy consumers of energy. In addition to this reduced rate, refunds of up to 100% were therefore granted to energy-intensive companies according to a progressive refund schedule. Under this schedule, a company received a refund proportional to the importance of its CO_2 tax liability relative to its refund base, *i.e.*, its gross margin (sales minus materials, inventory and investment purchases). The refund percentage was 50% for CO_2 tax liablities of 1-2% of the refund base, 75% for taxes of 2-3% of the refund base, and 90% for liabilities in excess of 3% of the refund base. For those companies with a CO_2 tax liability equal to more than 3% of their refund base, an additional subsidy could be obtained to cover the remaining 10% of the CO_2 tax not eligible for refund, except for a non-refundable amount of DKK 10,000.[16]

In 1994 Denmark adopted a general tax reform designed to reduce marginal tax rates on all income brackets, close a series of tax loopholes, and gradually shift the tax base from earned income to natural resource depletion and pollution. This was the first phase of a long ETR process. Over the period 1994-1998, labor taxes were to be reduced by 2.2% of GDP and the marginal tax rates on income were to be cut by 10%. As a counterpart, the capital tax base was broadened to supply additional revenue equal to 1% of GDP and a broad array of green taxes were raised to provide the extra 1.2%.[17]

In ETR's second phase, covering the period 1996-2000, carbon and sulphur taxes on industry played the lead role, to narrow down the difference in the green tax liability of households and businesses. In 1996, businesses started to contribute a greater share of reductions in CO_2 emissions, a necessary step if Denmark is to achieve its commitment to reducing CO_2 emissions by 20% by 2005 over the 1988 level. The new system, which abandoned the principle of a "tax/refund base ratio," is described in Table 2.3. The main factor now is the usage type—light or heavy processes, or space heating.[18]

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[16] Danish Ministry of Taxation, *Energy Taxes: The Danish Model* (Copenhagen: Ministry of Taxation, September 6, 1998): 15-7.
[17] Jens Holger Helbo Hansen, "Green Tax Reform in Denmark," ed. Kai Schlegelmilch, *Green Budget Reform in Europe: Countries at the Forefront* (Berlin: Springer, 1999): 51-66.
[18] Danish Ministry of Finance, *Energy Tax on Industry in Denmark* (Copenhagen: Ministry of Finance, December 1995): 10; Danish Ministry of Taxation, *Energy Taxes: The Danish Model* (Copenhagen: Ministry of Taxation, September 6, 1998): 18; Pentti Malaska, et al., *Environment-Based Energy Taxation in the Nordic Countries: Comparisons by Energy Source and a Review of the Finnish Discussion*, (Helsinki: Ministry of the Environment, 1997): 17.

Table 2.3: Carbon and Sulfur Taxation of Danish Corporations

(as of 1995 reform, rates after refund)

	1995	1996	1997	1998	1999	2000
Carbon dioxide tax (DKK per metric ton CO_2)						
- **Space heating**	50	200	400	600	600	600
- **Light processes, no agreement** [a]	50	50	60	70	80	90
- **Light processes, agreement**	0-2	50	50	50	58	68
- **Heavy processes, no agreement** [b]	0-2	5	10	15	20	25
- **Heavy processes, agreement**	0-2	3	3	3	3	3
Sulfur tax (DKK per kg SO_2)	--	10	10	10	10	10
- **Electricity consumption (öre per kWh)** [c]	---	0.9	0.9	0.9	1.3	1.3

a)   Light processes = lighting, office machines, *etc.*
b)   Heavy processes occur in energy-intensive enterprises, *e.g.*, energy that is used directly in the production of cement or glass
      or starch or paper, or for the refining of mineral oil, or for the smelting of metals.
c)   DKK 1 = 100 öre
Sources: Danish Ministry of Taxation, *Energy Taxes: The Danish Model* (Copenhagen: Ministry of Taxation, September 6,
1998): 20; Pentti Malaska, *et al.*, *Environment-Based Energy Taxation in the Nordic Countries: Comparisons by Energy Source
and a Review of the Finnish Discussion* (Helsinki: Ministry of the Environment, 1997): 18.

The third Danish energy tax instrument–an SO_2 tax–was introduced in 1996. It is levied on the
sulphur content of fossil fuels (petroleum products, coal and natural gas) containing more than
0.05% sulphur and on the sulphur content of wood, straw, waste and other fuels burned in
electric plants with an output of more than 1 megawatt. The tax rate is DKK 10 per kg of
sulphur.[19]

The gradual increase in CO_2 and SO_2 tax rates was achieved by reducing the scope of the various
refunds to businesses, especially the refund on the CO_2 tax due for space heating, which
disappeared altogether as of 1998, as shown in Table 2.4.

CO_2 tax rates depend on the use of energy, with space heating being taxed the heaviest. A
portion of the tax is refunded to the company provided that it has signed a voluntary agreement
whereby it commits to increasing energy efficiency and subjects itself to periodic audits.[20]

The revenues raised by the CO_2 and SO_2 taxes and other green taxes on industry in the second
ETR phase were partly earmarked to support adjustment to the tax. Instead of going to the
central budget, revenues were recycled to industry and the commercial sector in three ways.
First, investment subsidies could be granted for up to 30% of investments in energy efficiency
measures. Second, a pool was set aside to support smaller companies, including agriculture.
Third, the receipts of CO_2 and SO_2 taxes, net of refunds, financed reductions in employers' social
security contribution in a revenue-neutral way. The planned decrease in tax refunds to industry
allowed the reductions in employers' social security contribution and provided support for
energy-efficiency investments.[21] Social security contributions were reduced by 0.53% of gross

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[19] Danish Ministry of Taxation, *Energy Taxes: The Danish Model* (Copenhagen: Ministry of Taxation, September 6, 1998): 30.
[20] Pentti Malaska, et al., *Environment-Based Energy Taxation in the Nordic Countries: Comparisons by Energy Source and a Review of the Finnish Discussion* (Helsinki: Ministry of the Environment, 1997): 16-9.
[21] Danish Ministry of Taxation, *Energy Taxes: The Danish Model* (Copenhagen: Ministry of Taxation, September 6, 1998): 19.

salary over the period (0.11% in 1997, 0.27% in 1998, 0.32% in 1999 and 0.53% in 2000). The reduction in social security contributions increased in the period 1997-2000, while the investment support was phased out.[22]

Table 2.4: Recycling of Environment-Based Energy Tax Revenues in Denmark

(projected as of 1995, in DKK million)

	1996	**1997**	**1998**	**1999**	**2000**
		Phase 1		**Phase 2**	
Total tax revenue collected	915	1,440	1,955	2,220	2,450
Industrial and commercial sectors	710	1,230	1,730	1,900	2,075
- Space heating	420	750	1,050	955	910
- CO_2 tax	65	245	425	585	775
- SO_2 tax	225	235	255	360	390
Households	205	210	225	320	375
Revenue recycled					
To trade and industry	710	1,230	1,730	1,900	2,075
- Investment subsidies	300	500	500	500	0
- Small businesses	180	210	255	255	295
- Reductions in employers' SSC	200	490	945	1,115	1,750
- Administration costs	30	30	30	30	30
Compensation to electric heating users*	60	60	60	60	60
To households	165	160	165	250	295

* Subsidies for conversion to electric heating
Source: Jens Holger Helbo Hansen, "Green Tax Reform in Denmark," ed. Kai Schlegelmilch, *Green Budget Reform in Europe: Countries at the Forefront* (Berlin: Springer, 1999): 60.

The third phase in Denmark's ETR is phased in between 1999 and 2002. In addition to further shifting taxes from labor to environmental degradation, as in the prior phases initiated in 1994 and 1996, taxes on capital income are to be increased as well. The marginal tax rates on personal income, *i.e.*, earnings and transfers, are lowered and the tax base is broadened by closing some loopholes. The tax rate in the low-income bracket is reduced and tax deductions for the middle tax bracket are increased. The tax increases occur in individuals' capital gains taxes and in green taxes, with the latter expected to raise an extra DKK 5.6 billion by 2002, especially through higher taxes on gasoline and electricity. This third shift in the tax base is expected to amount to around 0.6% of GDP.[23]

The schedule and estimated effect on public revenues is indicated in Table 2.5. At the time of enactment of the third phase, the total tax burden was set to increase in 1998-2001, and decrease after that. The operation was estimated to be revenue positive by around DKK 6 billion in cumulative terms by 2002, although the government envisioned the operation as revenue-neutral in the longer term. The initial increase in total tax burden was designed to dampen a faster-than-expected macroeconomic growth. Private savings would be encouraged by higher after-tax

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[22] Danish Ministry of Taxation, *Energy Taxes: The Danish Model* (Copenhagen: Ministry of Taxation, September 6, 1998): 29-30; Jens Holger Helbo Hansen, Danish Ministry of Taxation, conversation with author, February 9 and April 14, 1999.
[23] Jens Holger Helbo Hansen, Danish Ministry of Taxation, conversation with author, February 9, 1999; Danish Ministry of Finance, *Summary of the Tax Adjustments* (Copenhagen: Ministry of Finance, August 14, 1998).

interest rates, through an increase in the deductibility of interest on savings and mortgages from the income tax.

Table 2.5: Denmark's Third Green Tax Shift

(forecasts for 1999-2002, in DKK billion)

	1998	1999	2000	2001	2002
Personal taxes	0	1.0	-0.1	-2.9	-6.2
Green taxes	0.6	3.1	3.9	4.8	5.6
Taxes on pension savings	0	-1.1	-3.7	-3.7	-3.8
Corporate taxes	0.8	1.9	2.0	2.0	1.9
Total	1.4	4.9	2.1	0.2	-2.5

Source: Danish Ministry of Finance, *Summary of the Tax Adjustments*, (Copenhagen: Ministry of Finance, August 14, 1998) on the web at http://www.fsk.dk/locations/fm/taxadjust/index.htm.

2.2   Finland

In 1990, Finland was the first country to introduce an environmentally-motivated CO_2 tax. Until January 1994, the environmental component of energy taxation was based solely on the fuel's carbon content. In 1994-1996, this component was adapted to become based on both the carbon and energy contents with a 60/40 relative weight ratio. Since 1997 the environmental component has again been based solely on the carbon content, except for electricity. Rates, especially on the carbon component, have been raised annually since the early 1990s. [24]

Coal is a prominent source of fuel for producing electricity in Finland. Before 1997, coal used for this purpose was heavily taxed. Finland intended to tax electricity imports to compensate for the negative effect of the CO_2 tax on the competitiveness of domestic electricity production. However, by joining the European Union, Finland relinquished the right to tax imports from a member state differently than its own production. Motivated by concerns about competitiveness, Finland then switched to the usual European Union pattern of eliminating the tax on fuels used to produce electricity, and instead taxed the electricity itself, regardless of its geographic origin, reducing the incentive for fuel-switching in Finnish electricity production relative to the previous system.[25]

Finland adopted rate reductions for some commercial uses of electricity in 1997. Hence mining, manufacturing and the greenhouse cultivation sector now pay 61% (Rate I) of the regular rate (Rate II) that other users pay (households, services, agriculture, *etc.*). Rate I increased from 54% of Rate II in 1997.[26] In addition to this differentiation in electricity tax rates, energy-intensive companies also receive a refund for the portion of excise duties exceeding 4% of the value added they produce. Furthermore, the final tax on electricity is waived totally if electricity is produced with wood, wood-based fuels, wind, or waste gases from metallurgical processes.[27]

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[24] Timo Parkkinen, *Environment-Related Energy Taxation in Finland in 1995* (Helsinki: Ministry of the Environment, 1995): 1.

[25] Gustav Teir, *Energy Taxes: The Experience of Finland*, Background Paper no.10 CCNM/CHINA/EPOC(98)13 (Paris: OECD, October 5, 1998): 2-3.

[26] Timo Parkkinen, *Environment-Related Energy Taxation in Finland as from 1 September 1998* (Helsinki: Ministry of the Environment, September 8, 1998): 2.

[27] Timo Parkkinen, Finnish Ministry of the Environment, conversation with author, October 1, 1998.

The Finnish ETR entered into force in 1997, at which time it was decided to reduce general tax revenues by FIM 5.5 billion. Cuts in the state personal income tax made up FIM 3.5 billion, those in employers' social security contributions and in the local personal income tax made up the rest. Part of this tax cut was financed by a higher CO_2 tax (yielding FIM 1.1 billion) and higher landfill taxes (yielding FIM 300 million). The government did not conceive of the operation as a revenue-neutral shift, but rather a slight overall reduction in the tax burden.[28]

The second phase in Finnish ETR started with the comprehensive wage agreement of November 1997, in which firms and labor unions agreed on limiting wage increases through the year 1999. In response, the government agreed to cut taxes on labor by FIM 1.5 billion (0.25% of GDP) in 1998, and by 3.5 billion (0.5% of GDP) in 1999. Further increases in energy and environmentally-motivated taxes, as well as a broadening of the corporate profits tax base, would finance part of the operation. Still, the government estimated the resulting central budget deficit at FIM 1.5 billion in 1998, and 2.5 billion in 1999. The reform also caused local governments' finances a loss of revenues of FIM 0.7 billion, which was partly compensated by higher real estate taxes. But it was expected that the losses of tax revenues from the net tax rate cut would be more than offset by the increase in revenues due to the generation of additional employment.[29]

Table 2.6: Energy Taxation in Finland

(as of September 1998)

Fuel	Fiscal Duty	Environmental Duty (* = carbon component)
Unleaded gas	FIM 3.094/liter	FIM 0.239/liter*
Leaded gas	FIM 3.544/liter	FIM 0.239/liter*
Diesel oil	FIM 1.666/liter	FIM 0.269/liter*
Light fuel oil	FIM 0.109/liter	FIM 0.270/liter*
Heavy fuel oil	--	FIM 0.321/kg*
Coal	--	FIM 246/metric ton*
Peat	--	FIM 9/MWh*
Natural gas	--	FIM 0.103/m³*
Electricity Rate I	--	FIM 41/MWh
Electricity Rate II	--	FIM 25/MWh
Pine oil	FIM 0.321/kg	n.a.

Note: excluding strategic storage fees and value added tax.
Source: Timo Parkkinen, *Environment-Related Energy Taxation in Finland as from 1 September 1998* (Helsinki: Ministry of the Environment, September 8, 1998): 1.

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[28] Finnish Ministry of Finance, *The Government of Finland Has Presented Its Proposal for the Budget of 1997 on September the 3rd 1996* (Helsinki: Ministry of Finance, September 1996); Timo Parkkinen, *The Use of Taxes and Charges for Environmental Policy in Finland* (Helsinki: Ministry of the Environment, April 17, 1997): 2; Timo Parkkinen, Finnish Ministry of the Environment, conversation with authors, July 1 and October 12, 1998.

[29] Finnish Council of State, *Finland Gets a Wage Agreement*, Press Release 244/97 (Helsinki: Council of State, November 27, 1997); Gustav Teir, Finnish Ministry of Finance, conversation with author, September 21, 1998.

Table 2.7: Actual CO$_2$ Tax on Fuels in Finland

(in FIM/tCO$_2$)

1990	1993	1996	1997	Jan. 1, 1998	Sept. 1, 1998
6.7	14	38	71	82	102

Source: Timo Parkkinen *Environment-Related Energy Taxation in Finland as from 1 September 1998* (Helsinki: Ministry of the Environment, September 8, 1998).

2.3   Germany

For many years the German Green Party had been pushing the government to adopt ETR. But it was only with the formation of the new SPD-Green coalition government in 1998 that the idea became a reality. The German ETR, which is slightly revenue-negative, is to unfold in at least five stages, the first of which went into effect in April 1999.

In the first stage, employers' and employees' contributions to the pension fund were cut by 0.8% points (0.4% for employers and employees), financed by higher taxes on gasoline, heating oils, natural gas and a new tax on electricity. Table 2.8 contains the energy tax rates in effect in 1999.[30]

Table 2.8: Energy Tax Rates in Germany

(as of April 1999)

	Unit	DEM/unit	DEM/metric ton CO$_2$	% increase in consumer price
Light heating oil	Liter	0.04	12.7	8
Natural gas	kWh therm.	0.0032	15.9	8
Gasoline	Liter	0.06	25.7	4
Diesel	Liter	0.06	22.7	4
Electricity	kWh elec.	0.02	35.7	7

Source: Stephan Singer, unpublished memo (Frankfurt: WWF Germany, March 1, 1999).

The German ETR entails several safeguards for energy-intensive industries, including the following. First, manufacturing, forestry, and agricultural firms pay only 20% of the above rates, except for motor fuels where they pay the full rate.   Second, tax burdens exceeding the reductions in employers' social security contributions by more than 20% are reimbursed up to the difference. Third, the industrial sector pays only 20% of the standard electricity tax. Fourth, co-generation plants (producing electricity and heat) utilized up to 70% of their capacity are completely exempt from the tax on petroleum products. Fifth, those co-generation plants with an electricity efficiency factor of at least 57.5% are also exempted from the tax on petroleum products for the first 10 years. Sixth, heavy heating oil is not subject to the tax on petroleum products.

It is worth noting that energy-intensive industries are not fully exempted, contrary to the original plan. Finally, the European Commission accepted the decision to extend a discount to the

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[30] Organisation for Economic Co-operation and Development (OECD), *Greening Tax Mixes in OECD Countries: A Preliminary Assessment* (Paris: OECD, 2000), web-site http://www.oecd.org/env/policies/online-eco.htm.

manufacturing industry and agriculture on the grounds that EU member states are allowed to grant state aid for environmental protection, a category of state aid that does not violate the European treaties.[31]

The second phase of ETR in Germany, to take place between 2000 and 2003, provides for the shift of an extra 1.0% reduction in contributions to the pension fund (half for employers, half for employees), financed by annual increases in motor fuel taxes of EUR 0.03 per liter and electricity taxes of EUR 0.025 per kWh. The law exempts oil or gas power stations with conversion efficiencies in excess of 57.5% from petroleum taxes and provides a tax incentive for the use of low-sulfur fuels. The second phase went into effect on January 1, 2000.[32]

2.4 Italy

Italy adopted ETR in 1999. The move has great significance since Italy is the second largest European economy (the first one being Germany) to embark on an environmentally-motivated, energy-based ETR. In addition, it is the first country in southern Europe to do so.

The Italian ETR began in 1999 with the modification of excise taxes on petroleum products according to their carbon content and the introduction of a consumption tax on coal and other fuels used in combustion plants. The new tax rates will be increased in annual stages from 1999 to 2004. Taking 1998 levels as baseline, taxes on gasoline will have increased by 7%, the tax on diesel by 12%, the tax on coal by 42%, and the tax on natural gas by 2% by 2005. Private diesel fuel trucks are exempt. The tax on heating oil will have risen by 52% for residential users and 61% for industry. Meanwhile, taxes on liquid petroleum gas (LPG) will have fallen. These taxes are intended to help Italy meet its commitments under the Kyoto protocol on climate change.[33]

Table 2.9: Carbon Tax Rates on Fossil Fuels in Italy

(in ITL)

	1999	2005
Coal (metric ton)	5,084	41,840
Natural Gas (m³)	0.87	8.7
Fuel Oil (metric ton)	1,286	30,830

Source: World Coal Institute, "Impact of Italian Carbon Tax," *Ecoal* 29 (March 1999) on the web at http://www.wci-coal.com.

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[31] Stephan Singer, unpublished memo (Frankfurt: WWF Germany, March 1, 1999); "Bonn Coalition Partners Act to Defuse Energy Tax Row," *The Financial Times* (London: November 10, 1998: 2); "Germany Politics: Differences over Planned Increases in Energy Taxes Fuel Dissent within Coalition," *The Financial Times* (London: November 9, 1998): 2; "Commission Approves German Eco-Tax Bill," *ENDS Environment Daily* (London: April 21, 1999); "German Ecological Tax Reform Plan Becomes Law," *ENDS Environment Daily* (London: March 22, 1999); "German Industry to Lose Energy Tax Exemptions," *ENDS Environment Daily* (London: February 5, 1999); "German Parties Agree Energy Tax Rises," *ENDS Environment Daily* (London: October 19, 1998); "L'accord de gouvernement allemand," *Le Monde* (Paris: October 29, 1998); Kai Schlegelmilch, *Cautious Steps Towards an Ecological Tax Reform in Germany: First Analysis* (Wuppertal, Germany: Wuppertal Institute, October 21, 1998).

[32] Center for a Sustainable Economy, *Tax News Update* 11, no. 9 (1999); "German Ecotax Plans Thrown into Crisis," *ENDS Environment Daily* (London: November 4, 1999); "German Ecotax Law "Back on Track"," *ENDS Environment Daily* (London: November 8, 1999).

[33] Organisation for Economic Co-operation and Development (OECD), *Greening Tax Mixes in OECD Countries: A Preliminary Assessment* (Paris: OECD, 2000), web-site http://www.oecd.org/env/policies/online-eco.htm.

Under the plan, 60.5% of the revenues raised in the tax's first year were to be spent on reducing compulsory contributions on labor. Specifically, those revenues will help pay for three years of welfare contributions incurred by employers hiring new staff in Italy's poorer south and half the pension contributions of young businessmen who change jobs. Italy's is thus a targeted version of ETR: it targets the unemployed workforce in the poorer regions. Thirty-one and one-tenth percent of the revenues would finance compensation measures and 8.4% would be used to promote energy efficiency. The revenues shifted in the tax base are forecast at EUR 1.1 billion in 1999 and EUR 5.4 billion by 2005.[34]

In November 1999 the carbon tax on diesel and gasoline was temporarily suspended to reduce short-term inflation rates in order to avoid the risk of violating the Maastricht Stability Pact. It was announced that the suspension would last only a few months.[35] The tax was returned to force in June 2000. Fuel price hikes in the second half of 2000 brought further disturbances to the implementation of Italy's ETR. Specifically, tax exemptions were extended to the road transport and fishing sectors.[36]

2.5   The Netherlands

The Dutch system of energy taxation consists of four taxes, the first two of which are the most important and will be discussed in some detail below: (i) the general fuel charge; (ii) the regulatory tax on energy; (iii) the excise tax; and (iv) the strategic oil storage tax.

The general fuel charge was introduced in 1988 as part of an integral system for financing environmental policy expenditures. Its revenues were earmarked for environmental expenditures and administered by the Ministry of the Environment. In 1992, however, the charge was transformed into a tax and became part of general tax revenues. As such, it fell under the administration of the Ministry of Finance. The general fuel tax is collected on all fossil fuels. Fuels used as raw materials are not subject to the tax. Tax rates are based 50/50 on the energy and carbon contents of fuels, and are given in Table 2.10.[37]

Under the general fuel tax, electricity is not taxed, though fuels used to produce electricity are taxable. Energy-intensive industries used to benefit from preferential rates under this tax but the benefit was cancelled in January 1997. Also, since 1997 nuclear power has been taxed under the general fuel tax at the rate of NLG 31.95 per gram of uranium-235.[38]

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[34] "Carbon Tax Boosts Italian Fossil Fuel Prices," *ENDS Environment Daily* (London: January 19, 1999); Organisation for Economic Co-operation and Development (OECD), *Greening Tax Mixes in OECD Countries: A Preliminary Assessment* (Paris: OECD, 2000), web-site http://www.oecd.org/env/policies/online-eco.htm.

[35] Center for a Sustainable Economy, "Italy Temporarily Suspends Carbon Tax to Reduce Inflation," Tax News Update 12, no. 6 (1999).

[36] "Italian Carbon Tax To Be Re-Introduced," *ENDS Environment Daily,* (London: April 7, 2000); "Italy Grants Further Fuel Tax Concessions." *ENDS Environment Daily,* (London: September 9, 2000); "Italian Fuel Tax Concessions Confirmed," *ENDS Environment Daily,* (London: September 26, 2000).

[37] Willem Vermeend, and Jacob van der Vaart, *Greening Taxes: The Dutch Model* (Deventer, Netherlands: Kluwer, 1998): 17-21, 31-5.

[38] Dutch Ministry of Housing, Spatial Development and Environment, *The Netherlands' Environmental Tax on Fuels: Questions and Answers* (The Hague: Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, January 1, 1997); Willem Vermeend, and Jacob van der Vaart, *Greening Taxes: The Dutch Model* (Deventer, Netherlands: Kluwer, 1998): 45.

