

THE ENVIRONMENTAL AND ECONOMIC EFFECTS OF EUROPEAN EMISSIONS TRADING IN GERMANY

Claudia Kemfert^{a,b}, Michael Kohlhaas^a and Truong Truong^c, Artem Protsenko^a

^a *German Institute for Economic Research, 14191 Berlin, Germany*

^b *Humboldt University of Berlin*

^c *School of Economics, University of New South Wales, NSW 2052, Australia*

Abstract

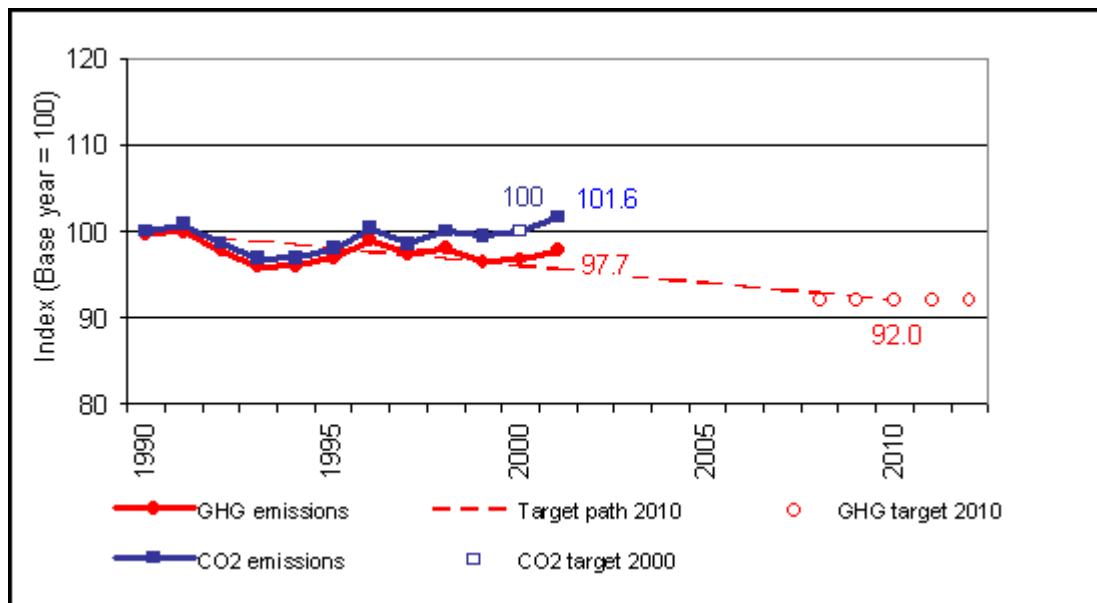
In 2005, the EU introduced an emissions trading system in order to pursue its Kyoto obligations. This instrument gives emitters the flexibility to undertake reduction measures in the most cost-efficient way and mobilizes market forces for the protection of the earth's climate. In this paper, we analyse the effects of emissions trading in Europe, especially the value of the flexibility gained by trading compared to fixed quotas. The analysis will be undertaken with a modified version of the GTAP-E model using the latest GTAP data base. It is based on the national allocation plans as submitted to and in most cases approved by the EU.

Introduction

The European Union considers climate change as “one of the greatest environmental, social and economic threats facing the planet.” It therefore took a leading role in the negotiations for international action against climate change, in particular for the Kyoto Protocol. In order to set an example, it accepted relatively ambitious targets. Whereas all Annex B countries were to reduce the emissions of greenhouse gases by about 5 percent, the EU is striving for a 8 percent reduction.

Compliance with this target, however, does not come easily for the EU. Figure 1 depicts the development of the emissions of CO₂ and of all greenhouse gases (GHGs). It shows that the emissions in the EU were reduced quite effectively in the first half of the 90s. This was to a large extent due to the massive breakdown and modernisation of the industry in the former East Germany. Emissions have been fluctuating since then and increasing since the end of the 1990s.