The regulatory tax on energy came into force on January 1, 1996. In contrast to the general fuel tax, the regulatory tax on energy was introduced to alter behaviors towards greater energy efficiency, the revenue objective being of only secondary importance. Electricity is taxed directly under the regulatory tax system.[39]

The regulatory tax on energy focuses on small users of energy for three main reasons. First, as in Denmark, large users are covered by voluntary agreements signed with the authorities whereby they commit to adopting energy-saving measures. Second, the Dutch government was worried that a unilateral CO_2 tax would harm the export competitiveness of large Dutch energy-intensive companies. Third, large companies are covered by the general fuel tax. Nevertheless, it is estimated that 95% of all Dutch companies, and all individuals, are covered by the tax. A tax-free allowance exists, which is set at 800 m³ of natural gas or 800 kWh of electricity per year. The tax rate follows the European Community's first proposal of a CO_2/energy tax of USD 10 per barrel of oil equivalent, which amounts to around NLG 30 per metric ton of CO_2. Tax rates for the various fuels are then based on their CO_2/energy content. Fuels used to power road vehicles are not subject to the tax as they are covered by excise duties. Special exemptions are meant to induce energy efficiency; thus heat supplied via district heating and electricity produced with natural gas or renewables are exempt from the tax. In addition, natural gas used in greenhouses is exempt from the regulatory tax on natural gas to preserve the international competitiveness of the flower- and vegetable- growing sectors.[40]

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[39] Dutch Ministry of Housing, Spatial Development and Environment, *The Netherlands' Regulatory Tax on Energy: Questions and Answers* (The Hague: Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 1997); Willem Vermeend, and Jacob van der Vaart, *Greening Taxes: The Dutch Model* (Deventer, Netherlands: Kluwer, 1998): 40-8.

[40] Dutch Ministry of Housing, Spatial Development and Environment, *The Netherlands' Regulatory Tax on Energy: Questions and Answers* (The Hague: Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 1997); Willem Vermeend, and Jacob van der Vaart, *Greening Taxes: The Dutch Model* (Deventer, Netherlands: Kluwer, 1998): 40-8.

Table 2.10: Energy Tax Rates in the Netherlands

(as of January 1996, in NLG)

Product	Unit	General fuel tax	Regulatory small-user tax	Excise tax	Strategic storage tax
Leaded gasoline	10^3 liter	25.10	--	1,373.50	12.50
Unleaded gas	10^3 liter	25.10	--	1,230.80	12.50
Light fuel oil	10^3 liter	27.50	84.60	102.60	12.50
Gasoil	10^3 liter	27.70	85.30	102.60	12.50
Diesel	10^3 liter	27.70	--	708.30	12.50
Heavy fuel oil	metric ton	32.33	--	34.24	0
Coal	metric ton	23.38	--	--	--
LPG motor fuel	metric ton	33.08	--	228.66	--
LPG for heating	metric ton	33.08	100.90	0	--
Natural gas					
< 800 m³	m³	0.02155	0	--	--
800-170,000 m³	m³	0.02155	0.0953	--	--
170,000 m³ -10 Mm³	m³	0.02155	--	--	--
> 10 Mm³	m³	0.01410	--	--	--
Special gases *	1,000 GJ	236.82	--	--	--
Residuals					
Petrocokes	metric ton	32.47	--	--	--
Liquid	metric ton	32.33	--	--	--
Gaseous	1,000 GJ	236.82	--	--	--
Electricity					
< 800 kWh	kWh	--	--	--	--
800-50,000 kWh	kWh	--	0.0295	--	--

* Special gases are blast furnace, cokes oven, refinery and coal gases.
Source: Willem Vermeend, and Jacob van der Vaart, *Greening Taxes: the Dutch Model* (Deventer, Netherlands: Kluwer, 1998): 29.

The regulatory tax on energy was the first tax in the Netherlands not to increase total budget revenues. The operation was conceived as revenue neutral, with the funds of the tax recycled to firms and households in several ways. Recycling to firms occurred by cutting the rate of employers' social security contributions by 0.19%, raising the tax credit for self-employed people by NLG 1,300, and reducing the corporate profits tax rate by 3% on the first NLG 100,000 of profits. Recycling to households was accomplished by reducing the personal income tax rate by 0.6%, increasing the standard income tax-free allowance, and increasing the tax-free allowance for older citizens.[41]

As a complement to taxation, the Netherlands also uses positive incentives, namely voluntary agreements, to induce energy efficiency. Firms can choose their preferred depreciation schedule for environmental investments. In addition, since 1997, firms have benefited from a 40% tax credit to be applied to their corporate or personal income tax base if they invest in energy-saving measures. The Dutch Green Tax Commission (GTC), moreover, has proposed building incentives into energy taxes themselves, so as to achieve the same level of environmental

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[41] Willem Vermeend, and Jacob van der Vaart, *Greening Taxes: The Dutch Model* (Deventer, Netherlands: Kluwer, 1998): 26-7.

benefits and simplify the corporate and personal tax systems. It has also suggested expanding positive incentives to private individuals. Some of the revenues from increased energy taxes could be used to finance such positive incentives.[42]

2.6   Norway

As early as 1991 Norway imposed a CO_2 tax on the combustion of fossil fuels as the main instrument to stabilize CO_2 emissions. Around 65% of Norwegian CO_2 emissions are subject to the tax. The CO_2 tax is levied on petroleum products, coal and coke, and oil production in the North Sea. Norway also has an SO_2 tax.[43]

Certain sectors exposed to international competition are exempted from both the CO_2 and SO_2 taxes. These include international air transport, international shipping, and water fishing. Other sectors benefit from significant rate reductions, including the pulp and paper, fish meal, national air transport and coastal goods transport industries. Similarly, the use of petroleum products on the continental shelf enjoys large reductions. The use of natural gas on the mainland is not taxed. The CO_2 tax is not levied on coal and coke used as a reducing agent or raw material in industrial processes or in the production of cement and lightweight concrete. Table 2.11 shows the estimated tax per ton of CO_2.[44]

Table 2.11: CO_2 Tax Rates in Norway

(in NOK, as of January 1999)

	Tax per metric ton CO_2
Gasoline	397
Petroleum products	
Light oil	174
Heavy oil	148
North Sea supply fleet	100
Coastal goods transport	100
Pulp and paper industry	87/74
Fish meal industry	87/74
Coal	189
Coke	144
Oil burned on continental shelf	336
Gas burned on continental shelf	381

Source: *The Norwegian CO_2 Tax Scheme* Unpublished Note (Oslo: Ministry of Finance and Customs, 1998).

Like several other governments in northern Europe in the mid-1990s, the Norwegian government established a Green Tax Commission for the purpose of evaluating the effect of environmental policies, including environmental taxes, and studying the possibility of raising environmental tax rates. The Green Tax Commission was split on whether to raise CO_2 tax rates unilaterally.[45]

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[42] Dutch Green Tax Commission, *A Summary of Its Three Reports 1995-1997* (The Hague: Ministry of Finance, March 1998): 4-21.

[43] "The Norwegian CO_2 Tax Scheme," Unpublished Note (Oslo: Ministry of Finance and Customs, 1998).

[44] "The Norwegian CO_2 Tax Scheme," Unpublished Note (Oslo: Ministry of Finance and Customs, 1998).

[45] Thorvald Moe, "Policies for a Better Environment and High Employment," *Green Budget Reform in Europe: Countries at the Forefront,* ed. Kai Schlegelmilch (Berlin: Springer, 1999): 105.

It took Norway more time than its neighbors to pass an explicit ETR. A tax reform took place in 1992 that alleviated the tax burden on labor, but it was not linked to the carbon tax imposed the year before.[46] Strictly speaking, therefore, an explicit ETR did not occur in Norway until 1998-1999. In June 1998, the parliament finally adopted Proposition Number 54, which recommended raising energy and other environmental tax rates in a revenue-neutral way, *i.e.*, by simultaneously reducing personal income tax and/or employers' social security contribution rates. The recycling option chosen was to reduce the personal income tax by NOK 790 million, or around 0.2% of estimated total tax revenue for 1999. This option was preferred to reducing employers' social security contributions because the unemployment rate was deemed low by the Norwegian government, hovering around 2.5% of the workforce. As part of the reform, the CO_2 tax was expanded to cover more sectors. Thus the North Sea fleet, national air transport and coastal goods transport sectors are now paying a tax of NOK 100 per metric ton of CO_2. This ETR took effect as of January 1, 1999.[47]

Although an explicit ETR took a long time to materialize, the CO_2 and other environmental tax revenues were substantial enough in the preceding years to argue that an implicit shift in the tax base occurred in Norway before 1999. The tax revenues raised by environmental taxes indeed would have had to be raised in different ways, *i.e.*, on capital and labor, had these environmental taxes not existed. Instead of a revenue neutral ETR, environmental taxes before 1999 arguably led to a fiscal expansion. But assuming that this expansion would have happened even in the absence of environmental taxes, the government implicitly shifted the burden of this expansion from capital and labor onto environmental degradation. In the case of Norway, as in the case of the Netherlands, this implicit ETR is greater in magnitude than the explicit package of 1999. As an illustration, the CO_2 tax alone raised around 2% of total tax revenues in 1998, while the 1999 ETR was expected to shift no more than 0.2% of total tax revenues in 1999.

2.7 Sweden

Sweden's 1991 ETR was the first instance of a major, explicit shift in the tax base from traditional factors to pollution. The context was a combination of very high marginal income tax rates and rising environmental awareness in the wake of a massive die-off of the seal population.

The shift in the tax base entailed expanding the value-added tax to energy and imposing an excise tax on CO_2 and SO_2, as well as raising a number of existing environmental levies. Simultaneously, energy taxes on fossil fuels were cut by 25-50%, but the net result was an increase in energy taxes. In addition, general value added tax rates were harmonized upwards, the tax base for both the value added tax and personal income tax was broadened, and tax deductibility from personal income was scaled back. Income tax rates were cut down to 30% for most wage earners and capped at 50% for the richest (excluding the social security contributions

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[46] "The Norwegian CO_2 Tax Scheme," Unpublished Note (Oslo: Ministry of Finance and Customs, 1998).

[47] Norwegian Ministry of Finance and Customs, *Grønne Skatter* St prp no. 54 (1997-98) (Oslo: Ministry of Finance and Customs, April 23, 1998): 24; *Green Taxes* Unpublished Note (Oslo: Ministry of Finance and Customs, 1998); *Norwegian Government Proposes New Green Taxes*, Press Release 18/98 (Oslo: Ministry of Finance and Customs, April 23, 1998); "The Norwegian CO_2 Tax Scheme," Unpublished Note (Oslo: Ministry of Finance and Customs, 1998).

paid by workers).[48] Energy and other environmentally-motivated taxes were increased by SEK 18 billion, while general consumption taxes were raised by SEK 10 billion. Personal income taxes, on the other hand, were reduced by SEK 71 billion. The shift in the tax base was therefore originally conceived as budget negative, with the shift from labor to environmental taxes representing about 2.4% of total tax revenue in 1991.[49] During this period the European Union (of which Sweden was not yet a member) was contemplating a Europe-wide carbon/energy tax, and the Swedish ETR was motivated in part by a desire to seize the first-mover advantage.

In 1993 successful lobbying by energy-intensive industries claiming that the competitiveness of Swedish firms, and as a consequence employment in Sweden, were being hurt, prompted the government to step back. Perhaps the fact that few countries followed suit after Finland, Norway and Sweden imposed CO_2 taxes also turned public opinion against using the national CO_2 tax. Thus, in 1993 the CO_2 tax rate for the industrial and horticultural sectors was cut to 25% of the level applicable to households and the commercial sector. The 1993 reform also simplified the structure and administration of energy taxes by replacing a complicated set of exemptions and reductions with lower rates for the industrial and horticultural sectors. All in all, the energy tax levels for industry in 1993 were reduced to a level lower than before the 1991 reform, while other consumers bore a corresponding tax increase.[50]

In 1997 the pendulum swung back toward the 1991 spirit: the CO_2 tax owed by industry and horticulture was raised from 25 to 50% of the general level.[51] Table 2.12 shows the evolution of CO_2 tax rates since 1991. The rate is now to be adjusted annually in line with inflation. Table 2.13 gives the excise duties on energy and CO_2 for non-industrial consumers (full rate). It is important to note that fuels used for electricity production are exempted from the CO_2 and energy taxes. Electricity is covered by a separate excise duty. However, fuels used for electricity production are not exempted from the SO_2 tax, which is imposed at the rate of SEK 30,000 per metric ton of sulfur.[52]

Since 1997, energy-intensive industries have benefited from an additional tax reduction. If the CO_2 tax of SEK 185 per metric ton of CO_2 exceeds 0.8% of the firm's total sales, a cap on the difference may be extended equal to 12% of the general tax level.[53]

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[48] Thomas Sterner, "Environmental Tax Reform: The Swedish Experience," *European Environment*, 4, no.6, (December 1994): 20; Sterner, Thomas, *Environmental Tax Reform: The Swedish Experience*, Studies in Environmental Economics and Development no.1994:3 (Gothenburg University, Department of Economics, March 1994): 2-5.

[49] Swedish Green Tax Commission, *Taxation, Environment, and Employment* (Stockholm: Fritzes, 1997): 8.

[50] Thomas Sterner, "Environmental Tax Reform: The Swedish Experience," *European Environment* 4, no.6 (December 1994): 22; Maude Svensson, "Energy and Environmental Taxes in Sweden," paper presented at the conference "Green Taxes and Duties in International Perspective" (Copenhagen: November 25, 1996), in *Green Taxes and Duties: A Way Towards a Better Environment and Increased Employment* (Copenhagen: SiD, The General Workers Union of Denmark, May 1997): 40.

[51] Part of the additional CO_2 tax revenues financed Sweden's new annual European Union membership fee. The motivation was the general feeling that sectors expected to gain from Sweden's accession to the E.U. should also contribute to the fee (Åsa Johannesson, conversation with author, October 6, 1999).

[52] Swedish Environmental Protection Agency, *Environmental Taxes in Sweden: Economic Instruments of Environmental Policy*, Report no.4745 (Stockholm: Swedish Environmental Protection Agency, March 1997): 41; Swedish Green Tax Commission, *Taxation, Environment, and Employment* (Stockholm: Fritzes, 1997): 47-51.

[53] Swedish Ministry of Finance, "Taxation of Energy in Sweden," Unpublished Report (Stockholm: Ministry of Finance, April 3, 1998): 7.

In January 2000 Sweden expanded the scope of its ETR by further increasing energy taxes. The tax on diesel rose by SEK 0.25/liter, the tax on electricity by SEK 0.01/kWh, and the tax on electricity produced from nuclear power by SEK 0.005/kWh.[54] SEK 1.3 billion of the total of 1.7 billion shifted by this reform financed continuous education for the workforce. This so-called "green adult education initiative" was conceived as an effort to shift the economy from reliance on natural resource extraction toward reliance on human skills. This second step towards ETR is conceived as a revenue-raising operation, since taxes on labor were not reduced as a counterpart of higher environmental taxes.[55]

Table 2.12: Actual CO_2 Tax Rates in Sweden

(in SEK/tCO_2)

	1991	1993	1996	1997
Industry and horticulture	250	80	92.5	185
Households, commercial, and motor fuels	250	320	370	370

Sources: OECD, *Environmental Performance Reviews: Sweden* (Paris: OECD, 1996): 59; Maude Svensson, "Energy and Environmental Taxes in Sweden," paper presented at the conference "Green Taxes and Duties in International Perspective" (Copenhagen: November 25, 1996), in *Green Taxes and Duties: A Way Towards a Better Environment and Increased Employment* (Copenhagen: SiD, The General Workers Union of Denmark, May 1997): 38; Swedish Ministry of Finance, *Taxation of Energy in Sweden*, Unpublished (Stockholm: Ministry of Finance, April 3, 1998):1; Swedish Green Tax Commission, *Taxation, Environment, and Employment* (Stockholm: Fritzes, 1997): 45-8.

Table 2.13: Excise Duties on Energy and CO_2 in Sweden

(as of January 1998, in SEK)

	Unit	Energy tax	CO_2 tax	Total tax
Petroleum products				
Unleaded gasoline class 2	liter	3.61	0.86	4.47
Unleaded gasoline class 2	liter	3.68	0.86	4.54
Leaded gasoline	liter	4.27	0.86	5.13
Gasoil, kerosene, heavy fuel oil class 1	m³	1,614	1,058	2,672
Gasoil, kerosene, heavy fuel oil class 2	m³	1,840	1,058	2,898
Gasoil, kerosene, heavy fuel oil class 3	m³	2,138	1,058	3,196
LPG as propulsion fuel	liter	1.01	0.56	1.57
LPG other purposes	metric ton	145	1,112	1,257
Other fuels				
Natural gas as propulsion fuel	1,000 m³	1,678	792	2,470
Natural gas other purposes	1,000 m³	241	792	1,033
Coal and petroleum coke	metric ton	316	920	1,236

Source: Swedish Ministry of Finance, *Taxation of Energy in Sweden*, Unpublished (Stockholm: Ministry of Finance, April 3, 1998): 3.

A new phase in Sweden's ETR, which is due to further widen the scope of the reforms initiated in 1990, started in 2001. The government has decided that environmental taxes should raise SEK 80 billion annually by the year 2010, compared to approximately SEK 50 billion currently,

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[54] Sweden had decided earlier to phase out nuclear power.
[55] Åsa Johannesson, correspondence with author, October 6, 1999.

though no timetable has been specified yet. However, specific measures have been taken and implemented regarding the year 2001, which were made possible in part by the state's strong fiscal position. In 2001, increases in the carbon dioxide tax, diesel tax and electricity tax will earn the state an extra SEK 2.84 billion, which will be recycled to increase income tax deductions (by SEK 2.8 billion) and cut employees' SSC to the pension fund (by SEK 0.04 billion). The carbon dioxide tax is increased by 15%, putting it at SEK 530 per ton of CO_2. The diesel tax is raised by SEK 0.10 per liter, and the electricity tax by SEK 0.018 per kWh. With the exception of the increased tax on diesel oil, these measures do not affect transport, manufacturing, and agriculture. The basic deduction for wage earners and pensioners is augmented by SEK 1,200 per person, while employees' pension contributions and the equivalent charges for the self-employed are lowered by 0.1%.[56]

2.8   The United Kingdom

When it comes to ETR, the case of the United Kingdom is interesting in at least three regards. First, the country adopted a landfill tax in 1996, which helped lower employers' social security contributions by a small fraction. So far this has been the first example of explicit ETR not using a carbon or energy tax to finance a shift in the tax base. The tax rate was set at GBP 2 per ton of inactive waste (all wastes not giving off gases when landfilled and having no potential for polluting ground water) and GBP 10 per ton for all other taxable waste.[57] Furthermore, the landfill tax was subject to an escalator of GBP 1 *per annum* from 2001 until 2004.[58]

Second, between 1993 and 1999, the British road fuel escalator system provided an economic instrument combining revenue raising and environmental protection, even though it fell short of a full-fledged green tax reform based on energy. The road fuel escalator system was introduced in 1993 to raise road fuel duties automatically every year. From a three- and then five-percent-above-inflation automatic increase per year in 1993, the escalator was set at 6% above inflation *per annum* in 1997. The system raised around GBP 1 billion in its third year. On the environmental side, it was expected to contribute to a reduction of 2-5 MtC in carbon emissions, a 1% reduction in NO_x emissions and a 1.2% cut in particulate emissions by 2010.[59] Although its revenues were not explicitly recycled, the system nonetheless is interesting in that it proposes to increase energy prices in small, predictable increments spread over a long period of time. However, the automatic escalator was scrapped in 1999, after a backlash from British truckers who complained of ever-increasing road fuel prices, and replaced by an *ad hoc* scheme for

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[56] Åsa Johannesson, correspondence with author, January 17, 2001; Swedish Ministry of Finance, The Revised Budget Statement. (Stockholm: Ministry   of   Finance,   2000). http://www.finans.regeringen.se/propositionermm/propositioner/bp01/pdf/finansplan_eng.pdf

[57] Environmental Preservation Initiatives Limited, Landfill Tax (Maerseyside, United Kingdom: 2001) on the web at http://www.epi-goodworks.org/pages/landf5.htm.; HM Customs and Excise, A General Guide to Landfill Tax (London: 2000) on the web at http://www.hmce.gov.uk/general/search/index.htm.

[58] Organisation for Economic Co-operation and Development (OECD), *Greening Tax Mixes in OECD Countries: A Preliminary Assessment* (Paris: OECD, 2000), web-site http://www.oecd.org/env/policies/online-eco.htm. As explained earlier, the first phase in Denmark's ETR did not use the CO_2 tax either, but Denmark did have an operational CO_2 tax by the time it adopted its ETR. What's more, the first phase did rely partly on increases in energy taxes. Finland also used a landfill tax to finance the first phase of its ETR, but in conjunction with a CO_2 tax.

[59] Gordon Brown, *Pre-Budget 1999 Report* (London: HM Treasury, November 1998): chapter 5; Stefan Speck, *A Database of Environmental Taxes and Charges* (Keele, UK: Keele University Department of Social Sciences, July 1998); Stephen Tindale, and Gerald Holtham, *Green Tax Reform: Pollution Payments and Labour Tax Cuts* (London: Institute for Public Policy Research, 1996): 23.

setting annual energy taxes, earmarked for use in the region where it is collected and for public transportation support.[60]

Third, the U.K. Has adopted a "climate change levy," *i.e.*, a CO_2 tax, on commercial and industrial use of natural gas, coal, LPG and electricity. The revenues are used to finance a 0.3-0.5 percent reduction in employers' social security contributions starting in April 2001. The rates are GBP 0.15/kWh for gas and coal and GBP 0.43/kWh for electricity, with a reduced rate of GBP 0.07/kWh for LPG. There are exemptions for electricity generated from renewable sources, fuels used in "high quality" CHP applications, and fuels used in chemical processes involving electrolysis. The tax includes 80 percent discounts for energy-intensive firms that agree to stringent efficiency improvement targets. Individual firms can either meet their emission reduction goals directly, or purchase emission reductions from other firms that achieve reductions beyond compliance through a system of tradable permits.[61] The tax is expected to raise about GBP 1 billion and save the emission of 2 million tons of carbon annually.[62]

The proposed 2000-1 budget also included additional eco-tax measures. The largest of these is a tax on virgin aggregates (sand, rock and gravel) removed from quarries of GBP 1.60/tonne, with the proceeds used to reduce employer social insurance contributions by 0.1% point and establish a national remediation fund for abandoned mines and quarries. Moreover, a reduction was planned in the annual vehicle excise duty (VED) of GBP 55 for vehicles with engines smaller than 1200 cc. Starting in March 2000, the VED switched to a variable rate based on carbon emissions per km driven. Finally, the budget also included a variety of smaller environmental tax initiatives.[63]

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[60] Greenpeace, and Deutsches Institut für Wirtschaftsforschung (DIW), *The Price of Energy* (Aldershot, UK: Dartmouth, 1997): 13; "UK Government Trims Energy Tax Plans," *ENDS Environment Daily* (London: November 9, 1999).

[61] U.K. Department of the Environment, Transport and the Regions, *Climate Change Levy and Climate Change Agreements,* http://www.environment.detr.gov.uk/ccl/index.htm.

[62] Dominic Hogg, ECOTEC Research and Consulting, London, conversation with author, March 15, 1999; Lord Marshall, *Economic Instruments and the Business Use of Energy* (London: HM Treasury, November 1998); "UK launches 'biggest ever' green tax reform," *ENDS Environment Daily* (London: March 9, 1999); "Electrolysis Excluded from UK Energy Tax," *ENDS Environment Daily* (London: September 29, 1999); "UK Government Trims Energy Tax Plans," *ENDS Environment Daily* (London: November 9, 1999).

[63] Budget of the United Kingdom, Chapter 6 (2000), on the web at http://www.hm-treasury.gov.uk/budget2000/fsbr/chap6.htm

3   COUNTRIES WITH ELEMENTS OF AN ETR PACKAGE

This section presents cases of environmental taxation that are not part of full-fledged explicit ETR packages in the energy sector, but are nonetheless interesting as variants of, alternatives to, or building blocks for ETR.

3.1   Austria: The Benefit of Earmarking

In July 1996 Austria imposed energy taxes on natural gas and electricity at the rates of ATS 0.6/m^3 and ATS 0.1/kWh, respectively. The revenues raised by the energy tax amounted to ATS 3 billion in 1996 and ATS 7.5 billion in 1997. These revenues were not used to finance a shift in the tax base from labor to environmental harm, however. In Austria, energy tax revenues are instead supposed to be earmarked partly for energy-saving measures and partly for public transport. Electricity produced from renewables is also subject to the energy tax. A ceiling on the total tax burden exists for energy-intensive firms so that their energy tax burden does not exceed 0.35% of their value of production. Heating oils are exempt when used to produce electricity, in order to avoid double taxation. Finally, heating oils used in combined heat and power plants are subject to a reduced rate.[64]

The principle underlying the Austrian energy tax is earmarking. Energy tax revenues do not flow into the general budget but are managed separately for specific purposes. Typically, the revenues of an earmarked environmental tax will be used to finance expenditures for environmental protection. Earmarking conforms to the benefit approach to taxation, according to which taxes should be paid only if a benefit is received as a counterpart. In the case of environmental taxation, the benefit lies in the use of nature, be it in the form of pollution (using nature as a sink) or resource harvesting or mining (using nature as a source).

When used to provide taxpayers with assistance in responding to the market incentive, earmarking can boost the incentive potential of the tax.[65] It can also have other benefits relevant to ETR, such as assuring continued revenue support to specified programs and inducing public support for (or reducing opposition to) new taxes.[66]

Thus it is not surprising that some of the successful cases of environmental taxation rely on earmarking. In Denmark, Norway and Sweden, for example, at least part of the SO_2 tax revenues are refunded to industry upon proof of investments in emissions reductions.   In Sweden, the revenues of the NO_x charge are refunded to plants in proportion to their share of total energy output. Under such a system, the refund to a NO_x-emitting plant that is energy efficient may be greater than the tax paid in. Those who pay the charge, as a group, incur no

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[64] "Austria: Natural Gas Importers Seek to Offset Impact of New Energy Tax," *Die Press, English Abstracts* (Reuter: July 2, 1996); George Hamilton, "Survey – Austria: The Energy Market," *The Financial Times* (London: December 11, 1998); Stefan Speck, *A Database of Environmental Taxes and Charges* (Keele, UK: Keele University Department of Social Sciences, July 1998); Stefan Speck, Ecotec Research and Consulting, London, conversation with author, April 14, 1999.

[65] Geoff Mulgan, "Functional Hypothecation as a Potential Solution," *Ecotation*, ed. Timothy O'Riordan (London: Earthscan, 1997): 52-9.

[66] Tax Foundation, *Earmarked State Taxes* (Washington DC: Tax Foundation, 1965).

extra burden and no net revenues are generated for the state.[67] Sweden has also earmarked a portion of its green tax revenues to continuous workforce education. In the Danish case, earmarking accompanies the ETR: the SO_2 tax revenues not used to reduce social security contributions are refunded to industry, as described above. Such hybrid systems are very promising. As discussed below, some analyses in Austria and the United Kingdom suggest that a hybrid ETR, in which revenues are partly recycled to cut employers' social security contribution and partly earmarked for environmental incentives, is the most productive policy option.

It should be observed, however, that earmarking can prevent allocating resources where the marginal benefit is the greatest. It also conflicts with the principle of revenue-neutral ETR, by limiting the revenues that are available to reduce distorting taxes on capital and labor.

3.2   Belgium: Labor Tax Cut Before Green Tax Hike

Belgium imposed an energy tax on gasoline, heating oil and electricity in 1993. The receipts were recycled in the form of a 1.5% reduction in employers' social security contributions paid by manufacturing firms, whose export competitiveness had been hurt by the recent devaluation of several European currencies. These new taxes, which raised the price of a liter of gasoline by BEF 0.65, were not applied to industry, so consumers bore the full burden.[68]

Chronologically, the cut in employers' social security contribution occurred first. It was designed as a fiscal measure supporting the macroeconomic objective of export promotion. The foregone revenue then had to be found elsewhere.[69] The Belgian government did not invoke environmental reasons for imposing the energy tax. Instead, it was preoccupied with filling a budget gap. The Belgian government had organized a roundtable in early 1993, which concluded that the energy tax was the favored instrument to achieve the desired economic improvement given its revenue potential and the ensuing employment gains.[70] Obviously, the potential environmental gain of an energy tax was an additional argument for using it to finance reductions in employers' social security contributions. Still, Belgium put the fiscal cart before the environmental horse, which is why the reform cannot be considered as ETR *stricto sensu*.[71]

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[67] Nordic Council of Ministers, *The Use of Economic Instruments in Nordic Environmental Policy*, Report no. 568 (Copenhagen: TemaNord, 1996): 48-50; Swedish Environmental Protection Agency, *Environmental Taxes in Sweden: Economic Instruments of Environmental Policy*, Report no. 4745 (Stockholm: Swedish Environmental Protection Agency, March 1997): 32.
[68] "Belgium to Tax Private Energy Consumption to Help Exports," *Europe Energy* (Brussels: Europe Information Service, October 1, 1993).
[69] "Belgium Plans Energy Tax Rise to Fund Export Boost," *The Reuter European Community Report* (Brussels: Reuters Limited, May 19, 1993).
[70] Bureau du Plan, *Marché du travail et financement de la sécurité sociale* (Brussels: Bureau du Plan, March 1993): 5.
[71] Rossella Bardazzi, "A Reduction in Social Security Contributions: Which Alternatives for Financing Coverage?" *Economic Systems Research* 8, no.3 (1996): 247-70.

4   TYPOLOGY OF ENACTED ETRS

The enacted environmental tax reforms surveyed above can be categorized in a number of ways. They may focus on increasing taxes or reducing subsidies; on front-end extraction of natural resources or on back-end emissions; on affecting price and behavior or on capturing resource rents. ETR may be implicit or explicit. It may be revenue-raising, revenue-neutral, or represent a reduction in total tax burden. The revenues may be returned by cuts in general taxes or portions of the revenue may be earmarked for environmental purposes. Tax cuts may be directed to income from labor or capital. Finally the reform may or may not include measures to mitigate burdens on pollution-intensive industries or low-income households. In this section we briefly discuss these seven dichotomies – and one trichotomy – and present an overview of the enacted measures in tabular form.

(1) *Raising taxes vs. reducing tax expenditures.* Although ETR has the word "tax" in its name, new taxes need not always be used to raise revenue. ETR could also be financed by removing environmentally harmful subsidies – tax expenditures which in some cases are quite substantial. Both environmental taxes and the reduction of environmentally harmful subsidies free up public resources that can be used to cut existing taxes on capital and labor.

(2) *Pollution vs. natural resources.* Pollution charges are usually imposed at the back-end of the throughput, when inputs to production and consumption, after being transformed by the economy, are released into the ecosystem as wastes. For instance, the release of effluents into waterways and pollutants into the air can be subject to charges. In contrast, natural resource user fees are typically levied at the front-end of the throughput, *e.g.*, at the well head for mineral resources, or when the catch is unloaded upon deck for fish resources.

(3) *Internalization of externality vs. rent capture.* ETR can aim at controlling externalities by using Pigouvian taxes or removing harmful subsidies, but it can also set as its primary goal to withdraw the economic rents generated by natural resource use.

"Rent is a surplus – the difference between the price of a good produced using a natural resource and the unit costs of turning that natural resource into the good. The unit costs include the value of the labor, capital, materials, and energy inputs used to convert the natural resource into a product. What remains after these factor inputs are netted out is the value of the natural resource itself – the land, water, . . ., fish minerals, forests, and environmental resources such as air and water."[72]

Whether the resource is extracted (harvested) or polluted, rent is present.[73] From this perspective, pollution taxes are a form of rent capture by the government. However, rent capture produces its primary benefits in terms of efficiency and equity of the tax system: it finances the reduction of distorting taxes with non-distorting taxes. In contrast, the environmental benefits of rent capture

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[72] M.J. Hartwick, and N.D. Olewiler, *The Economics of Natural Resource Use, 2ⁿᵈ Edition (Reading, MA: Addison-Wesley, 1998): 59.*

[73] Bovenberg and de Mooij, "Environmental Tax Reform and Endogenous Growth", *Journal of Public Economics* 63 (1997): 207-37.; D. Fullerton, D, and G.E. Metcalf., nvironmental Taxes and the Double-Dividend Hypothesis: Did You Really Expect Something for Nothing? (Chicago: Kent Law Review, 1998): 73.

only occur indirectly, and sometimes no such benefits occur at all. In these cases, though the tax may have an environmental or natural resource base and the tax reform may foster economic efficiency, it is questionable whether the reform should be called ETR.

(4) *Explicit vs. implicit*. ETR can be the result of a deliberate move by the government to shift the tax burden from capital and labor to the environment and natural resources. In that case it is explicit. However, absent any explicit ETR, environmental and natural resource user taxes can be adopted that raise significant revenues. In this case, there may be implicit ETR since the revenues raised by the array of green taxes was not levied from other taxes, provided the environmental taxes were not used to fund an increase in expenditure beyond what would otherwise have taken place.

(5) *Positive, neutral or negative budget effect*. This criterion is linked to the explicit-implicit one above. Revenue recycling allows the government to carry out the operation in a budget-neutral way, *i.e.*, leaving total tax revenues and expenditures unchanged. However, ETR can also be budget-positive or budget-negative, depending on how much tax revenue is recycled. Should the government elect to increase the overall budget, it can reduce existing taxes by less than it increases natural resource or environmental taxes. The overall tax burden will then increase. By definition, implicit ETR must be budget-positive. In contrast, if the government decides to use ETR to lower the overall tax burden on the economy, the shift can be carried out in a revenue-negative manner by cutting existing taxes by more than the additional revenues of green taxes.

(6) *Recycling vs. earmarking*. The revenue from environmental taxes can be recycled to reduce taxes on capital, labor, or both. Alternatively, these revenues can be earmarked to finance expenditures in specific areas. For example, the pollution tax revenues paid by industry may be used to help industry undertake pollution abatement investments. Full (or partial) earmarking to environmental purposes strengthens the environmental benefit of ETR but may eliminate (or reduce) the economic benefit from the associated tax cuts.

(7) *Tax cut favoring labor vs. capital*. If revenues are recycled, in whole or part, they can be recycled in at least two ways – by cutting existing taxes on labor (such as payroll taxes) or on capital (such as corporate income taxes)—or a combination of the two, such as personal income taxes, which tax income from both labor and capital).

(8) *Mitigation measures for households and industry*. The impact of ETR differs across households and economic sectors, depending on their dependence on the commodity subject to new taxes or subsidy reduction. The government may decide to alleviate the impact on the most vulnerable households and sectors by accompanying ETR with mitigation policies (reductions, exemptions, border adjustments, *etc.*

Table 4.1: Typology of European ETR

	1		2		3		4		5			6		7		8	
	Tax raised	*Subsidy. Cut*	*Pollution tax*	*Natural resources tax*	*Internalization*	*Rent capture*	*Explicit*	*Implicit*	*Budget positive*	*Budget neutral*	*Budget negative*	*Recycling*	*Earmarking*	*Labor tax cut*	*Capital tax cut*	*Mitigation*	*No compensation*
Sweden [a]	X		X		X		X				X	X	X	X		X	
Denmark [a]	X		X	X [e]	X		X			X		X	X	X	Tax [c]	X	
Netherlands [a]	X		X		X		X			X		X		X	X	X	
United Kingdom [a]	X		X		X		X			X		X		X		X	
Finland [a]	X		X		X		X				X	X		X	Tax [d]	X	
Norway [a]	X		X		X		X			X		X		X		X	
Germany [a]	X		X		X		X				X	X		X		X	
Italy [a]	X		X		X		X			X		X	X	X		X	
Austria [b]	X		X		X			X	X				X			X	
Belgium [b]	X		X					X	X					X		X	
Others [b]	X		X		X			X	X				X				

Notes:

a) The explicit ETR packages, which have occurred since 1990, are listed in the non-shaded rows. Examples of implicit ETR or elements of ETR are given in the shaded rows.

b) These countries are listed as examples of implicit budget-positive ETR. There has also been implicit ETR in each of the 8 countries with explicit ETR, since environmental taxes had been used for many years before the explicit shift in the tax base took place. As explained, before there was explicit ETR, all these implicit shifts were budget-positive.

c) Denmark raised the tax on individuals' capital income as well as closed capital income loopholes for individuals to finance the third stage of its ETR.

d) Finland raised corporate profit taxes in the second phase of its ETR.

e) Denmark used a tax on the withdrawal of water to finance part of the first stage of its ETR. Such taxes are also in use in other countries, but they have not served to finance ETR

It is interesting to observe that the enacted tax reforms demonstrate certain very strong patterns. They rely on taxes rather than subsidy reductions, probably because the latter are not perceived (perhaps not rightly so) to provide an adequate revenue source for substantial cuts in other taxes, and because strong political forces resist subsidy reductions. They focus primarily on emissions rather than natural resource extraction (treating taxes on fossil fuel consumption as emissions rather than extraction charges). The tax reforms we describe are all explicit, but this is an artifact of our study design, and many of these nations have engaged in implicit tax reform, as well. Most of the reforms have been budget-neutral, although a few have been net tax reductions. Most of the revenue from pollution charges has been used to reduce other taxes, although several nations have devoted part of the revenue – usually a small part – to environmental purposes. All of the enacting nations used the revenue to cut taxes on labor rather than capital, and indeed two nations enacted capital tax increases as part of the ETR package used to cut labor taxes. Finally, every nation enacting an ETR included measures to mitigate impacts on energy intensive industries, and most included measures to mitigate impacts on low-income households, as well.

5   IMPACT OF ETR: EVIDENCE FROM NATIONAL MODELING

This section reviews evidence on the macroeconomic and environmental effects of ETR, based upon several dozen studies. The studies come from ten European countries, and from groups of countries such as the European Community/Union. The overwhelming majority of these studies were carried out before the adoption of an ETR package. In some cases, countries that have not adopted an ETR also conducted studies. Very few *ex post* studies of economic impact and environmental effectiveness exist.

Indicators of interest include employment, prices and wages, and GDP, plus some measure of environmental impact, where available. The distributional and sectoral impacts of ETR will also be discussed where evidence is available.

5.1   Austria

The Austrian Institute of Economic Research (WIFO) analyzed the effect an energy tax with revenue recycling would have in Austria. The analysis was carried out using a macroeconomic model combined with an input-output model. The energy tax proposal was that of the Austrian CO_2 Committee, a multidisciplinary working group that is responsible for the foundations of the Austrian climate policy. However, this reform has not been formally endorsed by the Austrian government. Table 5.1 illustrates the significant commodity price increases caused by such an energy tax.

Table 5.1: Commodity Price Increases Due to Proposed Energy Taxation in Austria

(in %)

	1 year	5 years
Electricity	5.3	17.4
Natural gas	9.7	31.2
Heating oil	15.7	47.2
Coal/coke	10.3	31.4
Gasoline	9.7	27.6

Sources: Angela Köppl, "Empirical Assessment of an Energy Tax Proposal for Austria," ed. Kai Schlegelmilch, *Green Budget Reform in Europe: Countries at the Forefront* (Berlin: Springer, 1999): 33-40; Angela Köppl *et al*. "Macroeconomic and Sectoral Effects of Energy Taxation in Austria," *Environmental and Resource Economics* 8 (4) (December 1996): 417-30.

Three recycling scenarios were envisioned: (1) a reduction in employers' social security contributions and dissemination of energy-efficient technologies (renewables and co-generation district heating are exempted); (2) a reduction in the budget deficit; and (3) a reduction in employers' social security contributions only. Interestingly, as Table 5.2 indicates, the first scenario, *i.e.*, a combination of recycling and earmarking, generated the best economic results, except in terms of inflation.

Table 5.2: Effect of an Energy Tax in Austria

(difference in % relative to baseline scenario, after 5 years)

	Recycling scenario		
	SSC plus energy effic.	**None**	**SSC only**
GDP	0.4	-2.5	-0.2
Employment	0.4	-2.1	-0.3
Private consumption deflator	1.8	3.3	0.9
Private consumption	-0.3	-3.2	-0.4
Investment	4.2	-5.1	-0.7

Sources: Angela Köppl, "Empirical Assessment of an Energy Tax Proposal for Austria," ed. Kai Schlegelmilch, *Green Budget Reform in Europe: Countries at the Forefront* (Berlin: Springer, 1999): 33-40; Angela Köppl *et al*. "Macroeconomic and Sectoral Effects of Energy Taxation in Austria," *Environmental and Resource Economics* 8 (4) (December 1996): 417-30.

A sectoral analysis suggested that the largest negative impact of energy taxation would fall on the energy-intensive sectors of the economy, such as basic metals, paper and chemicals. There would be positive effects on labor-intensive sectors, technology sectors, and certain energy-related sectors, in particular energy insulation and co-generation.

5.2 Belgium

There have been three major ETR studies for Belgium (not including multi-country studies discussed below). First, a general equilibrium model was designed to predict the effect of the EC-wide (USD 10 per barrel) CO_2 tax on Belgium. No country outside the EC was assumed to impose the tax. The tax revenues were assumed to be used to reduce personal income taxes. This simulation was based upon a hypothetical reform, although the tax level was the one proposed by the EC. The model included neither competitiveness offsets nor technology promotion policies.

The study found that Belgian GDP would be only marginally affected, real wages would fall and unemployment would be unchanged. Among the necessary conditions to attain these results was the flexibility of the real wage rate in order to avoid unemployment, which would otherwise be caused by the increases in payments to labor. The tax increase could not be fully passed on to sales prices as the rest of the world would be prepared to absorb only a fraction of price increases. The rest must thus be split between domestic capital and labor.[74]

In sectoral terms, the study found that the energy and intermediate goods sectors would suffer losses in production (over 5%), while long-run output in consumer goods, equipment goods, construction, transport and communication, and services would range from nearly unchanged to slightly increased. Finally, such an ETR was predicted to help Belgium reduce its CO_2 emissions by over 10%.

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[74] European Commission, *European Economy: The Economics of Limiting CO_2 Emissions*, Special Edition no.1 (Brussels: European Commission, Directorate-General II, 1992): p.120.

Table 5.3: Effect of a EC-Wide CO_2 Tax on Belgium

(difference in % from baseline)

	7 years	14 years
GDP	0.1	0.0
Investment by firms	-1.5	-1.5
Real wage rate	-4.1	-3.1
Employment	0	0
CO_2 emissions	-11.2	-12.4

Source: S. Proost, and D. Van Regemorter, "Carbon Taxes in the European Community: Design of Tax Policies and their Welfare Impacts," *European Economy: The Economics of Limiting CO₂ Emissions*, Special Edition no.1 (Brussels: European Commission, Directorate-General II, 1992): 118-20.

Second, the Belgian Economic Ministry's planning unit designed Hermès, one of the earliest macroeconomic models used to simulate the effect of energy taxation. In 1993, simulations of an energy tax produced the results presented in Table 5.4. Again, this simulation was based upon a hypothetical energy tax reform, although the tax level was the one proposed by the EC.

Four scenarios were envisaged: (1) an energy tax without revenue recycling; (2) recycling via reductions in PIT; (3) recycling via reductions in employers' SSC; and (4) a combination of 70% recycling via reductions in employers' SSC and 30% earmarking for investments designed to improve energy efficiency.

The option of recycling the energy tax revenue by reducing employers' SSC produced the most favorable results in terms of jobs created and economic cost. However, the hybrid of 70% recycling and earmarking 30% for financing improvements in energy efficiency achieved the highest reduction in carbon emissions, while still enabling the creation of a substantial number of jobs.

Table 5.4: Effect of an Energy Tax in Belgium

(percentage difference from baseline scenario after 8 years)

	Recycling scenario			
	None	**PIT**	**SSC**	**70% SSC and 30% energy efficiency**
Private consumption	-0.70	1.22	-0.14	-0.24
Consumer prices	1.70	2.07	0.78	1.29
Firms' gross investments	-2.62	-2.28	-0.62	0.36
GDP	-0.55	-0.08	0.52	0.32
Employment (jobs)	-8,650	6,470	43,280	26,710
Real disposable income	-0.54	1.55	-0.10	-0.11
Unit wage cost	1.57	2.30	-2.01	0.04
CO_2 emissions	-6.31	~-5	~-5	-8.87

Source: F. Bossier, and T. Bréchet, "Impact économique et efficacité d'une taxe graduelle sur l'énergie: l'analyse du modèle Hermès," *Cahiers économiques de Bruxelles*, no.138 (2nd quarter 1993): 151-84.

Third, additional simulations were conducted in 1993, which entailed reducing the value-added tax as a way to recycle the tax revenue of a CO_2/energy tax (EC tax of USD 10 per barrel of oil).

The VAT avenue was found to be superior in terms of containment of inflation, but inferior to the employers' SSC option with respect to the number of jobs created and effect on GDP.[75]

5.3   Denmark

Modeling studies in preparation for the ETR contemplated by the Danish government were based on a tax of DKK 200 per metric ton of CO_2, or approximately USD 122 per metric ton of carbon or USD 19 per barrel of oil, *i.e.*, about twice the proposed EC tax.

As exlained earlier, the Danish tax base shift took a more complicated form, with respect to both the tax rate and the compensations to affected industries. The economic simulations, in contrast, contained neither compensations to industry nor incentives for improvements in energy efficiency.

Table 5.5 displays the modeling results of two recycling scenarios with the ADAM macroeconomic model, namely a reduction in employers' social security contributions or a reduction in personal income tax. The reduction in employers' SSC clearly was the preferred scenario in terms of employment creation.

Table 5.5: Effect of a DKK 200 Tax per Metric ton of CO_2 on the Danish Economy

(tax levied over 4 years from 1996; effect by 2005)

	Recycling Scenario	
	SSC	PIT
CO_2 emissions (%)	-5	-5
Employment (jobs)	3,000	-1,000
Private consumption (%)	0.3	0.3

Source: Danish Ministry of Finance, *Grønne afgifter og erhvervene* (Copenhagen: Ministry of Finance, April 1994): 107-14.

The Danish government estimated further that the macroeconomic effect of the environmental tax shift would be "very modest." Over the period 1996-2000, wage costs to firms were predicted to increase 0.5% before recycling. When recycling was taken into account, the increase was virtually annihilated. In addition, improved technology was expected to help boost competitiveness. Figure 5.1 deconstructs the various effects of the tax shift on employment. Note that these estimates included the economic effects from the energy efficiency investment grant.[76]

The expected employment effect of the third (1999-2002) ETR phase is a wider gap between wages and unemployment benefits, which should create incentives for employers to hire and for workers to shorten the time spent out of a job. Meanwhile, lower marginal tax rates were projected to increase average working time. This increase in labor supply would contribute to restraining wage inflation and widen the tax base. The reductions in marginal rates were targeted at low-income groups in order to reduce unemployment and alleviate poverty at the bottom end

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[75] F. Bossier, T. Bréchet, and N. Gouzée, *Faire face au changement climatique: les politiques de lutte contre le renforcement de l'effet de serre* Planning paper no.63 (Brussels: Bureau du Plan, September 1993): 90.
[76] Danish Ministry of Finance, *Energy Tax on Industry in Denmark* (Copenhagen: Ministry of Finance, December 1995): 17-9.

of the income scale.[77]   Through the various tax adjustments described in section 2.1, GDP growth was expected to be lower by 1% in 1999 (1.9% instead of 2.9%).[78]

Figure 5.1: The Effect of the Danish Tax Shift on Employment

(in thousand workers by the year 2000)

Source: Danish Ministry of Finance, *Energy Tax on Industry in Denmark* (Copenhagen: Ministry of Finance, December 1995): 9.

The sectoral impact of Denmark's ETR was found likely to benefit the services sectors as well as certain branches in the manufacturing industry characterized by high labor intensity. The worst affected branches within manufacturing would be food and drinks, iron and metals, engineering, textiles, and furniture. However, these energy-intensive sectors would benefit from favorable reimbursements as heavy processes (see Table 2.4 and accompanying text).[79]

In an *ex ante* assessment of environmental effectiveness, the Danish government recently concluded that the CO_2 tax-*cum*-rebate package would reduce carbon dioxide emissions by some 2.3 million tons over the period 1995-2005, which is equivalent to 3.8% of Denmark's 1995 emissions. An econometric analysis of the package suggests that the tax proper would yield a 2% reduction in business CO_2 emissions between 1995 and 2005, investment grants would achieve a 1.2% cut, and the various voluntary agreements in force between the government and industry sectors would enable a 0.6% reduction.[80]

Furthermore, the SO_2 tax is thought to have had a significant effect on the sulphur content of fuels. The sulphur content of gas has been reduced from 0.2% to 0.05%; that of heavy fuel oil has been lowered from around 1% to about 0.5%; and that of coal has been cut by about one-third. In addition, sulphur purification plants have spread and technology improved.[81] The SO_2

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[77] Danish Ministry of Finance, *Summary of the Tax Adjustments* (Copenhagen: Ministry of Finance, August 14, 1998), on the web at http://www.fsk.dk/locations/fm/taxadjust/index.htm.

[78] Danish Ministry of Finance, *Summary of the Tax Adjustments*, (Copenhagen: Ministry of Finance, August 14, 1998) on the web at http://www.fsk.dk/locations/fm/taxadjust/index.htm.

[79] Danish Ministry of Finance, *Energy Tax on Industry in Denmark* (Copenhagen: Ministry of Finance, December 1995): 19-21.

[80] "Danish Industrial CO_2 Tax Rated Successful," *ENDS Environment Daily* (London: February 15, 1999).

[81] Danish Ministry of Taxation, *Energy Taxes: The Danish Model* (Copenhagen: Ministry of Taxation, September 6, 1998): 31.

tax also helps to reduce CO_2 emissions: as sulphur-rich fuels also typically contain large amounts of CO_2, their reduced consumption will lead to a relatively large reduction in CO_2 emissions.[82]

5.4 Finland

Two studies were used by the government to decide on the reorganization of environmental and energy taxes: the KESSU IV model of the Ministry of Finance and the University of Oulu's FMS model. Both simulated a CO_2 tax and assumed revenue neutrality and unchanged wages and interest rates as a result of the CO_2 tax. The international tax was the CO_2 tax considered at the European level.

Neither model, however, simulated the actual Finnish ETR that took place in 1997. In particular, no compensation to domestic industry as a result of the unilateral imposition of a carbon tax was factored into the model.

Under KESSU IV model, the hypothetical tax was imposed gradually starting in 1994 and reached its full scope in 2000. The simulation extended until 2005. Under the FMS model, the tax was enacted in 1991 and reached its full scope in 2000. Table 5.6 contains the results of various simulations based on these models.

Both models predicted that imposing a CO_2 tax and recycling the revenues through reductions in PIT would negatively affect the Finnish economy on virtually all counts. These impacts would be smaller if revenue recycling happened through cuts in employers' SSC or in VAT. Although results are not unambiguous, reducing employers' social security contributions was expected to minimize the negative impact on the economy. In light of these findings, the decision of the Finnish government to recycle the carbon tax revenue to reduce primarily personal income taxes in 1997 suggests that the Finnish debate on ETR was influenced by factors other than economic forecasts.

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[82] If coal is replaced by fuel oil, CO_2 emissions are reduced by about 20%. If the coal is replaced by natural gas, emissions are reduced by almost 50%.

Table 5.6: Predicted Impact of a CO_2 Tax on the Finnish Economy in 2005

(recycling by reducing personal income tax, VAT or Employers' SSC; difference from baseline trend)

Model	Indicator	Unilateral tax			International tax		
		I*	II*	III*	I*	II*	III*
KESSU IV	GDP (%)	-1.1	-1.1	-0.8	-0.3	-0.4	-0.2
	Household consumption (%)	-0.5	-0.9	-1.2	0.3	-0.4	-1.0
	Investments (%)	-1.4	-1.3	-1.1	-0.5	-0.6	-0.4
	Exports (%)	-2.5	-2.1	-1.3	-1.4	-0.7	0.1
	Imports (%)	-1.0	-1.1	-1.2	-0.5	-0.8	-1.0
	Consumer prices (%)	1.9	0.5	1.3	2.4	0.6	1.6
	Employment (in thousand jobs)	-24.8	-24.8	-13.6	-7.0	-8.2	0.8
	Net foreign debt/GDP (%)	2.1	1.1	-1.6	-1.3	-2.5	-5.9
FMS	GDP (%)	-2.8	n.a.	1.0	-0.1	n.a.	-0.1
	Household consumption (%)	0.5	n.a.	1.8	1.2	n.a.	0.6
	Public consumption (%)	-3.8	n.a.	2.0	-0.2	n.a.	0.9
	Investments (%)	-6.2	n.a.	0.6	-1.0	n.a.	0
	Exports (%)	-3.0	n.a.	-0.4	-2.0	n.a.	-2.0
	Imports (%)	-1.4	n.a.	1.7	-0.5	n.a.	-0.7
	Employment (in thousand jobs)	-44.8	n.a.	21.6	8.6	n.a.	3.8

*   I = Reduced personal income tax scenario, amounting to 66% of environmental tax revenues with unilateral tax and 94% with international tax in 2005 (as above).

II = Reduced value added tax scenario, normal rate 20.1% with unilateral tax and 19.5% with international tax in 2005.

III = Reduced employers' social security contribution scenario, 50% of present rate with unilateral tax and 35% with international tax in 2005.

Source: Finnish Ministry of the Environment, *Interim Report of the Environmental Economics Committe*e (Helsinki: Ministry of the Environment, 1994): 59-60.

Table 5.6 contained the results of simulations assuming no wage adjustments as a result of the tax. This constraint was relaxed in further simulations using the KESSU IV model. Table 5.7 below shows the results for recycling of the CO_2 tax revenues through a reduction in employers' SSC, with and without adjustment of earnings. Results are much more favorable in terms of employment and inflation under the assumption that real earnings are not adjusted to compensate for the rise in environmental taxes. On the other hand, the model predicted that fully compensating real earnings for the environmental tax would reduce employment, due primarily to the rising labor costs resulting in lower demand for labor. Economic activity was also projected to slacken in this case.[83]

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[83] Finnish Ministry of the Environment, *Interim Report of the Environmental Economics Committe*e (Helsinki: Ministry of the Environment, 1994): 60-2.

Table 5.7: Predicted Impact of a CO$_2$ Tax on the Finnish Economy in 2000 or 2005

(recycling by cuts in employers' social security contributions, with wage adjustment; difference from baseline)

	Unilateral tax			International tax		
	I*	II*	III*	I*	II*	III*
GDP (%)	-0.8	-1.6	-0.3	-0.2	-1.1	0
Household consumption (%)	-1.2	-1.1	-1.5	-1.0	-1.8	-1.0
Investments (%)	-1.1	-2.1	-0.5	-0.4	-1.6	-0.2
Exports (%)	-1.3	-3.5	0.4	0.1	-2.4	0.6
Imports (%)	-1.2	-1.4	-1.3	-1.0	-1.3	-1.1
Consumer prices (%)	1.3	2.7	0	1.6	3.1	1.1
Nominal earnings (%)	n.a.	2.6	-2.4	n.a.	3.1	-0.6
Employment (in thousand jobs)	-13.6	-33.4	-0.7	0.8	-23.6	4.1
Net foreign debt/GDP (%)	-1.6	2.3	-3.4	-5.9	-0.7	-6.5

*   I = Nominal earnings unchanged (as above).
          II = Real earnings unchanged
          III = Adjusted nominal earnings

Source: Finnish Ministry of the Environment, *Interim Report of the Environmental Economics Committe*e (Helsinki: Ministry of the Environment, 1994): 61.

The likely effect of an ETR in Finland was also predicted outside of the government. One study using the same methodology as the Swedish Green Tax Commission simulated a reduction in employers' SSC using the revenues of a doubling of CO$_2$ taxes. It predicted that the CO$_2$ tax would slightly favor employment and GDP, but no substantial reductions in CO$_2$ emissions would ensue. In addition, it found that a general reduction in employers' SSC was better than one that discriminated among sectors. Different sectors would be impacted differently: labor-intensive sectors would see their employment level rise, while energy-intensive sectors would see a slight decline.[84]

5.5   Germany

In 1994 Greenpeace commissioned the German Institute for Economic Research (DIW) to study the effects of a hypothetical ETR in Germany. DIW's simulations, based on a macroeconometric model combined with an input-output analysis, assumed a tax on the energy content of electricity, gasoline, heating oil, diesel fuel and natural gas at the rate of DEM 0.63 per GJ. In accordance with Professor Hans Christoph Binswanger's automatic escalator proposal, the tax would be increased by a predictable annual rate of 7% for both private consumers and firms. Tax revenues would be fully recycled through cuts in SSC according to consumers' and firms' respective shares, *i.e.*, 29% to households and 71% to firms. Households would also be compensated in the form of an "eco-bonus," which would result in no net increase in tax burden for households with average energy consumption. No additional compensation to businesses, *e.g.*, in the form of tax refunds, border tax adjustments, or energy efficiency incentives, were contemplated in the model. Table 5.8 contains more details on the predicted effects of this package.[85]

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[84] Juha Honkatukia, *Are There Double Dividends in Finland? The Swedish Green Tax Commission Simulations for Finland* (Helsinki: Helsinki School of Economics and Business Administration, 1997).
[85] Greenpeace, and Deutsches Institut für Wirtschaftsforschung (DIW), *The Price of Energy* (Aldershot, UK: Dartmouth, 1997): 14.

Table 5.8: Potential Effect of Environmental Tax Reform in Germany

(change after 10 years, relative to reference scenario)

CO$_2$ emissions	-21%
Employment (jobs)	500,000
Private consumption	-1.0%
Consumer prices	3.1%
Investment	-1.0%
GDP	-0.2%
Unit wage costs	-2.2%

Source: Greenpeace, and Deutsches Institut für Wirtschaftsforschung (DIW), *The Price of Energy* (Aldershot, UK: Dartmouth, 1997): 14.

Given some minor adjustments to this basic scenario, *e.g.*, assuming that labor unions would moderate their demands for indexing wages on prices after the energy tax was levied, the slightly negative effect on GDP could be further minimized, and more jobs would even be created.

The input-output analysis also predicted that energy-intensive sectors would be the hardest hit, in particular iron and steel, cellulose, paper and cardboard, water, railway services and chemicals. By contrast, labor-intensive sectors would fare the best, including the government, the aircraft and aerospace industries, and the precision mechanics and optics sectors, which would all record cost reductions.[86]

In terms of distributional impact, the "eco-bonus" system would more than offset the additional burden for low-income households.[87]

Compared with this DIW scenario, the ETR passed by Germany in March 1999 (described in section 2.3) was much more timid. In particular, under the actual system, extensive rate reductions were granted to certain industrial sectors, preventing the full deployment of an ETR and the achievement of the positive results forecast by DIW.

A more recent study carried out by the Rhein-Westfalia Institute for Economic Research (RWI) projects the impact of the actual German ETR package. This is one of the rare examples of an actual legislative bill submitted by the government for economic modeling. Most of the simulations reviewed in this paper diverge in their assumptions from the ETR packages actually passed, thereby weakening their realism. The RWI study, the results of which are summarized in Table 5.9 and Table 5.10, does not exhibit this weakness.

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[86] Greenpeace, and DIW, *The Price of Energy* (Aldershot, UK: Dartmouth, 1997): 88-90.
[87] Greenpeace, and DIW, *The Price of Energy* (Aldershot, UK: Dartmouth, 1997): 120.

Table 5.9: Predicted Effect of Environmental Tax Reform in Germany

(change after 3 years, relative to reference scenario)

CO_2 emissions	~-3% *
Employment (jobs)	106,000
Private consumption	0.1%
Investment	-0.4%
GDP	0%

* 3% of the 140 million tons Germany needed to abate to reach its goal of a 25% reduction below 1990 emissions, or a little more than 3% below what the remaining climate policy measures would achieve without ETR.
Source: Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI), *Stellingnahme zum Entwurf eines Gesetzes zum Einstieg in die ökologische Steuerreform* (Essen, Germany: RWI, January 18, 1999)
http://www.rwi-essen.de/presse/fg/finanzen/oekosteu.htm

Using the macroeconometric Konjunkturmodell, RWI predicted that the impact of the German ETR (relying on a carbon/energy tax, the receipts of which are used to reduce employers and employees' SSC, together with the accompanying measures described earlier) would be positive. Over a period of two years in excess of 100,000 jobs would be created, with no change in GDP or inflation. Investment would be only slightly depressed.

Distributionally, families were predicted to benefit more than those couples without children. Sectorally, most branches would enjoy net cost reductions, except for agriculture and forestry, trade and transport, and the government. Energy-intensive industries, except for transport, would generally not be harmed by the reform, thanks to the competitiveness-safeguarding policies built into the package.

RWI again ran Konjunkturmodell to refine its predictions once the details of the German ETR were finalized. Table 5.10 thus fits the actual German reform better than Table 5.9. In particular, the fact that predicted emission reductions are triple the earlier prediction has to do in part with the fact that the reference scenario was lower the second time around (100 as opposed to 140 $MtCO_2$ to be abated to reach the national target of a 25% reduction below 1990 levels), and with the more aggressive tax pattern (which would achieve a reduction of 9 as opposed to 4 $MtCO_2$). Both in environmental and economic terms, the predicted results were better than in the first simulation.

Table 5.10: Predicted Effect of Environmental Tax Reform in Germany

(change after 6 years, relative to reference scenario)

CO_2 emissions	~-9% [a]
Employment (jobs)	125,000
Private consumption	0.1%
Consumer prices	0.1%
Investment	-0.1%
GDP	0.1% [b]

a) 9% of the 100 million tons Germany needed to abate to reach its goal of a 25% reduction below 1990 emissions, or a little more than 9% below what the remaining climate policy measures would achieve without ETR. Result by 2010;

b) after 1 year.

Source: Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI), Stellungnahme zum Entwurf eines Gesetzes zur Fortführung der ökologischen Steuerreform. (Essen, Germany: RWI, October 4, 1999)
http://www.rwi-essen.de/presse/fg/finanzen/oekost-2.htm

5.6 The Netherlands

Empirical studies carried out in 1992-1993 using the Athena industrial macroeconometric model were designed to forecast the effects of a CO_2/energy tax on the Dutch economy. Four scenarios were envisaged: (1) a general energy tax on all fossil fuels and uranium in the OECD area; (2) a general energy tax on all fossil fuels and uranium in the Netherlands only; (3) a small-user energy tax in the Netherlands only; and (4) a small-user energy tax in the Netherlands only, against the background of lower world energy prices. Scenarios 3 and 4 foreshadowed the actual Dutch ETR of 1996.

The first three scenarios assumed that the energy tax and revenue recycling would start in 1993 and that real world energy prices would double by 2015. In the fourth scenario, an energy tax was imposed on small users from 1995 onwards, revenues were also recycled, but real world energy prices in the year 2000 would be at their 1990 level. Recycling occurred by first reducing employers' SSC and, if enough revenues remained, through additional reductions in PIT. No additional measures to compensate the corporate sector were included in the model. Table 5.11 contains a synopsis of the quantified results.

Table 5.11: Predicted Effect of CO$_2$/Energy Taxation on the Dutch Economy

(% difference from reference scenario)

Scenario	I		II		III		IV	
	2005	**2015**	**2005**	**2015**	**2005**	**2015**	**2005**	**2015**
Household consumption	-4	-6	-9	-8	-0.2	-0.7	-0.1	-0.1
Consumer prices	-2.0	-8.0	2.0	1.0	3.8	4.0	0.4	0.6
Investments	-7	-10	-8	-8	-0.1	-0.5	0.3	0.1
Exports	-14	-17	-11	-6	-1.5	-1.5	0.1	0
GDP	-5	-6	-6	-5	-0.2	-0.4	0.2	0.4
Wage rate	-8	-12	-8	-11	0.5	1.4	-0.6	0
Disposable real wages	-6	-10	-12	-11	-0.1	-0.7	n.a.	n.a.
Employment (thousand jobs)	-155	-250	-270	-140	8	-12	9	5

I= OECD-wide 100% energy tax, with revenue recycling.
II= Dutch energy tax, with revenue recycling.
III= Dutch tax on small-scale energy consumption, with revenue recycling.
IV= Dutch tax on small-scale energy consumption, with revenue recycling and lower world energy prices.
Sources: Centraal Plan Bureau (CPB), *Economic Long-Term Consequences of Energy Taxation*, Working Paper no.43 (The Hague: CPB, February 1992); CPB, *Effecten van een kleinverbruikersheffing op energie bij lage en hoge prijsniveaus*, Werkdocument no.64 (Den Haag: Centraal Planbureau, December 1993).

Both scenarios I and II predicted very negative results. Firms would relocate abroad, causing sharp losses in production and employment. Interestingly, in the long run, the "Dutch-only" tax (scenario II) would cause less damage to GDP and employment because the Dutch economy would still benefit from unchanged import demand in other OECD countries. Scenario III returned much better results because no massive relocation of firms and employment ensued (large energy users were exempted from the CO$_2$/energy tax). Scenario IV was even better than III in light of the lower international energy prices. Given these results, it is no wonder that the Netherlands decided to focus on small users' energy consumption when the CO$_2$/energy tax and ETR were launched in 1996.

New evidence became available in 1997 when the Dutch Green Tax Commission asked the Netherlands Bureau for Economic Policy Analysis (CPB) to assess the macroeconomic effects of further raising energy tax rates. CPB's results for the period 1995-2020 are summarized in Table 5.12. Earlier results are essentially unchanged. Two scenarios were examined: (1) the rates of both the regulatory tax on energy and the general fuel tax rates were doubled, except for very large consumers; and (2) the regulatory tax rate was tripled for very small consumers. The basic exemptions of 800 m³ of natural gas and 800 kWh of electricity per year were maintained. In both variants, the extra revenues were recycled to firms through a reduction in employers' SSC and to households through a reduction in PIT. No additional measures were planned to compensate firms.

Table 5.12: Economic Effects of Raising Energy Tax Rates in the Netherlands

(percentage difference from reference trend)

Scenario	I*		II*	
	2010	**2020**	**2010**	**2020**
Household consumption	-0.2	-0.2	-0.2	-0.3
Consumer prices	0.8	0.8	1.2	1.2
Investments	0.1	0.1	0.1	0.1
Exports	-0.2	-0.2	-0.2	-0.2
GDP	-0.1	-0.1	-0.1	-0.1
Wage rate	0.0	0.1	0.4	0.4
Employment	0.0	0.0	0.0	0.0

*   I: doubling of regulatory tax on energy and general fuel tax rates, except for very large consumers. Revenues recycled.
     II: tripling of regulatory tax rates for households. Revenues recycled.
Source: Centraal Plan Bureau (CPB), *Greening Taxes and Energy: Effects of Increased Energy Taxes and Selective Exemptions*, Working Document no.96 (The Hague: CPB, June 1997): 15.

The predicted effects were very slight in relative terms. Notably, there was no predicted gain or loss in employment. This, however, assumed that no increased wage demands followed from the shift in the tax base. According to CPB, recycling revenues by cutting employers' SSC would have a more favorable effect on employment than recycling through PIT reductions.[88] Moreover, the positive impact of cuts in employers' SSC on employment would be the greatest when those cuts targeted the low-income brackets.[89]

A separate study underscored the importance of factor mobility and international harmonization in determining the impact of ETR on employment. In particular, if capital weres mobile and labor immobile across borders, the incidence of a unilateral CO_2/energy tax would ultimately fall on the labor factor, thereby reducing the initial incentive to work and hire.[90]

In a European study designed to assess the effect of a CO_2 tax recycled through differential cuts in employers' SSC, *i.e.*, a greater reduction in the contributions due for low-income workers, the MIMIC model was run for the Netherlands. The results suggested a 1% increase in the number of jobs in the reference year, or a 0.6% reduction in the unemployment rate.[91] (In the actual reform, of the NLG 2.2 billion raised by the regulatory tax on energy in 1997, about 42% was recycled to firms and 58% was recycled to households. As explained, recycling to households was done by a combination of a personal income tax rate reduction and an increase in income tax-free allowances). From a distributional point of view, the model predicted this combination of energy tax and tax relief would produce a negligible impact on households with average energy consumption. In sectoral terms, as a percentage of value added, the model predicted that

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[88] CPB, *Greening Taxes and Energy: Effects of Increased Energy Taxes and Selective Exemptions*, Working Document no.96 (The Hague: CPB, June 1997): 16; Dutch Green Tax Commission, *A Summary of Its Three Reports 1995-1997* (The Hague: Ministry of Finance, March 1998): 18.

[89] Dutch Ministry of Finance, *Belastingen in de 21e eeuw: een verkenning* (The Hague, Ministry of Finance, 1998): 30.

[90] Gerrit de Witt, "Belastingverschuiving en werkgelegenheid," *Economisch statistische berichten* 3996 (February 8, 1995): 134-7; Gerrit de Witt, *Werkgelegenheidseffecten van een belastingverschuiving van arbeid naar milieu* (Delft, The Netherlands: Centrum voor energiebesparing en schone technologie, April 1994).

[91] European Commission, *Croissance, compétitivité, emploi: les défis et les pistes pour entrer dans le XXIe siècle* (Brussels: European Commission White Book, 1994): 163-5.

the impact on firms would vary between – 0.6% for the hotel and catering sector, and + 0.1% for the construction, wholesale trade, transport, and financial services sectors. The effect would be negligible for many sectors, including chemicals and metals.[92]

Turning to the environmental consequences of the Dutch environmental tax reform, several estimates of the effectiveness of the CO_2 tax exist. First, all energy taxes in the Netherlands probably caused a one percent reduction in CO_2 emissions in 1994 alone. Second, it was estimated that by the year 2000 energy taxes would reduce CO_2 emissions by 1.3% compared to the baseline scenario, a result which could be further enhanced if some of the revenues of the energy tax were to be recycled to firms and households for investments in energy efficiency.[93] Third, each NLG 1 billion raised by the general fuel tax is estimated to contribute to a reduction of over 1 Mt CO_2. Fourth, the regulatory tax on energy is expected to result in a 1.5% reduction in CO_2 emissions, while the CO_2 emissions from the groups targeted by the tax are projected to decline by 5%. Finally, in addition to CO_2 reductions, energy taxes also induced comparable reductions in NO_x emissions.[94]

5.7 Norway

The main Norwegian studies carried out to simulate a revenue-neutral tax shift from labor to CO_2 used the macroeconomic model MODAG. Three scenarios will be reported here, which differ by the type and level of carbon taxation. All three assumed that the industrial sectors traditionally exempted from the existing tax (see section 2.6) would see their advantages scaled down or phased out. The tax revenues would be recycled through reductions in employers' SSC, the level of which would be determined by the amount of revenue received from the tax. No additional accompanying measures to firms or specific incentives for investments in energy efficiency improvements were taken into account in the simulations, contrary to the actual Norwegian ETR of 1999.

The main conclusions of the simulations were that, in the short run, CO_2 emissions would decline in response to the tax, but no significant gains in employment would be registered as a consequence of the shift. However, in the longer run, the shift would exercise a positive effect on employment, conditional upon the moderation of wage increases throughout the economy. Table 5.13 contains more details on the estimated economic and environmental effects of the tax between 1992 and 2010.[95]

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[92] Willem Vermeend, and Jacob van der Vaart, *Greening Taxes: The Dutch Model* (Deventer, Netherlands: Kluwer, 1998): 26-48.

[93] Dutch Green Tax Commission, *A Summary of Its Three Reports 1995-1997* (The Hague: Ministry of Finance, March 1998): 42; Dutch National Institute of Public Health and the Environment (RIVM), *Ecologisering van het belastingstelsel: Indicatieve berekeningen van de milieu-effecten van belastingen op het terrein van energie en verkeer en vervoer, Achtergronddocument* no. 408130 001 (Bilthoven, Netherlands: RIVM, 1996): 16-23.

[94] Willem Vermeend, and Jacob van der Vaart, *Greening Taxes: The Dutch Model* (Deventer, Netherlands: Kluwer, 1998): 35, 45.

[95] Norwegian Green Tax Commission, *Policies for a Better Environment and High Employment: An English Summary of the Norwegian Green Tax Commission* (Oslo: Ministry of Finance, September 1996): 143-51.

Table 5.13: Effect of Carbon Taxation in Norway

(percentage difference from baseline scenario)

	Scenario *							
	I		II		III		IV	
	2000	2010	2000	2010	2000	2010	2000	2010
GDP	-0.1	0	-0.1	-0.3	-0.2	0.3	n.a.	n.a.
Employment	0	0.1	0.2	0.4	0.1	0.4	0.3	0.7
Consumer prices	-0.1	-0.3	-0.2	-1.3	-0.8	-1.0	-0.6	-1.2
Unit Wages	-0.2	-0.4	-0.5	-2.3	-1.2	-0.9	n.a.	n.a.
CO_2 emissions	-0.2	-0.4	-1.5	-4.8	-0.9	-1.6	-3.7	-6.0
SO_2 emissions	-0.6	-1.1	-3.9	-11.8	-1.3	-3.8	-7.5	-9.5

*   I = NOK 50/metric ton CO_2 tax on sectors currently not paying the tax; 0.2% reduction in employers' social security contributions.

II = escalation scheme: all sectors paying a NOK 360/metric ton CO_2 tax after 7 years; diesel tax increased to equal gasoline tax; 2% reduction in employers' social security contributions.

III = extension of the consumption tax on electricity to all industrial sectors; 1% reduction in employers' social security contributions.

IV = increase in CO_2 taxes by 1% of GDP; 2.3% reduction in employers' social security contributions.

Sources: Thorvald Moe, "Policies for a Better Environment and High Employment," ed. Kai Schlegelmilch, *Green Budget Reform in Europe: Countries at the Forefront* (Berlin: Springer, 1999): 101; Norwegian Green Tax Commission, *Policies for a Better Environment and High Employment: An English Summary of the Norwegian Green Tax Commission* (Oslo: Ministry of Finance, September 1996): 143-51.

It was predicted that certain individual enterprises, notably in the ferro-alloy and carbide sectors, would be negatively impacted by a CO_2 tax, while many labor-intensive branches of industry would benefit from cuts in employers' SSC.

Despite those simulations, the ETR that took effect in January 1999 does not recycle environmental tax revenues through reductions in employers' SSC, but rather through reductions in PIT to households and tax refunds to industry.

At least some *ex post* data exists on the environmental effect of the Norwegian carbon tax: one source reports that the CO_2 tax is estimated to have achieved a 3-4% reduction in the carbon emissions of stationary sources in the manufacturing and services sectors, as well as stationary and mobile sources of households, together representing around 40% of total CO_2 emissions in Norway, over the period 1991-1993.[97]

5.8 Sweden

Swedish studies involved the use of a sophisticated CGE model. The main conclusion was that a "strong double dividend," *i.e.*, an economic improvement regardless of the level of environmental impact (see Goulder's definitions *supra* in section 1), was unlikely in Sweden.

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[96] Norwegian Green Tax Commission, *Policies for a Better Environment and High Employment: An English Summary of the Norwegian Green Tax Commission* (Oslo: Ministry of Finance, September 1996): 150-1.

[97] Bodil Merethe Larsen, and Runa Nesbakken, "Norwegian Emissions of CO_2 1987-1994: A Study of Some Effects of the CO_2 Tax," *Environmental and Resource Economics* 9 (3) (April 1997): 275-90.

According to the simulations, a revenue-neutral tax base shift whereby a carbon tax would finance a reduction in labor taxes (*e.g.*, through reductions in employers' or employees' social security contributions or through reductions in personal income tax) would cause losses in Swedish welfare, as Table 5.14 illustrates.[98]

Table 5.14: Predicted Effect of a Tax Base Shift on Welfare and CO_2 Emissions in Sweden

Scenario *	"Welfare" (billion SEK)	CO_2 emissions (% change)	CO_2 revenue (% change)
C100EJVX	-4.6	-0.2	91
C50	-1.9	< -0.1	47
C100	-4.0	-0.1	92
C200	-8.1	-0.3	177
SELECT	-3.7	< -0.1	92

* C100EJVX = 100% increase in CO_2 tax without revenue recycling.
    C50= 50% increase in CO_2tax with recycling through cuts in labor taxes.
    C100= 100% increase in CO_2 tax with recycling through cuts in labor taxes.
    C200= 200% increase in CO_2 tax with recycling through cuts in labor taxes.
    SELECT= 100% increase in CO_2 tax with recycling through cuts in labor taxes in the service sector only.
Sources: Glenn W. Harrison, and Bengt Kriström, *Carbon Taxes in Sweden* (Umeå, Sweden: University of Umeå, January 15, 1997) on the web at http://www.sekon.slu.se/~bkr/Carbon.pdf; Statens Offentliga Utredningar (SOU), *Skatter, miljö och sysselsätning: Slutbetänkande av Skatteväxlingskommitén* (Stockholm: SOU, 1997:11): 321-38; Swedish Green Tax Commission, *Taxation, Environment, and Employment* (Stockholm: Fritzes, 1997): 130-46.

Under scenario C100, the model predicted a welfare loss of SEK 4 billion, which equals around 0.2% of GDP. This welfare loss means a reduction in real income for households, with the exact cost distributed differently across different households, depending on their use of energy. For example, in the C100 scenario, all households would lose, but those with children would lose the most. In general, richer households would bear the highest costs given their greater use of fossil fuels. A selective cut in labor taxes (SSC) in the service sectors may be the most effective option for increasing employment. Actual CO_2 tax revenues would be less than the potential suggested by the tax rate because of the reduced consumption of fossil fuels in response to the tax (substitution away from fossil fuels without compensating rate hikes causes the CO_2 tax base to erode).

The key indicator in this study was changes in welfare, defined as households' real income and consumer surplus. It is important to bear in mind that this notion of welfare did not include the value of environmental benefits, which were excluded from the simulations. Also notably absent from the model was unemployment, *i.e.*, the labor market was assumed to clear, which means that the possibility of a second dividend in the form of reduced unemployment cannot be formally examined. It should moreover be noted that the simulations did not include any measures designed to alleviate the effect of increased energy taxation on firms. Finally, the CGE model did not attempt to describe the relationship between a shift in the tax base and technical innovations, precluding conclusions as to the degree of dynamic efficiency.

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[98] Statens Offentliga Utredningar (SOU), *Skatter, miljö och sysselsätning: Slutbetänkande av Skatteväxlingskommitén* (Stockholm: SOU, 1997:11): 482-3; Swedish Green Tax Commission, *Taxation, Environment, and Employment* (Stockholm: Fritzes, 1997): 131-2.

Likely sectoral winners of the ETR included telecommunications and medicines. Likely losers included the pulp-and-paper, transportation and retail sectors.[99]

The CGE model predicted very modest reductions in CO_2 emissions. However, the investigators revised these numbers upward by aggregating the emission reductions estimated in the partial equilibrium analyses of various sectors. The likely reduction in emissions was then estimated at 0.1-1.7%.

According to other technical estimations, Sweden's CO_2 emissions would have been 2-3% higher in 1994 without the introduction of the CO_2 tax. The Swedish Environmental Protection Agency estimated that part of the switch from fossil fuels to biomass fuels in the period 1989-1995 can be attributed to the CO_2 and energy taxes.[100] Finally, of all the Swedish taxes with an explicitly environmental purpose, the CO_2 tax is the one that collects the largest receipts, around 2% of total tax revenue.[101]

5.9 Switzerland

Switzerland has pondered levying a CO_2 tax for a number of years. Several attempts were made at modeling the likely impact of such a scheme on the Swiss economy. Appendix Table 1 at the end of this paper synthesizes the results of these studies. However, the study conducted jointly by INFRAS and ECOPLAN, one of the latest available, is reviewed in greater detail in this section.

The results of the INFRAS/ECOPLAN study, based on the static Swiss CGE model, reveal generally positive economic effects for a carbon/energy tax, assuming that this tax would be phased in gradually, that it would be revenue neutral through cuts in employers' social security contributions, preferably targeting low-income workers, and that rebates would be extended for energy-intensive industries. Table 5.15 summarizes the results from this study.

INFRAS/ECOPLAN studied two taxes: a CO_2 tax, only slightly different from the government's 1994 proposal, and an energy tax that broadly corresponded to the European Community proposal.

Under both the CO_2 and energy taxes, exemptions were extended to international aviation, non-energy use of fossil fuels, renewable energy sources, and exported fossil fuels. In addition,

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[99] Glenn W. Harrison, and Bengt Kriström, *Carbon Taxes in Sweden* (Umeå, Sweden: University of Umeå, January 15, 1997): 30-1, on the web at http://www.sekon.slu.se/~bkr/Carbon.pdf; Statens Offentliga Utredningar (SOU), *Skatter, miljö och sysselsätning: Slutbetänkande av Skatteväxlingskommitén* (Stockholm: SOU, 1997:11): 482.

[100] OECD, *Environmental Performance Reviews: Sweden* (Paris: OECD, 1996): 66; Maude Svensson, "Energy and Environmental Taxes in Sweden," paper presented at the conference "Green Taxes and Duties in International Perspective" (Copenhagen: November 25, 1996), in *Green Taxes and Duties: A Way Towards a Better Environment and Increased Employment* (Copenhagen: SiD, The General Workers Union of Denmark, May 1997): 39; Swedish Environmental Protection Agency, *Environmental Taxes in Sweden: Economic Instruments of Environmental Policy*, Report no.4745 (Stockholm: Swedish Environmental Protection Agency, March 1997): 26, 47-52.

[101] Åsa Johannesson, conversation with author, October 6, 1999; Swedish Environmental Protection Agency, *Environmental Taxes in Sweden: Economic Instruments of Environmental Policy*, Report no.4745 (Stockholm: Swedish Environmental Protection Agency, March 1997): 44.

energy-intensive sectors, whose energy tax liability represented more than 1% of gross production, benefited from tax reimbursements.[102]

The CO_2 tax was predicted to achieve better results than the energy tax in terms of minimizing the economic cost of the reform, especially when revenue recycling was targeted at low-income earners. However, an energy tax recycled through a combination of lump sum transfers to households and cuts in employers' SSC was estimated to lead to greater reductions in CO_2 emissions and slightly larger gains in employment. The different effects on aggregate output indicate that the tax would achieve efficiency gains allowing a higher GDP by increased labor and capital inputs and reduced energy consumption. Interestingly, the Swiss model suggested that the same gains might be achieved in a first-mover scenario as in an internationally-harmonized framework, provided that offsetting measures, such as border tax adjustments, sectoral recycling of revenues or a rebate scheme, were provided. The authors of the study also underlined that the long-term technological advances triggered by an ETR, which are referred to as dynamic efficiency, are usually underestimated in models, which causes an underestimation of the positive economic effects.

Table 5.15: Effect of a Swiss CO_2/Energy Tax

(percentage difference from baseline scenario)

	CO_2 tax		Energy tax
Recycling scenario	**General SSC**	**Targeted SSC**	**LSTH and SSC**
GDP	0.22	0.35	-0.20
Exports	0.38	0.45	-0.71
Imports	0.36	0.43	-0.65
CO_2 emissions	-6.05	-5.94	-12.13
Low-income employment	0.38	0.86	0.88
High-income employment	0.31	0.28	0.34

Source: INFRAS and ECOPLAN, Economic Impact Analysis of Ecotax Proposals: Comparative Analysis of Modelling Results (Brussels: European Commission, Directorate-General XII, November 1996).

These results are to be contrasted with those of a more recent study by ECOPLAN alone, in which an energy tax was used to finance an expansion in social security payments, to respond to the needs of an aging Swiss population. In that case, welfare effects were predicted to be negative. The difference points to the importance of reducing marginal tax rates on labor.[103]

5.10 The United Kingdom
In 1996 the Institute for Public Policy Research commissioned Cambridge Econometrics to study various ETR packages for the United Kingdom, not all of them grounded in an energy tax. At the time the British government had already introduced a small ETR using a landfill tax to replace the revenue foregone in the concomitant reduction in employers' SSC (National

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[102] INFRAS and ECOPLAN, *Economic Impact Analysis of Ecotax Proposals: Comparative Analysis of Modelling Results* (Brussels: European Commission, Directorate-General XII, November 1996): 67-71.

[103] Stefan Felder, Otto von Guericke, and Renger van Nieuwkoop, *Using Revenue From an Energy Tax to Finance Social Security: A Dynamic General Equilibrium Model for Switzerland* (Bern: ECOPLAN, 1998); Renger van Nieuwkoop, ECOPLAN, conversation with author, February 5, 1999.

Insurance Contributions) and the system of road fuel escalators, which were described in Section 2.8.

The model used was E3, a multisectoral dynamic macroeconomic model. The main scenario raised six different green taxes and used all the revenues to reduce either employers' SSC (in the "economist's package") or a combination of VAT, CPT and employers' SSC (in the "politician's package"). The "economist's package" confirmed the finding of other studies that the best results in terms of employment promotion and economic cost minimization are achieved when energy tax revenues are used to reduce employers' SSC. The "politician's package" also factors in the need for cutting other taxes to enlist the support of certain political groups. Note that neither scenario corresponded to an actual ETR package put forward by the British government. In addition, the packages contained no accompanying measures designed to alleviate the impact of the new taxes on the corporate sector.

Tables Table 5.16 through Table 5.18 give an overview of the two packages and their projected fiscal and macroeconomic impacts. On balance, the positive effect on employment after eight years would be substantial, while the drag on GDP would be minimal and inflationary pressure would be moderate. Environmental benefits would be considerable.

Table 5.16: Effect of ETR Proposals for the U.K.

(after 8 years; relative to baseline scenario)

	Energy tax	Higher landfill tax	Higher road fuel escalator	Quarrying tax	Office parking tax	End to company car perks	Total
Total tax revenues (GBP billion)	8.8	1.9	8.0	2.1	0.52	0.349	21.7

Source: Stephen Tindale, and Gerald Holtham, *Green Tax Reform: Pollution Payments and Labour Tax Cuts* (London: Institute for Public Policy Research, 1996): 98-122.

Table 5.17: Environmental Effect of a Comprehensive ETR Package for the U.K.

(after 8 years; relative to baseline scenario)

CO_2 emissions (%)	-9
SO_2 emissions (%)	-6
Waste produced (%)	-16
Landfill (%)	-18

Source: Stephen Tindale, and Gerald Holtham, *Green Tax Reform: Pollution Payments and Labour Tax Cuts* (London: Institute for Public Policy Research, 1996): 98-122.

Table 5.18: Macroeconomic Effects of an ETR Package for the U.K.

(after 8 years; relative to baseline scenario)

	Recycling scenario	
	"Economist" [a]	"Politician" [b]
Employers' SSC	-6.9	-4.5
VAT	--	-1.7
CPT	--	-3.0
GDP	-0.03	-0.27
Employment	2.56	2.06

a)   Reduction in employers' SSC
b)   Reduction in VAT, CPT and employers' SSC
Source: Stephen Tindale, and Gerald Holtham, *Green Tax Reform: Pollution Payments and Labour Tax Cuts* (London: Institute for Public Policy Research, 1996): 98-122.

The distributional impact of energy taxes without compensation could be regressive in the United Kingdom, as suggested by another study. In other words, energy taxes are predicted to affect low-income groups disproportionately, unless compensating measures are passed.[104]

5.11 Europe-Wide Studies

Environmental tax reform is offering interesting prospects in Europe where high tax rates on labor are thought to induce distortions harmful to employment. In the European Union as a whole, over 50% of total taxation falls on labor.[105] A number of voices have called for reducing the tax burden on labor in order to stimulate employment and economic activity. The European Commission itself recommended in the early 1990s that member states reduce the non-wage costs of low-income labor by an amount equivalent to 1-2% of GDP (1.5 to 4% of total tax revenue) by shifting taxes onto pollution and natural resources.[106]

The 1992 Commission's proposal for a CO_2/energy tax at the level of the European Community or European Union (EC or EU),[107] in particular, triggered a flurry of studies attempting to forecast the economic effects of the tax and revenue recycling.[108]

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[104] Elizabeth Symons, and John Proops, *The Distributional Implications of Pollution Taxes on European Families* (Keele, UK: Keel University, 1998).

[105] European Commission, *Environment and Employment: Building a Sustainable Europe* (Brussels: European Commission, Directorate-General XI, February 1998): 20; Thomas Jaegers, European Commission, Directorate-General XXI.C.5, conversation with author, October 19, 1998.

[106] European Commission, *Croissance, compétitivité, emploi: les défis et les pistes pour entrer dans le XXIe siècle Livre blanc* (Brussels: European Commission, 1994): 146, 162; Matthias Mors, "Employment, Revenues and Resource Taxes: Genuine Link or Spurious Coalition?" *International Journal of Environment and Pollution* 5, nos.2-3 (1995): 118-34.

[107] European Commission, "Proposal for a Council Directive Introducing a Tax on Carbon Dioxide Emissions and Energy," COM(92) 226 Final, *Official Journal of the European Communities,* no. C 196/1 (Brussels: European Communities, August 3, 1998).

[108] The 1992 European proposal of a CO_2/energy tax would be applied *ad quantum* (specific tax) to the final consumption of energy, on top of existing taxes. Its base rate would be USD 3 per barrel of oil equivalent, to be broken down equally between the carbon and energy content of the fuel. The rate would increase by USD 1 per year until it reached USD 10. The rate would be calculated in real terms to adjust for inflation. When the tax reached its maximum, the tax revenues, recycled through cuts in employers' social security contributions, would reach between 0.8 and 1.3% of GDP, depending on the country.

The Hermès model was used to simulate a USD 10 energy tax per barrel (with no differentiation according to carbon content), imposed from 1993 onwards, the revenues of which would be used to reduce PIT or employers' SSC. Although the simulations covered only four countries (France, Germany, Italy and the United Kingdom), the tax was assumed to be imposed in all EC countries and in no countries outside of the EC. No protective policies for energy-intensive industries were modeled, neither were tax refunds or energy-saving incentives. The results of the Hermès model are presented in Table 5.19.

The trend is that GDP would be only marginally affected, investments would drop somewhat, prices would increase, real wages would fall and the unemployment rate would decline. It is worth noting that recycling the energy tax revenues through reductions in SSC produced better results than reductions in PIT at the 2005 horizon. However, among the necessary conditions to attain these positive results was the flexibility of the real wage rate. If, on the contrary, wages were assumed to be rigid, no substitution of labor for capital and energy would materialize; on the contrary, substantial losses of employment might result. [109]

Table 5.19: Effect of an EC-Wide USD 10 Energy Tax on 4 Countries

(percent difference from baseline)

| | Revenue recycling | | | |
| | PIT | | Employers' SSC | |
Time horizon	**1995**	**2005**	**1995**	**2005**
GDP	-0.13	-0.53	-0.34	-0.12
GDP deflator	1.52	3.43	0.02	1.28
Gross fixed capital formation by firms	-0.64	-1.45	-1.14	-1.29
Real wage cost	-0.35	-0.17	-2.23	-2.15
Employment	0.04	-0.05	0.22	0.45
Unemployment rate	-0.07	0.01	-0.28	-0.37

Source: Stan Standaert, "The Macro-Sectoral Effects of an EC-Wide Energy Tax: Simulation Experiments for 1993-2005," European Economy: The Economics of Limiting CO_2 Emissions, Special Edition No.1 (Brussels: European Commission, Directorate-General II, 1992): 134-8.

Hermès was used again to simulate the effect of a CO_2/energy tax in six European countries (the same as in the previous exercise, plus Belgium and the Netherlands). The scenario focused on recycling the tax revenues through reductions in employers' SSC. Again, no additional accompanying measures were included in the model. Some of the macroeconomic results are synthesized in Table 5.20.

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[109] INFRAS and ECOPLAN, *Economic Impact Analysis of Ecotax Proposals: Comparative Analysis of Modelling Results* (Brussels: European Commission, Directorate-General XII, November 1996); S. Proost, and D. Van Regermorter, "Carbon Taxes in the European Community: Design of Tax Policies and Their Welfare Impact," *European Economy: The Economics of Limiting CO_2 Emissions*, Special Edition no.1 (Brussels: European Commission, Directorate-General II, 1992): 91-124; Stan Standaert, "The Macro-Sectoral Effects of an EC-Wide Energy Tax: Simulation Experiments for 1993-2005," *European Economy: The Economics of Limiting CO_2 Emissions*, Special Edition no.1 (Brussels: European Commission, Directorate-General II, 1992): 127-51.

GDP would be virtually unaffected, while this time employment gains were registered, alongside CO_2 emissions. Again, unit wages would decline in the short to medium term, but real disposable incomes would progress somewhat at the end of the period.

Table 5.20: Effect of the European CO_2/Energy Tax in 6 European Countries

(percentage difference from reference scenario)

	1993	1997	2001
Private consumption	-0.15	-0.01	0.15
Firms' investment	-0.05	0.02	-0.15
GDP	-0.09	0.01	0.15
Real wage	-0.08	0.18	0.39
Unit wage cost	-0.62	-1.28	-1.86
Real disposable income	-0.13	-0.02	0.07
Employment	0.04	0.31	0.64
CO_2 emissions	n.a.	n.a.	-4.40

Sources: F. Bossier, and T. Bréchet, "A Fiscal Reform for Increasing Employment and Mitigating CO_2 Emissions in Europe" *Energy Policy* 23, no.9 (1995): 789-98; F. Bossier *et al*., *Un redéploiement fiscal au service de l'emploi en Europe: Réduction du coût salarial financée par une taxe CO_2/énergie* Planning paper no.65 (Brussels: Bureau du Plan, November 1993): 45.

From a sectoral perspective, labor-intensive industries, *i.e.*, those that pay the highest payroll taxes as a percentage of total cost, would benefit most. As expected, fossil fuel taxation would penalize the most energy-dependent sectors. On balance, all sectors except energy and intermediary goods would benefit from reductions in production costs.[110]

The economic impact of energy taxation is likely to be modest for the following reasons: The great majority of branches in manufacturing have a direct energy cost share between 0 and 5% of total production costs. A few branches are energy-intensive, with a direct energy cost share between 10 and 20%; employment in those sectors represents less than 10% of total industrial employment. Incidentally, direct energy cost shares appear to be higher in the southern member states of the European Union, which would suggest a more detrimental impact of energy taxation in that region.[111]

A team of French researchers further refined the Hermès model in an attempt to account for the likely technological effect of the European proposal for a CO_2/energy tax. This study is interesting as it attempts to capture dynamic efficiency, an important phenomenon usually left out of simulations. Accordingly, energy saving measures were predicted to create well in excess of half a million jobs by the year 2005, without exerting any drag on GDP, as Table 5.21 indicates.

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[110] F. Bossier, et al., *Un redéploiement fiscal au service de l'emploi en Europe: Réduction du coût salarial financée par une taxe CO_2/énergi,* Planning paper no.65 (Brussels: Bureau du Plan, November 1993): 42-3.
[111] European Commission, *European Economy: The Climate Challenge, Economic Aspects of the Community's Strategy for Limiting CO_2 Emissions,* no.51 (Brussels: European Commission, Directorate-General II, May 1992): 88-91.

Table 5.21: Effect of the European CO_2/Energy Tax on 6 European Countries

(with technological adjustments)

Private consumption	0.27
Firms' investment	-0.53
GDP	0.27
Real wage	0.50
Unit wage cost	-1.46
Real disposable wage	0.15
Employment	0.78
Employment (in number of jobs)	863,600

Source: Lionel Lemiale, and Paul Zagamé, "Taxation de l'énergie, efficience énergétique et nouvelles technologies: les effets macroéconomiques pour six pays de l'Union européenne," eds. Katherine Schubert, and Paul Zagamé, *L'environnement: une nouvelle dimension de l'analyse économique* (Paris: Vuibert, June 1998): 353-70.

Following these first modeling attempts, new simulations were conducted to test the effect of different revenue recycling arrangements. The EC Directorate-General II, in charge of Economic and Financial Affairs, simulated these effects using its QUEST model. The hypothesis was that employers' SSC would be cut by 1% of GDP. Three main scenarios were then run: (I) an offsetting increase in PIT; (II) an increase in VAT; and (III) the budget-neutral introduction of the desired USD 10 per barrel of oil equivalent CO_2/energy tax. ETR corresponds to (III). No additional accompanying measures or economic incentives for energy efficiency were provided. Table 5.22 summarizes the results.

Table 5.22: Effect for Europe of a 1% of GDP Cut in Employers' SSC

(percent difference from reference scenario)

	After 1 year			After 4 years			After 7 years		
	I	**II**	**III**	**I**	**II**	**III**	**I**	**II**	**III**
Household consumption	0.5	-0.4	0.1	1.7	0.3	0.3	0.7	-1.2	1.3
Investment	1.5	-0.1	0.5	3.5	0.6	0	0.3	-3.4	-0.2
GDP	0.9	-0.1	0.4	2.4	0.5	0.5	0.7	-1.6	1.0
Employment	0.2	0.1	0.3	1.1	0.5	1.0	0.7	0	1.0
Consumer Price Index	-1.4	0.9	0	-4.4	-0.5	0.3	-2.0	3.6	-0.7

I = Reduction in employers' SSC financed by a budget-neutral increase in personal income tax.
II = Reduction in employers' SSC financed by a budget-neutral increase in value added tax rates.
III = Reduction in employers' SSC financed by a budget-neutral CO_2/energy tax.
Sources: European Commission, *Taxation, Employment and Environment: Fiscal Reform for Reducing Unemployment*, II/645/93-EN (Brussels: European Commission, Directorate-General II, December 1993); Gert Jan Koopman, *Eco-Taxes and Employment in Europe: Under which Conditions Can an Employment Benefit From Green Fiscal Reform Be Expected?* II/563/94-EN (Brussels: European Commission, Directorate-General II, September 27, 1994): 9; J. M. Op de Beke, *Macroeconomic Effects of Lower Non-Wage Cost for the Bottom End of the Pay Scale, Financed With a CO_2 Tax* DOC II 06449 (Brussels: European Commission, Directorate-General II, October 10, 1993).

By the seventh year, the introduction of the CO_2/energy tax (Scenario III) would produce the best results on almost every count. Compared to the increase in VAT rates, where almost all the extra burden was borne by consumption, the CO_2/energy tax would spread out the burden more evenly over all demand categories. Consumer prices were therefore unaffected in the first year. In addition, as firms paid only part of the taxes and received all of the benefits, costs were cut and

profits increased, which boosted investment. Employment also increased, as firms substituted more labor for energy and capital. The substitution effect would be quite strong, because the relative factor price change was pushed in the same direction by both the energy tax and the cut in employers' SSC. Compared to the scenario of increasing PIT, the boost to the economy would be more gradual and would not exert the same pressure on wages and prices.[112]

QUEST was also used to compare various recycling avenues assuming the existence of the EC CO_2/energy tax. Table 5.23 contains the results of this comparison. No accompanying measures other than revenue recycling were provided. First, it would be better to recycle revenues than not. Second, the best ways of recycling revenues from a macroeconomic point of view would be to cut employers' SSC or, even better, VAT. A reduction in PIT would tend to restore disposable income and therefore private consumption but also trigger an inflationary effect, causing a slow-down in economic activity. On the contrary, a compensatory reduction in employers' SSC or in VAT would attenuate cost increases and favor investment.[113] It must be noted, however, that the finding that revenue recycling through a VAT rate reduction could be superior to the employers' SSC option is not corroborated by most other studies.[114]

Table 5.23: Comparison of CO_2 Tax Effects in Europe

(percent change from baseline after 5 years)

	Revenue recycling scenario			
	None	PIT	SSC	VAT
Private consumption	-1.9	-1.0	-0.7	0.4
Private investment	-2.2	-2.0	-1.9	0.7
GDP	-1.2	-1.1	-0.7	-0.1
Employment	-0.4	-0.3	0	0.1
Consumer price index	3.8	3.5	2.5	0.9
Real unit labor costs	-0.3	-0.4	-0.6	-0.2

Source: European Commission, *European Economy: The Climate Challenge, Economic Aspects of the Community's Strategy for Limiting CO₂ Emissions* No.51 (Brussels: European Commission, Directorate-General II, May 1992): 52.

Subsequently, the QUEST model was run to estimate the effect of a CO_2 tax recycled through differential cuts in employers' social security contributions, *i.e.*, a greater reduction in the contributions due for low-income workers. QUEST revealed that a CO_2/energy tax of USD 10 per barrel compensated by a reduction equivalent to 1% of Europe's GDP would boost the number of jobs in Europe by 2.2%, or a two percentage-point reduction in the unemployment rate.[115]

Other simulations concur with QUEST and Hermès in indicating that a CO_2/energy tax can produce enough revenues to reduce employers' social security contribution and create

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[112] European Commission, *Taxation, Employment and Environment: Fiscal Reform for Reducing Unemployment*, II/645/93-EN (Brussels: European Commission, Directorate General II, December 1993).

[113] European Commission, *European Economy: The Climate Challenge, Economic Aspects of the Community's Strategy for Limiting CO₂ Emissions,* no.51 (Brussels: European Commission, Directorate-General II, May 1992): 168.

[114] INFRAS and ECOPLAN, *Economic Impact Analysis of Ecotax Proposals: Comparative Analysis of Modelling Results* (Brussels: European Commission, Directorate-General XII, November 1996): S-2.

[115] European Community, *Croissance, compétitivité, emploi: les défis et les pistes pour entrer dans le XXIe siècle* (Brussels: European Commission White Book, 1994): 163-5.

employment, provided that a wage-price spiral is avoided. Higher export prices as a result of the tax also would improve the terms of trade but harm competitiveness. However, because wages were assumed not to respond directly to the increase in the CPI, the former effect outweighed the latter.[116]

The firm DRI conducted yet another study to estimate the economic impact of a CO_2/energy tax. Two recycling scenarios were developed: (1) in "INT" 80% of the tax revenues were used for reductions in personal income tax, and 20% were used to finance public expenditures for environmental improvements; and (2) in "INT+" 100% of the tax revenues were recycled to reduce non-wage labor costs, *i.e.*, employers' social security contributions. No additional accompanying measures were extended to alleviate the economic cost of adjustment.
DRI predicted a positive effect in terms of GDP and employment, especially when employers' social security contributions were reduced, and provided, once again, that the substitution of labor for capital did not translate into a wage-price spiral. Table 5.24 summarizes the main results.[117]

Table 5.24: Economic Effect of a CO_2/Energy Tax on 6 European Countries

(difference in annual percentage growth between 1992 and 2010)

	Recycling scenario	
	INT [a]	INT+ [b]
GDP	0.05	0.06
Employment	0.07	0.15

a)   80% of the CO_2 tax revenues are used for reductions in personal income tax, and 20% are used to finance public expenditures for environmental improvements.
b)   100% of the tax revenue are recycled to reduce employers' SSC.
Sources: DRI *et al.*, *Potential Benefits of Integration of Environmental and Economic Policies: An Incentive-Based Approach to Policy Integration* (Luxembourg,: European Commission, 1994): 10; Organisation for Economic Co-operation and Development, *Environmental Policies and Employment* (Paris: OECD, 1997): 52-3.

Based on the outcome of several simulations carried out in the early 1990s, a tentative conclusion of Europe's DG II, was that the economic effects of a CO_2/energy tax would be "rather modest," implying neither major gains nor critical losses.[118]

A different study arrived at similar results in 1995: assuming a CO_2/energy tax gradually increasing to USD 10 per barrel of oil equivalent, the revenues of which would be recycled through cuts in employers' social security contributions, GDP in six European countries would

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[116] O. Beaumais, and T. Bréchet, *La Stratégie communautaire de régulation de l'effet de serre: quels enjeux pour la France? L'analyse des modèles Hermès-Midas* (Paris: ERASME, Ecole centrale et Université de Paris I, 1993); Cambridge Econometrics, *The Effects of the European Commission's Carbon/Energy Tax on the UK Economy*, Supplement to Cambridge Econometric's Autumn 1991 Forecasts (Cambridge, UK: Cambridge Econometrics, 1991); European Commission, *Taxation, Employment and Environment: Fiscal Reform for Reducing Unemployment*, II/645/93-EN (Brussels: European Commission, December 1993): 15.
[117] DRI et al., *Potential Benefits of Integration of Environmental and Economic Policies: An Incentive-Based Approach to Policy Integration* (Luxembourg,: European Commission, 1994): 10; Organisation for Economic Co-operation and Development (OECD), *Environmental Policies and Employment* (Paris: OECD, 1997): 52-3.
[118] European Commission, *European Economy: The Climate Challenge, Economic Aspects of the Community's Strategy for Limiting CO_2 Emissions* no.51 (Brussels: European Commission, Directorate-General II, May 1992): 61.

register a small gain of 0.15%, and CO_2 emissions would drop by 4.4%, each time compared to the baseline scenario by the year 2000.[119]

The debate around the Europe-wide CO_2 tax proposal ended in the failure of Member States to reach agreement. In 1996, the Economic and Financial Council of Ministers asked the Commission to study the alternative possibility of minimum taxation rates on energy products across the Union. According to the proposal, some countries would have to raise national rates to meet these minimum rates. A new round of simulations was thus conducted to test the economic impact of this proposal, using the macro-econometric models Hermès and E3ME, and the computable general equilibrium model GEM-E3. One of the assumptions was that Member States would use the revenues provided by the increase in energy tax rates to reduce employers' social security contributions. No additional accompanying measures or economic incentives for energy efficiency would be provided. The new results corroborated those of the studies of the first generation: the economic impact of a revenue-neutral increase in energy taxes was likely to be small and favorable. Table 5.25 summarizes the results.[120]

Table 5.25: Impact of Europe-Wide Minimum Energy Rates (I)

(effect in 2005, compared to baseline scenario [a])

	Hermès	**E3ME**	**GEM-E3 [b]**
GDP (%)	0.06	0.20	0.02
Consumer prices (%)	0.04	-0.08	0.08
Employment (jobs)	190,000	457,000	155,000
CO_2 emissions (%)	-1.60	-0.50	-1.47

a)   Minimum rates to be set at the beginning of 1998
b)   Year 2004 instead of 2005
Source: European Commission, *Présentation du nouveau dispositif communautaire de taxation des produits énergétiques: Evaluation de l'impact de la proposition* SEC(97) 1026/2 (Brussels: European Commission, July 30, 1997): 55.

With the exception of the energy sector, most firms should be able to alleviate the impact of the energy tax by switching to other energy sources or investing in more energy-efficient equipment. The impact in terms of value added would thus be either positive (for agriculture, investment goods, consumption goods and services) or slightly negative (for transportation and energy-dependent manufacturing goods). Adjustment costs would be small, except in the energy sector, notably in the metals and gas distribution sub-sectors. These were Europe-wide trends, however, which conceal negative and positive effects depending on the country.[121]

E3ME, a sectoral, regionalized, econometric model developed by an international consortium supported by the European Commission, was again used to simulate the impact of higher minimum energy excise rates across the members of the European Union, which would be used to reduce employers' SSC. Table 5.26 shows the forecasts. The results are more positive than in

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[119] Richard Baron, et al., *Policies and Measures for Common Action*, Annex I Experts Group on the UNFCCC (Paris: International Energy Agency, July 1996): 44.
[120] European Commission, *Présentation du nouveau dispositif communautaire de taxation des produits énergétiques: Objectifs et dispositions* SEC(97) 1026 (Brussels: European Commission, May 23, 1997); European Commission *Présentation du nouveau dispositif communautaire de taxation des produits énergétiques: Evaluation de l'impact de la proposition* SEC(97) 1026/2 (Brussels: European Commission, July 30, 1997).
[121] European Commission, *Présentation du nouveau dispositif communautaire de taxation des produits énergétiques: Evaluation de l'impact de la proposition* SEC(97) 1026/2 (Brussels: European Commission, July 30, 1997): 60-1.

the former simulation using E3ME. The 1.2% increase in employment corresponds to 1.9 million new jobs. However, employment was predicted to respond very unevenly to higher energy taxes across countries, depending in part on the labor market situation. For example, Belgium was to benefit the most due to its rigid wage rates: reductions in non-wages costs have a more powerful effect in such circumstances.

The most interesting conclusion of this simulation was that all households would gain from the reduction in payroll taxes, though the richer ones would benefit the most. In that sense, the reform would be very slightly regressive in most countries.

Table 5.26: Impact of Europe-Wide Minimum Energy Rates (II)

(effect in 2010, in % compared to baseline scenario)

GDP	1.4
Employment	1.2
CO_2 emissions	-10.0

Source: Terry Barker, and Jonathan Köhler, "Equity and Ecotax Reform in the EU," *Fiscal Studies* 19, no. 4 (1998): 375-402.

6   POLICY LESSONS

6.1   Introduction

This final section draws conclusions and identifies the main policy lessons from the preceding review. It is based largely on the synopsis table in the Appendix, which contains summary information from the various individual studies examined above and from studies reviewed in previous work. The table also includes studies that do not recycle the tax revenue and a (less complete) sample of non-European studies for comparison purposes.

Economics theory and empirical models are unanimous in concluding that, when the revenues of environmental taxes are used to reduce other distorting taxes, the economic outcome is better than if those revenues are not so distributed. Thus ETR is better than environmental taxes alone. The major reason for this is that returning revenues to the economy restores aggregate demand (or prevents negative effects on aggregate supply). Without recycling of tax revenues, the introduction of environmental taxes, such as a CO_2 tax, risks raising the general price level, imposing a burden on consumption, harming competition and deterring investments and employment.

But revenue recycling does more than restore macroeconomic aggregates to their *status quo ante*. By lowering other taxes in an appropriate manner, ETR can reduce some of the distortions caused by the existing tax system and so encourage employment, investment, or both. If the benefits of the tax cut are greater than the economic burden of the environmental taxes, this can result in a "double dividend," increasing employment or GDP, as well as producing environmental benefits. Even if the benefits from the tax cuts are less than the economic costs of the ecotax, they will still generally offset much or most of the economic cost, thus allowing a nation to minimize the economic cost of reaching its environmental goals. Whether (ignoring the environmental benefit) the net economic effect is modestly positive or modestly negative is an empirical matter. It depends on the underlying structure of a particular economy and its current state in the business cycle; the existing pattern of economic rigidities and distortions including regulations, subsidies, other taxes, sticky prices, and the like; the exact form of taxes increased and taxes cut, including exemptions, competitive offsets, *etc.*; other policies (such as energy efficiency promotion policies) enacted together with the ETR; and various other factors. Different economic models capture these different factors with varying degrees of effectiveness. No model is perfect. However, the 45 studies (104 simulations) examined here do allow certain broad conclusions to be drawn.[122] The next few sections will try to put forward these conclusions.

Before turning to the lessons to be learned from models, however, it is worth contemplating how the ETR proposals that have been modeled differ from the ETR packages that have been enacted. First, though almost all models have looked at revenue-neutral ETR, Finland, and to a lesser

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[122] The reason the number of simulations is higher than the number of studies is that many studies produce separate results for either several countries or several different recycling options or both. For instance, Detemmerman *et al.* (European Commission 1991) examines two revenue-recycling options for each of four countries, for a total of eight simulations. Only simulations that specify the nature of revenue recycling are used in our lessons learned sections, though simulations without revenue recycling are included in Appendix Table 1.

degree Germany, have carried out revenue-negative ETR, *i.e.*, they have enacted reforms that constitute net tax cuts. This option may be appealing in both a political and a policy sense, especially for nations operating under a budget surplus. Second, few of the simulations modeled but all of the enacted proposals include special provisions to protect the competitiveness of energy-intensive industries. Finally, most of the nations enacting ETR have put in place a parallel suite of policies to encourage the development and diffusion of energy efficient and renewable energy technologies. These have been modeled in only a handful of cases.

We close with a cautionary note about an uncritical application of the lessons of these European modeling efforts to U.S. policy. The U.S. economy is different from Europe's in a number of important respects. First, the lower energy prices and higher energy use per capita in the U.S. suggest that there are likely to be more low-cost conservation opportunities in the U.S. than in Europe. Second, U.S. labor markets are more flexible and U.S. average unemployment rates are well below those of major European economies. Third, because of its sheer size, the U.S. economy is more affected by internal markets and economic linkages and less dependent on international trade. This has many economically important implications. For instance, domestic savings and domestic investment are more highly correlated in the U.S. than in most European nations. Taken together, these differences imply that both the employment-related benefits and the competition-related costs from ETR are likely to be smaller (as a percentage of their business-as-usual values) for the U.S. than they are in many European studies.

6.2   Economic Effects of ETR[123]

6.2.1 Employment

One hundred and four of the simulations contain both revenue recycling and estimates of employment impact. Figure 6.1 displays these results, distinguishing negative from positive or zero results. Seventy-four percent of the simulations predict that ETR will create jobs on net, and an additional 4% show no change in employment. Therefore this set of modeling results suggests that a positive employment dividend is possible in certain circumstances.
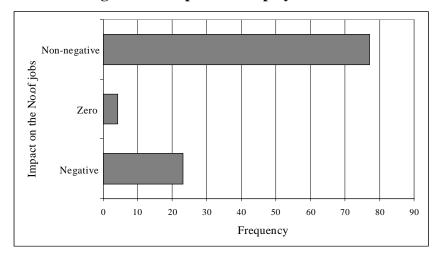
Figure 6.1: Impact on Employment

The weight of evidence from Belgium,[124] Denmark,[125] Finland,[126] Germany,[127] the Netherlands,[128] the United Kingdom,[129] as well as Europe as a whole,[130] suggests that the best results in terms of employment are obtained when recycling occurs through cuts in social security contributions. This is because employers' social security contributions directly influence the price of labor.

The conclusion that an ETR focusing on payroll tax cuts is likely to increase employment is borne out by the results of the present survey. Table 6.1 below shows that 86% of the simulations that recycle revenue through reductions in social security contributions result in net employment increases, the largest percentage of any tax recycling option. The employment impact of cuts in the personal income or corporate profits tax is more equivocal. For these options, only about half of the simulations showed positive results. 100% of the five studies that examined recycling through investment in energy efficiency found positive employment results. However, most of the studies recycling part of the revenue through energy efficiency also recycled a portion of the revenue through social security contribution cuts. Moreover, the small number of studies makes this result much less certain.

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[123] For a review including non-European studies, see also B. Bosquet, "Environmental Tax Reform: Does It Work? A Survey of the Empirical Evidence*", Ecological Economics*, 34,1 (2000): 19-32. The conclusions of that and the current review are the same.

[124] F. Bossier, and T. Bréchet, "Impact économique et efficacité d'une taxe graduelle sur l'énergie: l'analyse du modèle Hermès", *Cahiers économiques de Bruxelles,* No.138 (1993): 151-184; F. Bossier, T. Bréchet, and N. Gouzée, *Faire face au changement climatique: Les politiques de lutte contre le renforcement de l'effet de serre*, Planning paper no.63 (Brussels: Bureau du Plan, 1993): 90.

[125] Danish Ministry of Finance, *Grønne afgifter og erhvervene* (Copenhagen: Danish Ministry of Finance, 1994): 107-114.

[126] Finnish Ministry of Environment, *Interim Report of the Environmental Economics Committee* (Helsinki: Finnish Ministry of Environment, 1994): 59-60.

[127] Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI), *Stellungnahme zum Entwurf eines Gesetzes zum Einstieg in die ökologische Steuerreform* (Essen, Germany: RWI, 1999).

[128] Centraal Plan Bureau (CPB), "Greening Taxes and Energy: Effects of Increased Energy Taxes and Selective Exemptions," Working Paper no.96. CPB, The Hague (1997): 16.

[129] S. Tindale and G. Holtham, *Green Tax Reform: Pollution Payments and Labour Tax Cuts* (London: Institute for Public Policy Research, 1996): 98-122.

[130] Baron et al., *Policies and Measures for Common Action, Annex I Experts Group on the UNFCCC* (Paris: International Energy Agency, 1996): 44; S. Standaert, "The Macro-Sectoral Effects of an EC-Wide Energy Tax: Simulation Experiments for 1993-2005," *The Economics of Limiting CO_2 Emissions*, Special Edition no.1 (Brussels: European Commission, 1992): 134-138.

Table 6.1: Predicted Impact of ETR by Recycling Mode

Recycling	Impact	Employment		GDP	
		No. Of simulations	%	No. Of simulations	%
SSC	Positive	64	86	52	67
	Negative	10	14	26	33
	Total	74	100	78	100
PIT	Positive	15	54	7	25
	Negative	13	46	21	75
	Total	28	100	28	100
VAT	Positive	7	78	4	44
	Negative	2	22	5	56
	Total	9	100	9	100
CPT	Positive	1	50	0	0
	Negative	1	50	2	100
	Total	2	100	2	100
LSTH	Positive	4	80	4	50
	Negative	1	20	4	50
	Total	5	100	8	100
EFF	Positive	5	100	4	80
	Negative	0	0	1	20
	Total	5	100	5	100

SSC = Cuts in social security contributions; PIT = Cuts in personal income tax; VAT = Cuts in value added tax; CPT = Cuts in corporate profits tax; LSTH = Lump sum transfers to households; EFF = Financial incentives for energy efficiency. Scenarios using more than one form of revenue recycling are listed in each category.

Some studies suggest that even more jobs are created when reductions in employers' social security contributions are targeted at low-income workers.[131] European unemployment, like U.S. unemployment, consists to a large degree of low-income and low-productivity unemployed. These workers face technological change that has reduced the demand for low-skill labor. In addition, workers at the low-income end of the labor market generally have higher elasticity of labor supply than that of other workers. Moreover, low-income labor tends to be a good substitute for energy and capital. Reducing social security contributions therefore encourages a general shift to a more labor-intensive economy.[132]

One important caveat is that, for employment gains to materialize, the labor market must be flexible. Modelers have underscored the need for preventing wage-price spirals in the wake of

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[131] INFRAS and ECOPLAN, "*Economic Impact Analysis of Ecotax Proposals: Comparative Analysis of Modelling Results*" (Brussels: European Commission, Directorate-General XII, 1996); European Commission, "Croissance, compétitivité, emploi: les défis et les pistes pour entrer dans le XXIe siècle," *White Book* (Brussels: European Commission, Brussels (1994): 163-165.

[132] F. Bossier et al., "Un redéploiement fiscal au service de l'emploi en Europe: Réduction du coût salarial financée par une taxe CO_2/énergie," *Bureau du Plan*, Planning paper no.6 (Brussels: 1993): 70-71; A.L. Bovenberg, "Environmental Policy, Distortionary Labor Taxation, and Employment: Pollution Taxes and the Double Dividend," *Nota di Lavoro*, Environmental Policy no. 38.95 (Milan: Fondazione Eni Enrico Mattei, 1995); A.L. Bovenberg, "Environmental Taxation and Employment," *De Economist* 143, 2 (1995): 111-140; European Commission, *Taxation, Employment and Environment: Fiscal Reform for Reducing Unemployment* (Brussels: European Commission, 1993): ii; M. Mors, "Employment, Revenues and Resource Taxes: Genuine Link or Spurious Coalition?" *International Journal of Environment and Pollution* 5, no. 2/3 (1995): 118-134.

environmental taxes. If wages are directly linked to the price level, *e.g.*, by the terms of employment contracts covering a large sector of the economy, then environmental taxes may cause wage-induced inflation, which in turn would suppress the employment gains that would otherwise occur. A few models, particularly those that show GDP losses from ETR, even suggest that reductions in the real wage rate are necessary to avoid losses in employment. This caveat has been made in studies from many countries, including Finland,[133] Germany,[134] the Netherlands,[135] Norway,[136] and Europe as a block.[137]

It is worth observing that, although most models predict net employment gains, there are several distinct mechanisms by which those gains occur. In some models, expansion of labor-intensive sectors outweighs contraction of energy-intensive sectors, resulting in increased overall labor demand. This increase in demand can result in increased wages, increased employment, or both. Other models find that the energy tax increase is more fully passed through to the consumer than the labor tax cut is to the worker. The resulting fall in real wages causes an increase in the number of workers hired. This in turn leads to increased growth, often yielding long-run real wage increases to offset the short-run real wage cuts. In either case, these gains may be partially or fully offset by losses due to international competition in energy-intensive industries (though labor-intensive industries may become *more* competitive under a labor tax cut). Some models suggest strengthened economies due to reduced reliance on imports. Other models tell other, more idiosyncratic stories.

The remarks above support the European Commission's earlier conclusion that "if a wage-price spiral can be avoided then a CO_2-energy tax has the potential of improving employment if the revenues are used for a cut in social security contributions . . . . a *noticeable although not spectacular increase in employment on the order of 0.5% can be expected."* [emphasis in original][138]

6.2.2 *Gross Domestic Product*
One hundred and four simulations return quantified results of the impact of ETR on gross domestic product (GDP). These range between +2.5% and –5%. In Figure 6.2, the results are regrouped in classes of 0.5 percentage points of GDP. For example, class "-1.0" includes values

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[133] Finnish Ministry of Environment, Interim Report of the Environmental Economics Committee. Finnish Ministry of Environment, Helsinki (1994): 61.

[134] Greenpeace, and Deutsches Institut für Wirtschaftforschung (DIW), *The Price of Energy* (Aldershot, UK: Dartmouth Publishing Company, 1997): 14; Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI), *Stellingnahme zum Entwurf eines Gesetzes zum Einstieg in die ökologische Steuerreform* (Essen, Germany: RWI, 1999).

[135] H. Don, "Tax Reform and Job Creation," *CPB* Report no. 1996/4, (The Hague: 1996); M. Mors, "Employment, Revenues and Resource Taxes: Genuine Link or Spurious Coalition?" *International Journal of Environment and Pollution* 5, 2/3 (1995): 128.

[136] Norwegian Green Tax Commission, *Policies for a Better Environment and High Employment* (Oslo: Norwegian Ministry of Finance and Customs, 1996): 143-151.

[137] O. Beaumais, and T. Bréchet, *La Stratégie communautaire de régulation de l'effet de serre: quels enjeux pour la France? L'analyse des modèles Hermès-Midas* (Paris: ERASME, Ecole centrale and Université de Paris I, 1993); European Commission, *Taxation, Employment and Environment: Fiscal Reform for Reducing Unemployment* (Brussels: European Commission, 1993): 15; INFRAS and ECOPLAN, *Economic Impact Analysis of Ecotax Proposals: Comparative Analysis of Modelling Results* (Brussels: European Commission, Directorate-General XII, 1996); S. Proost, and D. Van Regemorter, "Carbon Taxes in the European Community: Design of Tax Policies and their Welfare Impact*s," ed. European Commission, *The Economics of Limiting CO₂ Emissions* Special Edition no.1 (Brussels: European Commission, 1992): 91-124; S. Standaert, "The Macro-Sectoral Effects of an EC-Wide Energy Tax: Simulation Experiments for 1993-2005," ed. European Commission, *Economics of Limiting CO₂ Emissions* Special Edition no.1 (Brussels: European Commission, 1992): 127-151.

[138] European Commission, *Taxation, Employment and Environment: Fiscal Reform for Reducing Unemployment* (Brussels: European Commission, Brussels: 1993): 15.

between –1.0 and –0.51%. Three simulations returning impacts of –5.0, +2.0 and +2.5% on GDP, respectively, are omitted from the graph below. The graph in Figure 6.2 shows the distribution of GDP outcomes in the 101-simulation sample described above.

Fifty-four percent of the simulations had positive or zero GDP impacts. The mode is at the 0 to +0.5% of GDP class. However, almost two-thirds of the simulations predict an impact of only –0.5 to +0.5% of GDP, *i.e.*, a change of less than 0.5% of GDP by the end of the period, relative to the reference scenario. From the evidence of our sample as a whole, it appears that the impact of ETR on GDP is likely to be small.
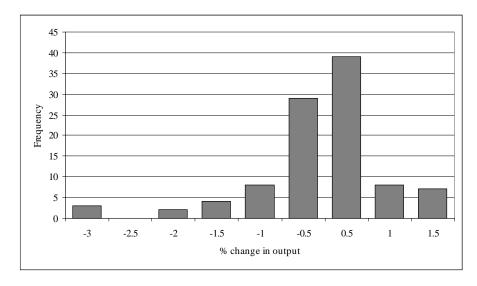
Figure 6.2: Predicted Impact on GDP

It is important to know under what conditions output losses are minimized or GDP gains are maximized. Over two-thirds of the simulations returning a positive impact on output assume recycling through cuts in employers' social security contributions. Table 6.1 above shows that, in our sample of simulation results, 33% of the ETR simulations based on cuts in payroll taxes (social security contributions) resulted in net GDP losses, while 67% showed net gains or no net impact. This contrasts with simulations returning ecotax revenue through personal income tax cuts, where 75% of the simulations show net GDP losses. Value-added tax (VAT) cuts and lump-sum transfers of the revenue to households (LSTH) show intermediate results. Corporate profit taxes appear to do worst of all, but with a sample of only two simulations, this should not be taken as a consensus result. Again, investment in energy efficiency appears to do best of all, subject to the caveats given in the employment section above.

Projected GDP reductions from ETR can be attributed in part to the simplifications modelers impose on ETR packages. All ETR proposals actually enacted include policies to protect the competitiveness of energy-intensive industries and policies to promote energy efficiency technologies. When modeled, these policies usually improve the GDP outcome. All but one of the modeling efforts that included either energy-efficiency promotion policies or competitiveness offset policies found net GDP increases. Thus it is troubling that most studies have modeled tax reforms without such policies.

6.2.3 Sectoral Changes

In an energy-based ETR, one expects that the energy-intensive sectors of the economy – fuels and electricity, and materials sectors such as primary metals, chemicals, paper and ceramics – will be the most affected, in terms of output and investments. Conversely, labor-intensive sectors, such as wholesale and retail trade, services, government and education, ought typically to benefit under a labor-oriented ETR. Those simulations in our sample of models support these speculations.[139]

At the European level, the economic impact of energy taxation, although real, is likely to be modest. First, the great majority of manufacturing industries have a direct energy cost share between 0% and 5% of total production costs. A few branches are energy-intensive, with a direct energy cost share between 10% and 20%. However, employment in those sectors represents less than 10% of total manufacturing employment, and all manufacturing is less than a third of total employment.[140] Second, with the exception of the energy sector, most firms should be able to mitigate the impact of the energy tax by switching to other energy sources or investing in more energy-efficient equipment.[141] Finally, all ETR proposals actually enacted include measures to reduce the competitive burden on energy-intensive industries and to assist them in adapting to the new price regime. Such policies include border tax adjustments, refunds, exemptions, and subsidies, and also energy-efficiency promotion policies of several sorts.

In the final analysis, it needs to be recognized that some modest negative impact on the most pollution-intensive economic sectors may be an unavoidable, indeed desirable, consequence of the social goal of reducing pollution emissions. In the words of a report by the European Commission, "the dispersion of effects at a sectoral level against the background of relatively unchanged aggregate costs is exactly what an incentive tax aims at: by giving an incentive modulated according to the CO_2/energy content of consumption and production patterns it discourages energy use in an economically efficient manner."[142]

6.2.4 Distributional Consequences

Without revenue recycling, the impact of broad-based carbon or energy taxes on income distribution is likely to correlate with the share of energy expenditures in total household expenditures or income. Hence households with the most energy-intensive expenditures would suffer the most. The relationship between income level and the energy intensity of consumption varies across nations. According to one study, energy taxation is likely to be progressive in Italy

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[139] Danish Ministry of Finance, *Energy Tax on Industry in Denmark* (Copenhagen: Danish Ministry of Finance, 1995): 19-21; G.W. Harrison, and B. Kriström, *Carbon Taxes in Sweden* (Umeå, Sweden: University of Umeå, 1997): 30-31; Norwegian Green Tax Commission, *Policies for a Better Environment and High Employment* (Oslo: Norwegian Ministry of Finance and Customs, 1996): 150-151; Statens Offentliga Utredningar (SOU), *Skatter, miljö och sysselsätning: Slutbetänkande av Skatteväxlingskommitén* (Stockholm: Swedish Ministry of Finance, 1997): 482; S. Standaert, "The Macro-Sectoral Effects of an EC-Wide Energy Tax: Simulation Experiments for 1993-2005," ed. European Commission, *Economics of Limiting CO_2 Emissions* Special Edition no.1 (Brussels: European Commission, 1992): 135-141; Willem Vermeend, and Jacob van der Vaart, *Greening Taxes: The Dutch Model* (Deventer, Netherlands: Kluwer, 1998): 26-48.

[140] European Commission, "European Economy: The Climate Challenge, Economic Aspects of the Community's Strategy for Limiting CO_2 Emissions, Statistical Annex," *Long-Term Macroeconomic Series* no.51 (Brussels: European Commission, Directorate-General II, 1992): 88-91.

[141] European Commission, *Présentation du nouveau dispositif communautaire de taxation des produits énergétiques: Evaluation de l'impact de la proposition* Working Document no. SEC(97) 1026/2 (Brussels: European Commission, 1997): 60-61.

[142] European Commission, "European Economy: The Climate Challenge, Economic Aspects of the Community's Strategy for Limiting CO_2 Emissions, Statistical Annex," *Long-Term Macroeconomic Series* no.51 (Brussels: European Commission, Directorate-General II, 1992): 108.

and Spain. As mentioned earlier, a similar pattern emerges from a study for Sweden. In Denmark, Ireland and the United Kingdom, it would be the most regressive.[143] According to another study, domestic energy price increases might be slightly regressive in Belgium, France, the Netherlands and Portugal, and weakly progressive in other countries of the European Union, because rich households in these four countries spend comparatively more on electricity. In contrast, higher taxes on motor fuels would be strongly regressive.[144]

With revenue recycling and special poverty alleviation measures, the negative impact of energy taxes on low and middle-income households can be reduced or eliminated. Most of the enacted ETR packages have included such measures.

In Germany, ETR benefits all households but those with children more than those without.[145] In the Netherlands, the combination of energy tax and tax relief is predicted to have a negligible impact on the households whose energy consumption is average. However, additional compensatory measures exist to protect the particularly vulnerable, energy-dependent, members of society.[146]

As discussed in the section on employment above, the poor will benefit from higher employment if CO_2/energy tax revenues are recycled through reductions in employer's social security contributions targeted at low-income jobs. However, there remain equity issues concerning low-income citizens who are not in the workforce. In the United States, Social Security and many poverty programs are indexed for inflation, as measured over baskets of goods that include personal energy consumption. This provides a partial solution, but additional measures such as increased low-income home weatherization assistance would probably be necessary if the poorest were not to suffer.

6.2.5 Modeling Bias
It is interesting to investigate whether and how the modeling techniques and assumptions used in empirical studies influence the results obtained. Table 6.2 suggests that the type of model chosen might affect the direction of the second dividend, as has been suggested earlier in the literature.[147] Table 6.2 analyzes the employment and GDP results of 76 macroeconomic simulations and 33 general equilibrium simulations. (The small number of partial equilibrium and input-output simulations are omitted.) It appears that a smaller proportion of macroeconomic models predict favorable results than general equilibrium ones. 50% of the macroeconomic simulations predict a positive or neutral impact of ETR on GDP, compared to 68% for general equilibrium simulations.

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[143] E. Symons and J. Proops, *The Distributional Implications of Pollution Taxes on European Families* (Keele, UK: Keele University, 1998).

[144] Terry Barker, and Jonathan Köhler, "Equity and Ecotax Reform in the EU," *Fiscal Studies* 19, no. 4 (1998): 375-402.

[145] Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI), *Stellingnahme zum Entwurf eines Gesetzes zum Einstieg in die ökologische Steuerreform* (Essen, Germany: RWI, 1999).

[146] Willem Vermeend, and Jacob van der Vaart, *Greening Taxes: The Dutch Model* (Deventer, Netherlands: Kluwer, 1998): 26-48.

[147] N. Mabey and J. Nixon, "Are Environmental Taxes a Free Lunch? Issues in Modelling the Macroeconomic Effects of Carbon Taxes," *Energy Economics* 19 (1997): 29-56.

Table 6.2: Estimated Impact of ETR by Model Type

		Employment		GDP	
	Impact	**No. Of simulations**	**%**	**No. Of simulations**	**%**
Macroeconomic	Positive + Zero	57	75	38	50
	Negative	19	25	38	50
	Total	76	100	76	100
General equilibrium	Positive + Zero	22	88	20	71
	Negative	3	12	8	29
	Total	25	100	33	100

The numbers are less meaningful with respect to employment, as many general equilibrium simulations do not return employment results. Based upon available results alone, however, the trend is similar: 75% of the macroeconomic simulations predict a non-negative impact of ETR on employment, compared to 88% for general equilibrium simulations.

6.3   Environmental Effects of ETR

Whatever the sign and size of the economic cost or benefit, environmental improvements remain the primary motivation for ETR proposals.   Most models bear out the environmental effectiveness of ETR: substantial reductions in carbon emissions are generally achieved, and, with them, reductions in emissions of NO_x, SO_x and other air pollutants. However, several governments confess to the difficulty of evaluating the effect of ETR separate from non-revenue neutral energy taxes and macroeconomic developments. The environmental evaluation of CO_2 taxes in Denmark and some sulfur taxes in Scandinavia are exceptions to this rule.

Figure 6.3 shows the distribution of carbon savings as a percentage of baseline emissions for the 53 simulations in our sample that showed carbon emission results. One outlier, at –25%, was omitted from the histogram. It is interesting to note that in a handful of cases ETR actually increases emissions relative to the baseline.   These are cases where the reform stimulates substantial economic growth and the improvement in energy efficiency caused by the energy tax is not sufficient to offset the additional growth-related emissions.
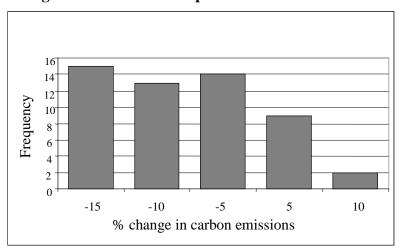
Figure 6.3: Predicted Impact on Carbon Emissions

6.4   Implementation Issues

6.4.1 Gradual and Predictable Phase-in

In order to minimize negative economic shocks, excessive capital stock turnover, and the like, economic theory suggests that reforms should be implemented gradually and according to a schedule known in advance to economic agents. By minimizing the adjustment costs inherent in switching to cleaner energy sources or lower energy use and substituting labor for energy, this approach reduces the aggregate macroeconomic cost of the reform. European nations adopting such reforms have generally followed this prescription. Illustrations include Denmark's several-tiered ETR, the step-by-step increases in the Finnish, German and Italian tax rates, and the U.K. Road fuel escalator.

6.4.2 Revenue Neutrality

ETR should be regarded as fundamental tax reform: the intention is to alter the system of incentives through a *shift* in the base of taxation, lowering taxes on beneficial activities, such as work and investment, and raising taxes on destructive activities, such as pollution and natural resource consumption. Revenue neutrality is not a *sine qua non*, however. ETR can in fact be revenue-positive, revenue-negative, or revenue-neutral. In Europe, ETR is normally advertised under the banner of revenue neutrality, as the overall tax burden in these countries is already high, and additional taxation is often regarded as economically damaging and politically unpalatable. However, Finland, Sweden, and, to a lesser degree, Germany adopted ETRs that constituted net tax cuts, thereby reducing the overall tax burden on the economy.

6.4.3 The Taxes Raised

The environmental goal ("first dividend") pursued by most governments is to reduce greenhouse gas emissions. Among various measures to achieve these objectives, several European countries have adopted a carbon/energy tax. The carbon portion of the tax discourages the use of fossil fuels that release CO_2. The energy portion of the tax spreads the cost of the tax more evenly over a larger number of energy sources than fossil fuels exclusively.

A carbon/energy tax has considerable revenue potential, which proves necessary to carry out substantial reductions in taxes on economic goods. For example, of all the Swedish taxes with an explicitly environmental purpose, the CO_2 tax is the one that collects the largest receipts, namely 2-3% of total tax revenue.[148]

So far, ETR has relied on carbon and energy, but proposals are being studied for using taxes on sand, gravel, phosphorus, *etc.*[149] These taxes are singled out as candidates for expanding the scope of ETR as they induce materials internalization (first dividend) and have sufficient revenue potential to finance the reduction of other taxes (second dividend).

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[148] F. Bohlin, "Taxes and Subsidies". In *Sustainable Economics Forum* (Boulder: University of Colorado, October 16, 1998); Swedish Environmental Protection Agency (EPA), *Environmental Taxes in Sweden: Economic Instruments of Environmental Policy* Report no. 4745, (Stockholm: Swedish EPA, 1997).

[149] S. Axelsson, *Ecological Tax Reform: Tax Shift, A Tool to Reduce Unemployment and Improve the Environment* (Stockholm: Naturskydds föreningen, 1996): 5-6; "UK Outlines Possible Tax on Aggregates," *ENDS Environment Daily* (London: May 4, 1999); HM Customs and Excises, *Potential Aggregates Tax* (London: HM Customs and Excise, 1999); R. Repetto, "Shifting Taxes from Value Added to Material Inputs," eds. C. Carraro, and D. Siniscalco, *Environmental Fiscal Reform and Unemployment* (Dordrecht, Netherlands: Kluwer Academic Publishers, 1996): 53-72; Willem Vermeend, and Jacob van der Vaart, *Greening Taxes: The Dutch Model* (Deventer, Netherlands: Kluwer, 1998): 12.

6.4.4 ETR and Technology Incentives

Some countries may choose not to recycle all environmental tax revenues, but instead reserve part for environmental expenditures. This raises the question whether full recycling is better than partial earmarking. Some studies have suggested that using environmental taxes to finance an increase in expenditures, *e.g.*, through earmarking, may reduce the benefits of ETR.[150] However, the cases of the Danish and Italian ETR, modeling results for Austria and Belgium, the debate on going in the United Kingdom, and practical examples of air and water pollution abatement in Europe suggest that partial earmarking may provide an effective combination of economic and environmental incentives.[151]

The full economic benefits may not be captured by most models: the positive feedback effect of environmental improvements on technological development is generally not accounted for, which may result in underestimates of the economic gains resulting from ETR. Dynamic efficiency is achieved through technological progress and may enable further gains in output and employment, especially in clean technology areas. An example of dynamic efficiency is the development in Denmark of wind turbines to produce energy. This sector now employs 15,000 people and wind turbines have become the country's fourth largest export commodity.[152] It is not clear that this results from the imposition of energy taxes alone, but the price signals sent by these taxes have likely given incentives for research and development of these cleaner technologies.

Technology incentives may be structured as mandates or standards, spending initiatives, or tax incentives. Virtually all nations that have adopted ETR have also adopted measures to promote new clean technologies at the same time. Denmark, Germany, the Netherlands, Norway, and Sweden explicitly included tax incentives for efficiency technologies in their ETR packages, and other nations have included exemptions from their carbon or energy taxes for efficient technologies such as district heating or super-efficient electrical plants. Studies on the impact of hybrid packages including both ETR and tax or non-tax measures to promote efficiency technologies – from Austria, Denmark, and the U.K., and a multinational study using the Hermes model – all found that the net economic effect of such packages was both positive and preferable to ETR alone. An older Belgian study, also using the Hermes model, found that using 30% of the revenue to fund energy efficiency slightly reduced the GDP gain but greatly increased the emissions savings.

As discussed above, our sample of simulation results suggests that policy packages that include the use of a portion of the environmental tax revenues to finance energy efficiency or renewable energy improvements tend to result in employment and GDP gains. See Table 6.1.

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[150] European Commission, "European Economy: The Climate Challenge, Economic Aspects of the Community's Strategy for Limiting CO_2 Emissions, Statistical Annex," *Long-Term Macroeconomic Series* no.51 (Brussels: European Commission, Directorate-General II, 1992): 52; S. Felder et al., *Using Revenue From an Energy Tax to Finance Social Security: A Dynamic General Equilibrium Model for Switzerland* (Bern: ECOPLAN, 1998); W.E. Oates, "Green Taxes: Can We Protect the Environment and Improve the Tax System at the Same Time?" *Southern Economic Journal* 61, 4 (1995): 915-22; Organisation for Economic Co-operation and Development (OECD), *Environmental Taxes and Green Tax Reform* (Paris: OECD, 1997).

[151] F. Bregha, and J. Moffet, "Sustainable Development and Budget Reform," eds. R. Gale, S. Barg, and A. Gillies *Green Budget Reform: An International Casebook of Leading Practices* (London: Earthscan, 1995): 346-58; G. Mulgan, "Functional Hypothecation as a Potential Solution," ed. T. O'Riordan, *Ecotaxation* (London: Earthscan, 1997): 52-9; M. Spackman, "Hypothecation: A View from the Treasury," ed. T. O'Riordan, *Ecotaxation* (London: Earthscan, 1997): 45-51.

[152] "Groups Call for Offshore Wind Boost," *ENDS Environment Daily* (London: February 24, 1999).

6.4.5 International context

Modeling has suggested that the more mobile the capital factor of production, the greater the risk of relocation of firms abroad as a result of the imposition of environmental taxes.[153] This points to the desirability of coordinated action at the international level. Most of the studies examined here that looked at both unilaterally and multilaterally harmonized initiatives found that harmonized initiatives produced greater economic benefits or lower economic costs. However, a few models that predict economic losses from ETR also predict greater economic losses from harmonized initiatives, as the depressing effect on each nation is exacerbated through trade effects.

It is worth noting that some options for unilateral ETR are barred by international rules. These include recycling revenues through cuts in value added tax in Europe: VAT rates are harmonized across the Member States of the European Union into two bands – a regular band (15-25%) and a reduced band (5-10%) – and unilateral cuts in national value-added tax rates must remain within these bands.

6.4.6 Economic and Political Considerations

The experience of several countries demonstrates that what models predict to be best for the economy is not necessarily what is adopted as the real reform. Models prepared for testing the Finnish ETR concluded that the economy would benefit the most from recycling carbon tax revenues through cuts in employers' social security contributions or in value-added tax rates.[154] In actuality, the Finnish government in 1997 decided to cut mostly personal income tax rates. Similarly, the Norwegian Green Tax Commission recommended in the mid-1990s to cut payroll taxes. Yet, the Norwegian ETR initiated in 1999 finally opted to reduce personal income tax, at least in part because of a low unemployment rate.[155]

Lobbying power must be taken into account. In Sweden, ETR was first carried out by imposing a carbon tax on firms and households and reducing personal income tax rates. According to one observer, the various elements of the package neutralized the "blocking power of special interest groups."[156] Nevertheless, successful lobbying by industry resulted in the repeal of the carbon tax on firms for a period of time.

A modeling analysis for the United Kingdom openly anticipated that situation by simulating two reform packages, namely an economically optimal package, in which all green tax receipts are mobilized to reduce employers' social security contributions, and a politically realistic package, in which some of the receipts are used to reduce value added tax and corporate profits tax rates.[157] The corporate sector is traditionally in favor of low taxation on capital and energy. Energy-intensive branches of industry, in particular, are opposed to green taxation. The general public, on the other hand, will favor reductions in social security contributions, personal income

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[153] G. de Wit, "Belastingverschuiving en Werkgelegenheid" *Economisch Statistische Berichten,* no. 3996 (February 8, 1995): 134-7.

[154] Finnish Ministry of Environment, *Interim Report of the Environmental Economics Committee* (Helsinki: Finnish Ministry of Environment, 1994): 59-60.

[155] Norwegian Ministry of Finance and Customs, conversation with authors, February 17 and 18, 1999.

[156] P. Bohm, "Environment and Taxation: The Case of Sweden," *Environment and Taxation: The Cases of the Netherlands, Sweden and the United States* (Paris: OECD, 1993): 86.

[157] S. Tindale and G. Holtham, "Green Tax Reform: Pollution Payments and Labour Tax Cuts," *Institute for Public Policy Research* (London: 1996): 98-122.

tax, or VAT. The government will typically be concerned about the level of tax revenues. Navigating among these sometimes conflicting interests can be difficult. The examples above suggest political as well as economic concerns must be addressed in crafting ETR packages that can be passed. Both involving a wide range of stakeholders in the debate and carefully selecting tax instruments, recycling mechanisms, and related policies have generally proven necessary in order to enlist enough support for passage of a major environmental tax reform.[158]

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[158] D. Gee, "Eco-Nomic Tax Reform: Shifting the Tax Burden from Economic Goods to Environmental Bads," *European Environment* 4 (1992): 17-22; S. Tindale, "The Political Economy of Environmental Tax Reform," ed. M. Jacobs, *Greening the Millennium? The New Politics of the Environment* (Oxford: Blackwell Publishers, 1997): 98-108; E.U. von Weizsäcker, and J. Jesinghaus, *Ecological Tax Reform* (London: Zed Books, 1992).

7   CONCLUSIONS

7.1   ETR Is No Longer the Exception

For a number of years, only the small Nordic economies and the Netherlands had adopted an explicit ETR package. The number has since grown and larger economies have caught on, amongst them Germany and Italy. And ETR is still gaining ground in Europe: the United Kingdom has announced that a "climate change levy" will finance an ETR starting in April 2001;[159] France has also announced its intention to raise energy taxes in 2001, including a significant carbon tax;[160] Austria and Switzerland are likely to adopt a reform package in the next few years as well. Finally, the scope of several existing reforms is scheduled to broaden, in particular by raising the green taxes paid by firms to bring rates closer to those paid by households.[161] Even central and eastern European countries are studying the possibility of ETR or auctioned pollution permits,[162] as is Canada. Although Japan has not explicitly adopted an ETR, it has pre-tax energy prices in excess of the European average, and energy taxes roughly half way between the U.S. and European average,[163] and further carbon/energy taxes to address climate policy and persistent fiscal deficits are under study.

Among the world's largest advanced economies, only one has neither adopted ETR nor appears to be actively considering it: the United States.[164]

7.2   Design is Important

The results of this survey suggest that a poorly-designed environmental tax reform can impose substantial costs on the economy. On the other hand, a well-designed reform can increase employment and have GDP and distributional effects that are negligible or positive. The weight of economic evidence suggests that, for most economies, elements of good design include a labor tax reduction, ideally targeted at lower-wage workers to maximize employment benefits and offset distributional problems; policies to protect the competitiveness of energy-intensive industries; measures to prevent a wage-price inflationary spiral; policies to promote the development and diffusion of new cost-effective clean technologies; and policies to compensate low-income households outside of the workforce. Most of these elements have been included in many of the ETR initiatives that have been enacted.

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[159] "UK Launches 'Biggest Ever' Green Tax Reform," *ENDS Environment Daily* (London: March 9, 1999).

[160] As announced, the tax will come into force at FF 150/tonne and rise to FF 500 over ten years, with revenue recycled to cut social security contributions. Benoit Hopquin, "Le plan prévoit l'instauration d'une écotaxe" *Le Monde* (Paris: 1/20/2000); "France Adopts National Climate Change Plan," *ENDS Environment Daily* (London: January 20, 2000); Lawrence J. Speer, "France Unveils Climate Change Plan Including Industrial Carbon Tax, Alternative Fuel Credit," BNA Inc., *Daily Tax Report*, no. 14, January 21, 2000: G-3.

[161] "Little Impact Seen from French Tax Ruling," *ENDS Environment Daily* (London: January 12, 2001).

[162] Kai Schlegelmilch, ed., *Green Budget Reform in Europe: Countries at the Forefront* (Berlin: Springer, 1999).

[163] See, e.g., International Energy Agency, *Energy Prices and Taxes* (Paris: OECD, 1999). It should be observed, however, that much of the current energy tax revenue in Japan is earmarked for construction of roads and power plants, undermining the environmental effect.

[164] It should be observed, however, that the discussion of ETR in Canada is much less advanced than in most of Europe. Because Canada is so thoroughly integrated with the US economy, it would be difficult for it to act alone. This raises the possibility of a North American block of low energy tax nations.

It would be highly desirable to conduct more economic studies that incorporate all the key design elements of such an ETR package. At this point, models of richer and more realistic ETR packages would be more useful to policy makers than additional simulations of ETR proposals that have been unrealistically simplified.

7.3 ETR Can Provide Environmental and Economic Benefits to Adopting Nations

Although the initial motivation for environmental tax reform often comes from the need to address environmental problems, ETR should be regarded as fundamental tax reform, not just environmental protection: the intention is to alter the system of incentives through cuts in taxes on economic goods, such as work and investment, financed by increased taxes on "bads," such as pollution and natural resource consumption. In so doing, it creates the potential for a "double dividend," *i.e.*, an environmental improvement coupled with an economic benefit or a greatly reduced economic cost. The European experience with ETR suggests that a well-designed ETR can produce a variety of economic benefits. The economic benefits of such reforms would be revealed to be even greater if the economic value of the environmental benefits were included as well.

Significant challenges remain: to continue to expand the pool of nations with ETR; to better harmonize tax reforms across adopting nations; to more effectively integrate tax and non-tax environmental policies; to find the best way of preserving the competitiveness of resource-intensive industries while preserving the environmental incentive; to develop workable taxes to cover a broader range of environmental damages; and to synchronize ETR with emerging and promising initiatives in pollution rights trading.

It is sometimes argued that ETR cannot be pursued on the level of individual nations or states, or even by the developed nations collectively; that only a global initiative can solve global environmental problems. As global agreement on economic instruments for environmental protection is extraordinarily difficult to achieve, this view seems to imply that global environmental problems cannot be solved, or at best that progress will necessarily be extremely slow and difficult. This survey generally supports the idea that international harmonization reduces the economic cost of ETR. However, it also makes clear that Western nations can use well-designed economic instruments to adopt a role of environmental leadership without necessarily suffering significant economic harm as a result. By taking leadership in demonstrating that economic instruments are workable, effective and economically beneficial, and in developing clean technologies, such nations may be able to blaze the trail for the poorer and more fragile economies of the world to follow.

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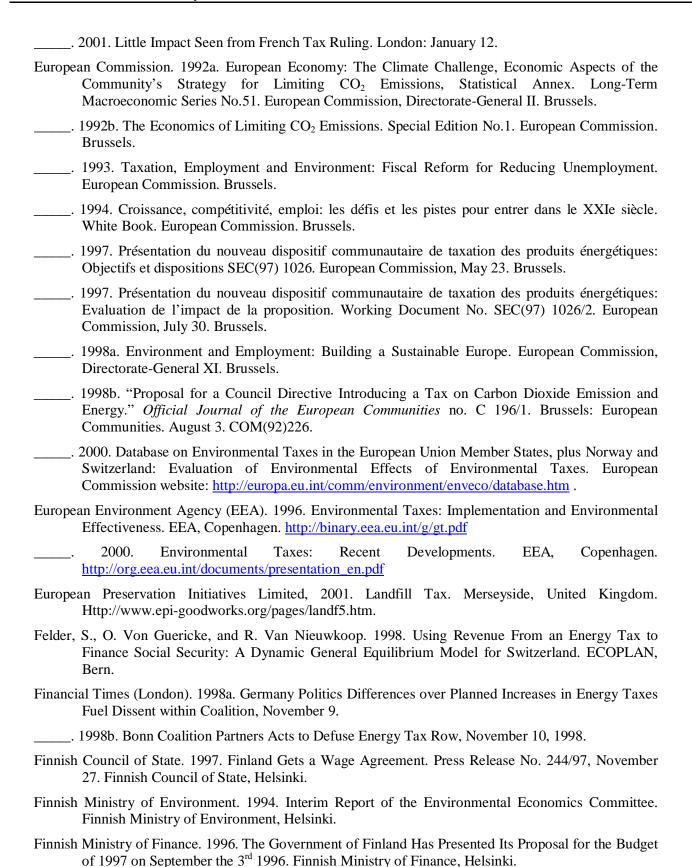
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APPENDIX

Appendix Table 1: Environmental and Macroeconomic Effect of Environmental Tax Reform pe

Study	Country	Model	Model type	Tax	Recycling	CO_2 emissions [a]	Employment [a]	GDP [a]	Firms' invest-ments [a]	Consum. prices [a]	Time period
Bach *et al.* 1994; Greenpeace and DIW 1997	Germany	DIW	M and IO	Energy tax	SSC and "eco-bonus"	-21	500,000 jobs	-0.2	-1.0	3.1	10 years
Bardazzi 1996	Italy	INTIMO	IO	Energy tax	SSC	n.a.	0.08	0.11	0.6	0.34 [o]	1 year
Barker 1995 [h]	UK	MDM9	M	CO_2/energy tax	SSC	n.a.	-200,000 jobs	0.3	n.a.	n.a.	1995-2005
Barker and Köhler 1998	11 European countries	E3ME	M	Energy tax	SSC	-10	1.2 (1,9 million jobs)	1.4	n.a.	n.a.	1999-2010
Beaumais and Godard 1993 [p]	France	Hermès-Midas	M	EC tax in France	PIT	-5.9	103,000 jobs	-0.04	n.a.	4.47	1993-2000
					SSC	-6.6	132,000 jobs	0.5	n.a.	2.79	
				EC tax in EC	50% PIT, 50% SSC	-5.9	139,000 jobs	0.55	n.a.	3.63	
				EC tax in OECD	SSC	-5	196,000 jobs	0.93	n.a.	5.31	
				EC tax in EC	53% VAT, 31% SSC, 16% energy efficiency	-13.4	288,000 jobs	1.18	n.a.	3.13	
Bossier and Bréchet 1993	Belgium	Hermès	M	Energy tax	None	-6.31	-8,650 jobs	-0.55	-2.63	1.70	1993-2001
					PIT	~-5	6,470 jobs	-0.08	-2.28	2.07	
					SSC	~-5	43,280 jobs	0.52	-0.62	0.78	
					70% SSC, 30% energy	-8.87	26,710 jobs	0.32	0.36	1.29	

Study	Country	Model	Model type	Tax	Recycling	CO_2 emissions [a]	Employment [a]	GDP [a]	Firms' invest-ments [a]	Consum. prices [a]	Time period
					efficiency						
Bossier *et al.* 1993a	Belgium	Hermès	M	EC tax	PIT	-7.44	2,850 jobs	-0.08	-1.21	1.40	1993-2000
					SSC	-7.11	24,150 jobs	0.46	-0.22	0.52	
					VAT	-7.56	11,460 jobs	0.11	-0.34	-0.38	
Bossier *et al.* 1993b	6 European countries	Hermès	M	EC tax	SSC	-4.4	0.64	0.15	-0.15	0.95	1993-2001
Bovenberg and Goulder 1995	USA	n.a.	GE	BTU tax	LSTH	n.a.	n.a.	~-0.4	~-0.6	n.a.	1995-2025
					PIT	n.a.	n.a.	~-0.06	~-0.1	n.a.	
				Gasoline tax	LSTH	n.a.	n.a.	~-0.2	~-0.2	n.a.	
					PIT	n.a.	n.a.	~0.12	~0.3	n.a.	
Bréchet 1992 [j]	France	Hermès	M	EC tax	70% VAT, 30% SSC	n.a.	0.4	-0.03	n.a.	1.62	1993-2000
					SSC	n.a.	0.4	-0.12	n.a.	2.33	
Bureau du Plan 1993	Belgium	Hermès	M	Energy tax	None	n.a.	-5,000 jobs	-0.19	n.a.	0.35	1993-2000
					SSC	n.a.	22,900 jobs	0.26	n.a.	0.44	
Bureau du Plan 1993 [j]	Belgium	Hermès	M	EC tax	SSC	n.a.	0.62	0.46	n.a.	0.52	1993-2000
					30% VAT, 70% SSC	n.a.	0.52	0.35	n.a.	0.25	
Cambridge Econometrics 1992 [j]	UK	E3	M	EC tax	90% VAT, 10% LSTH	n.a.	78,000 jobs	0.41	n.a.	0.6	1993-2005
Cambridge Econometrics (Holtham and Tindale 1996)	UK	E3	M	Array of green taxes	SSC	-9	2.56	-0.03	n.a.	3.06	1997-2005
					VAT, CPT and SSC	-9	2.06	-0.27	n.a.	2.70	

Study	Country	Model	Model type	Tax	Recycling	CO_2 emissions [a]	Employment [a]	GDP [a]	Firms' invest-ments [a]	Consum. prices [a]	Time period
Carraro *et al.* 1995	Italy	WARM	GE	EC tax	SSC	~7	~0.4	~0	n.a.	n.a.	1995-2010
	France					~5	~-0.2	~0	n.a.	n.a.	
	Spain					~2	~0.7	~0	n.a.	n.a.	
	UK					~1	~1.3	~-0.1	n.a.	n.a.	
	Germany					~-2	~0	~0.2	n.a.	n.a.	
	Netherlands					~-3	~0.4	~0	n.a.	n.a.	
CPB 1992	Netherlands	Athena	M	Energy tax	SSC and PIT	n.a.	-140,000 jobs	-5.0	-8.0	1.0	1993-2015
				Small-scale energy tax		n.a.	-12,000 jobs	-0.4	-0.5	4.0	
CPB 1997	Netherlands	Athena	M	Doubling small-scale energy tax	SSC and PIT	-4.6	0	-0.1	0.1	1.2	1995-2020
Danish Ministry of Finance 1994	Denmark	ADAM	M	CO_2 tax	SSC	-5	3,000 jobs	n.a.	n.a.	n.a.	1996-2005
				PIT		-5	-1,000 jobs	n.a.	n.a.	n.a.	
DRI 1993 [j]	11 European countries	DRI	M	EC tax	35% PIT, 35% CPT, 30% SSC	n.a.	Negative	-0.52	n.a.	2.1	1993-2005
DRI *et al.* 1994 [k]	6 European countries	DRI	M	EC tax	80% PIT and 20% environ. Expend.	n.a.	0.07	0.05	n.a.	n.a.	1992-2010
					SSC	n.a.	0.15	0.06	n.a.	n.a.	
ECOPLAN 1996 [h]	Switzerland	n.a.	GE	Tax on fossil fuels and electricity	LSTH and SSC	-8	16,200 jobs	-0.49	n.a.	n.a.	2003-2025
ESRI 1991 [j]	Ireland	Hermès	M	EC tax	SSC	n.a.	0.7	0.4	n.a.	0.4	1991-2000
European	EC	Quest	M	EC tax	None	n.a.	-0.4	-1.2	-2.2	3.8	1993-

Study	Country	Model	Model type	Tax	Recycling	CO_2 emissions [a]	Employment [a]	GDP [a]	Firms' invest-ments [a]	Consum. prices [a]	Time period
Commission 1992a											2000
					PIT	n.a.	-0.3	-1.1	-2.0	3.5	
					SSC	n.a.	0	-0.7	-1.9	2.5	
					VAT	n.a.	0.1	-0.1	0.7	0.9	
European Commission 1997	EU	Hermès	M	Minimum energy rates across EU	SSC	-1.6	190,000 jobs	0.06	n.a.	0.04	1998-2005
		E3ME	M			-0.5	457,000 jobs	0.2	n.a.	-0.08	
		GEM-E3	GE			-1.47	155,000 jobs	0.02	n.a.	0.08	
Felder and Schleiniger 1995 [h]	Switzerland	n.a.	GE	Energy tax	SSC	n.a.	Negative	Negative [g]	Positive	n.a.	Adjustment period
				Tax on dirty goods	SSC	n.a.	Positive	Positive [g]	Negative	n.a.	
Finnish Ministry of Environment 1994	Finland	KESSU IV	M	National CO_2 tax	PIT	-14 [n]	-24,800 jobs	-1.1	-1.4	1.9	1994-2005
					VAT	-14 [n]	-24,800 jobs	-1.1	-1.3	0.5	
					SSC	-14 [n]	-13,600 jobs	-0.8	-1.1	1.3	
					SSC, adjusted earnings	-14 [n]	-700 jobs	-0.3	-0.5	0	
				EC tax	PIT	-11 [n]	-7,000 jobs	-0.3	-0.5	2.4	
					VAT	-11 [n]	-8,200 jobs	-0.4	-0.6	0.6	
					SSC	-11 [n]	800 jobs	-0.2	-0.4	1.6	
					SSC, adjusted earnings	-11 [n]	4,100 jobs	0	-0.2	1.1	
		FMS	GE	National	PIT	-14 [n]	-44,800 jobs	-2.8	-6.2	n.a.	1991-

Study	Country	Model	Model type	Tax	Recycling	CO$_2$ emissions [a]	Employment [a]	GDP [a]	Firms' invest-ments [a]	Consum. prices [a]	Time period
				CO$_2$ tax							2000
					SSC	-14 [n]	21,600 jobs	1.0	0.6	n.a.	
				EC tax	PIT	-11 [n]	8,600 jobs	-0.1	-1.0	n.a.	
					SSC	-11 [n]	3,800 jobs	-0.1	0	n.a.	
Goulder 1994a [i]	USA	n.a.	GE	CO$_2$ tax	PIT	n.a.	n.a.	-0.22 [b]	n.a.	n.a.	21 years
Goulder 1994b [i]	USA	n.a.	GE	Fossil or Btu tax	PIT	n.a.	n.a.	-0.18 [b]	n.a.	n.a.	21 years
Harrison and Kriström 1997	Sweden	Small Open Economy	GE	CO$_2$ tax	SSC	-0.1	n.a.	-0.2 [c]	n.a.	n.a.	~10 years
Honkatukia 1997	Finland	Small Open Economy	GE	CO$_2$ tax	SSC	0.58	0.13	1.02	n.a.	1.56	~10 years
INFRAS and ECOPLAN 1996	Switzerland	Swiss CGE	GE	CO$_2$ tax	SSC	-6.05	0.46 0.21 [d]	0.22	n.a.	n.a.	~15 years
				Energy tax	SSC and LSTH	-12.13	-0.26 0.08 [e]	-0.20	n.a.	n.a.	~30 years
Jorgenson and Wilcoxen 1993	USA	n.a.	GE	CO$_2$ tax	LSTH	-32.24	n.a.	-1.70 [b]	-2.13 [l]	n.a.	1990-2020
					Labor taxes	-32.09	n.a.	-0.69 [b]	-1.36 [l]	n.a.	
					Capital taxes	-31.65	n.a.	1.10 [b]	1.89 [l]	n.a.	
Kuper 1996	Netherlands	n.a.	Putty-clay	Energy	SSC	n.a.	n.a.	~-0.2	~-0.2	n.a.	40 years
Kypreos 1994 [h]	Switzerland	Markal	Engin.	CO$_2$ tax	n.a.	n.a.	n.a.	[-1.7, -4] [f]	n.a.	n.a.	1993-2030
Lemiale and Zagamé 1998	6 European countries	Hermès with technol. Adjust.	M	EC tax	SSC	n.a.	0.78	0.27	-0.53	0.76	1992-2005

Study	Country	Model	Model type	Tax	Recycling	CO_2 emissions [a]	Employment [a]	GDP [a]	Firms' investments [a]	Consum. prices [a]	Time period
LINK 1992 [i]	USA	LINK	M	CO_2 tax	PIT	n.a.	n.a.	-0.35 [b]	n.a.	n.a.	21 years
Mabey and Nixon 1997	UK	SLEEC	M	CO_2 tax	PIT	n.a.	-3.39	-2.87	n.a.	n.a.	1995-2020
					SSC	n.a.	-1.78	-1.74	n.a.	n.a.	
		EGEM	M		PIT	n.a.	~0.2	~-0.8	n.a.	n.a.	
					SSC	n.a.	~2.5	~-0.4	n.a.	n.a.	
		EGEMX	M		PIT	n.a.	0.38	-0.27	n.a.	n.a.	
					SSC	n.a.	3.19	0.39	n.a.	n.a.	
		EGEME	M		PIT	n.a.	0.64	-0.05	n.a.	n.a.	
					SSC	n.a.	2.60	0.58	n.a.	n.a.	
Manne and Richels 1992 [j]	EC-12	Global 2100	GE	EC tax	Full	n.a.	n.a.	-0.4	n.a.	n.a.	1993-2030
Meyer zu Himmern and Kirchgässner 1995 [h]	Switzerland	n.a.	IO	Swiss CO_2 tax	LSTH of 2/3 of revenues or full recycling	n.a.	[-0.52, -0.03] [f]	[-0.6, -0.02] [f]	n.a.	n.a.	1996-2000
Müller and Carlevaro 1995 [h]	Switzerland	n.a.	PE and GE	Swiss CO_2 tax and alternatives	LSTH	n.a.	n.a.	~ -1.1	~ -3	n.a.	1995-2030
Norland and Ninassi 1998	USA	Jorgenson-Wilcoxen	GE	Energy and consumption taxes	All income taxes	-44.1	n.a.	7.7	12.6	n.a.	1996-2025
Norwegian Green Tax Commission 1996	Norway	MODAG	M	CO_2 tax	SSC	-0.4	0.1	0	n.a.	-0.3	1992-2010
OECD 1992 [j]	EC-12	Green	GE	EC tax	Full	n.a.	n.a.	-0.6	n.a.	n.a.	1993-2050
Op de Beke	EC	QUEST	M	EC tax	SSC	n.a.	1.0	1.0	-0.2	-0.7	7 years

Study	Country	Model	Model type	Tax	Recycling	CO_2 emissions [a]	Employment [a]	GDP [a]	Firms' invest-ments [a]	Consum. prices [a]	Time period
1993											
Previdoli and Stephan 1996 [h]	Switzerland	n.a.	GE	Tax on fossil fuels and electricity	LSTH and SSC	n.a.	n.a.	-2.6	-0.8	n.a.	2003-2025
Prognos 1993 [h]	Switzerland	n.a.	IO	Swiss CO_2 tax	75% LSTH, 25% SSC	~-8	~ 0.1	~ 1.1	~ 1.1	n.a.	1990-2025
Proost and Van Regemorter 1992	Belgium	n.a.	GE	EC tax	SSC	-12.4	0	0	-1.5	n.a.	14 years
RWI 1999a	Germany	Konjunk-turmodell	M	CO_2/energy tax	SSC	~-3	106,000 jobs	0	-0.4	0	1999-2001
RWI 1999b	Germany	Konjunk-turmodell	M	CO_2/energy tax	SSC	~-9 after 10 years	125,000 jobs	0.1 after 1 year	-0.1	0.1	2000-2005
Schmid and Rosenbaum 1994 [h]	Switzerland	n.a.	PE	Energy tax	SSC	n.a.	Negative in the first years, then positive	Cyclical: negative, then positive, then negative again	Negative	n.a.	1974-1991
Shah and Larsen 1992	USA	n.a.	PE	CO_2 tax	PIT	-5.3	n.a.	-0.02 [m]	n.a.	n.a.	1 year
					CPT	-5.3	n.a.	-0.017 [m]	n.a.	n.a.	
	India				PIT	-13.3	n.a.	-0.06 [m]	n.a.	n.a.	
					CPT	-13.3	n.a.	0.11 [m]	n.a.	n.a.	
	Indonesia				PIT	-3.9	n.a.	-0.005 [m]	n.a.	n.a.	
					CPT	-3.9	n.a.	0.03 [m]	n.a.	n.a.	
	Japan				PIT	-1.6	n.a.	-0.008 [m]	n.a.	n.a.	
					CPT	-1.6	n.a.	0.007 [m]	n.a.	n.a.	
	Pakistan				PIT	-4.5	n.a.	-0.07 [m]	n.a.	n.a.	
					CPT	-4.5	n.a.	0.04 [m]	n.a.	n.a.	

Study	Country	Model	Model type	Tax	Recycling	CO$_2$ emissions [a]	Employment [a]	GDP [a]	Firms' invest-ments [a]	Consum. prices [a]	Time period
Standaert 1992	4 European countries	Hermès	M	EC tax	PIT	n.a.	-0.05	-0.53	-1.45	3.54	1993-2005
					SSC	n.a.	0.45	-0.12	-1.29	1.92	
Standaert 1992	Germany	Hermès	M	EC tax	PIT	n.a.	0.3	-0.6	-2.3	2.7	1993-2005
					SSC	n.a.	0.7	-0.2	-0.9	2.0	
	France				PIT	n.a.	0.1	-0.7	-1.5	4.3	
					SSC	n.a.	0.3	-0.3	-0.5	3.2	
	Italy				PIT	n.a.	0.1	0.0	-0.6	1.8	
					SSC	n.a.	0.7	0.2	-0.9	-0.5	
	UK				PIT	n.a.	-0.6	-0.7	-1.4	5.5	
					SSC	n.a.	0.1	-0.2	-1.1	3.1	
Stephan and Imboden 1995 [h]	Switzerland	n.a.	GE	CO$_2$ tax (20% reduction by 2010)	LSTH	n.a.	n.a.	Negative	Negative	n.a.	1985-2010
					None	n.a.	n.a.	Negative	Negative	n.a.	
WIFO (Köppl 1996; Köppl *et al.* 1999)	Austria	WIFO	M and IO	Energy tax	SSC and fund for renewable energies	n.a.	0.4	0.4	4.2	1.8	1988-1992
					None	n.a.	-2.1	-2.5	-5.1	3.3	1988-1992
					SSC only	n.a.	-0.3	-0.2	-0.7	0.9	1988-1992

Notes:

a) Figures expressed as percentage difference relative to the reference scenario by the end of the time period, unless mentioned otherwise.

b) Percent change in real GNP.

c) Welfare loss of around 0.2 of GDP.

d) 0.38% for low-income employment and 0.31% for high-income employment.

e) 0.88% for low-income employment and 0.34% for high-income employment.

f) Depending on recycling and exchange rate scenario.

g) Welfare effect.

h) Study reviewed and full reference in INFRAS and ECOPLAN 1996

i) Study reviewed and full reference in Goulder 1995

j) Study reviewed and full reference in Majocchi 1996

k) Study reviewed and full reference in OECD 1997b

l) Percent change in capital stock.

m) Welfare loss (-) or gain (+) relative to GDP.

n) Estimated by the Technical Research Center of Finland's EFOM model, which did not consider differences in tax revenue recycling. Reference in Finnish Ministry of the Environment, *Interim Report of the Environmental Economics Committee* (Helsinki: Ministry of the Environment, 1994), p.45.

o) Percent change in producer price index.

p) Study reviewed and full reference in Audinet 1996.

Abbreviations:

EC-12: 12 members of the European Community (as of 1992 EC tax proposal).

EC tax: The 1992 European proposal of a CO_2/energy tax would be applied *ad quantum* (specific tax) to the final consumption of energy, on top of existing taxes. Its base rate would be USD 3 per barrel of oil equivalent, to be broken down equally between the carbon and energy content of the fuel. The rate would increase by USD 1 per year until it reached USD 10. The rate would be calculated in real terms to adjust for inflation. When the tax reached its maximum, the tax revenues, recycled through cuts in employers' social security contribution, would reach between 0.8 and 1.3% of GDP, depending on the country.

Engin.: Engineering model.

Appendix Table 2: Abbreviations and Symbols Used

CGE	Computable general equilibrium	MtC	Megaton of carbon
CH_4	Methane	$MtCO_2$	Megaton of carbon dioxide
CO_2	Carbon dioxide	$MtCO_2e$	Megaton of carbon dioxide equivalent
CPT	Corporate profits tax	N_2O	Nitrous oxide
EC	European Community	NIC	National Insurance Contributions
ETR	Environmental tax reform	NO_x	Nitrogen oxides
EU	European Union	OECD	Organisation for Economic Co-operation and Development
GDP	Gross domestic product	PFCs	Perfluorocarbons
GE	General equilibrium	PIT	Personal income tax
GHG	Greenhouse gas	SF_6	Sulphur hexafluoride
GJ	Gigajoule	SO_2	Sulphur dioxide
HFCs	Hydrofluorocarbons	SSC	Social security contributions
kWh	Kilowatt-hour	toe	Metric ton of oil equivalent
LPG	Liquid petroleum gas	UNFCCC	United Nations Framework Convention on Climate Change
LSTH	Lump sum transfer to households	USD	U.S. dollar
m^3	Cubic meter	VAT	Value added tax

Appendix Table 3: Exchange Rates Used

National Currency per USD or EUR (End of Period)

Currency name	Austrian shilling	Belgian franc	Danish krone	Deutsche mark	Finnish markka	Italian lira	Netherlands guilder	Norwegian krone	Pound sterling	Swedish krona
Symbol	*ATS*	*BEF*	*DKK*	*DEM*	*FIM*	*ITL*	*NLG*	*NOK*	*GBP*	*SEK*
Year										
1990	11.37	33.42	6.19	1.62	3.82	1,198.10	1.82	6.26	0.56	5.92
1991	11.68	34.15	6.40	1.66	4.04	1,240.61	1.87	6.48	0.57	6.05
1992	10.99	32.15	6.04	1.56	4.48	1,232.41	1.76	6.22	0.57	5.82
1993	12.14	36.11	6.77	1.73	5.78	1,704.00	1.94	7.52	0.68	8.30
1994	10.97	31.84	6.08	1.55	4.74	1,629.70	1.74	6.76	0.64	7.46
1995	10.09	29.41	5.55	1.43	4.36	1,584.70	1.60	6.32	0.65	6.66
1996	10.95	32.01	5.95	1.55	4.64	1,530.60	1.74	6.44	0.59	6.87
1997	12.63	36.92	6.83	1.79	5.42	1,759.20	2.02	7.32	0.60	7.88
1998	11.75	34.58	6.39	1.67	5.09	1,653.10	1.89	7.60	0.60	8.06
1999	13.70	40.15	7.40	1.95	5.92	1,927.27	2.19	8.04	0.62	8.52
1999 EUR	13.7603	40.3399	--	1.95583	5.94573	1,936.27	2.20371	--	--	--

Sources: Organisation for Economic Co-operation and Development (OECD), *Revenue Statistics* (Paris: OECD, 1998) for the years 1965-1997; International Monetary Fund, *International Financial Statistics* (Washington, DC: IMF, 2000) for the years 1993-1999.

Appendix Table 4: Conversion Factors

EC tax carbon/energy tax proposal	USD 10 per barrel of oil equivalent
EC tax carbon/energy tax proposal	USD 70 per metric ton of oil equivalent
Weight of carbon to carbon dioxide	12/44
Carbon density of crude oil	0.838 ton of carbon per ton of oil
Carbon density of coal (anthracite)	0.84152 ton of carbon per ton of coal
Carbon density of natural gas	0.00053 ton of carbon per m^3 of gas