Figure 1: Total EU greenhouse gas emissions in relation to the Kyoto target



Therefore, in 2000 the EU Commission launched the European Climate Change Programme (ECCP), a continuous multi-stakeholder consultative process which serves to identify cost-effective ways for the EU to meet its Kyoto commitments, to set priorities for action and to implement concrete measures.¹ One of the main elements of this program was the establishment of a European CO₂ emissions trading scheme. The EU considers this as “a cornerstone in the fight against climate change” which will help its Member States to achieve compliance with their commitments under the Kyoto Protocol and the EU burden sharing at lower costs. The basic idea of emissions trading is to limit the amount of some kind of emission by creating rights to emit a certain amount of a gas and to make these rights – which are called allowances – tradable. The scarcity of emission allowances gives them a market value and thus a positive price which increases the costs for emitters. This creates an incentive to reduce emissions in an efficient way. Those emitters whose avoidance costs are lower than the market price of allowances will reduce their emissions and buy less certificates or sell excess emissions rights and vice versa.

Emissions trading has been introduced to international climate change policy through the Kyoto Protocol. However, there is a fundamental difference between the two approaches: The Kyoto Protocol permits trading between the Parties to the protocol on the level of

¹ Communication from the Commission to the Council and the European Parliament on EU policies and measures to reduce greenhouse gas emissions: Towards a European Climate Change Programme (ECCP), Com(2000)88 final.

states, the EU ETS comprises several thousand installations and involves trade among individual emitters in 25 Member States.

In this paper we analyse the effects of the European Emissions Trading System (ETS), in particular the cost reduction that may be obtained by the flexibility of trading. This will be done by comparing three scenarios where the same reduction target is achieved with a different degree of flexibility. In the first case, fixed quotas do not permit any flexibility at all. The second scenario allows trading between the sectors within the national economy. The third scenario represents the EU ETS where all participating European emitters can trade emission allowances among each other.

European Emissions Trading

The ETS started on 1 January 2005. The first trading period – which has been nick-named “warm up phase” or “learning phase” – covers the years 2005 to 2007. The second phase corresponds to the Kyoto period 2008 to 2012.

The framework for European Emissions Trading has been defined by a Directive in October 2003² which lines out the basic features of the system, but leaves substantial scope for the Member States to decide on important aspects of the implementation. The most important features set by the EU are the following:³

- The European ETS will be a cap-and-trade system, i.e. the absolute quantity of emission rights (rather than relative or specific emissions) will be fixed at the beginning. This is the only way to guarantee that the emissions will be limited to a given quantity, regardless of economic growth and structural change.
- Only one of the six greenhouse gases of the Kyoto Protocol will be subject to the ETS, at least during the first period from 2005 to 2007. The main reason for this is that CO₂ is the greenhouse gas which is easiest to monitor, since the emissions are directly related to the use of fossil fuels for which most countries have already established a monitoring system in order to levy energy taxes. Restricting emissions trading in this way is likely to produce some inefficiencies, since differences in avoidance costs cannot be exploited systematically within this framework.

² “Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC,” Official Journal of the European Union, L 275/32, 25.10.2003.

³ For a more detailed description and good discussions of the ETS see Kruger / Pizer (2004).

- The EU ETS is implemented as a *downstream* system, i.e. the users (rather than the producers and importers of fossil fuels) will be obliged to hold emission allowances. This has some fundamental consequences: All users of fossil fuels which are covered by the ETS will have to be monitored and will participate actively in the trading system. In order to limit the administrative costs of the ETS, the system will be restricted to large installations. Therefore, only installations belonging to one of four broad sectors which are listed in the Directive and which exceed a sector-specific threshold are subject to emissions trading. The four sectors are

- Energy activities (such as, electric power, direct emissions from oil refineries)
- Production and processing of ferrous metals (iron and steel),
- Mineral industry (such as cement, glass, or ceramic production),
- pulp and paper.

The thresholds refer to the production capacity of the installation, e.g. in the case of combustion installations with a rated thermal input exceeding 20 MW. The EU estimates that the Emissions Trading Scheme will cover a total of more than 12.000 installations in the 25 EU Member States representing close to half of Europe's emissions of CO₂. This partial coverage of the ETS is likely to produce inefficiencies. This can only be avoided if the total quantities of allowances are set at level which equalises the marginal avoidance costs between the emissions trading sector and other emitters.

- At least 95% of the total quantity of allowances must be issued for free in the 2005/07 period, at least 90% in 2008/12.
- Allowances are issued by each Member State, but trading can take place between any EU participant.
- In April 2004, the EU Parliament passed the so-called "linking Directive". The new Directive builds on the project-based mechanisms "Clean Development Mechanism" and "Joint Implementation" created by the 1997 Kyoto Protocol and will participants in emissions trading to count credits from emission reduction projects around the world towards their obligations under the European Union's emissions trading scheme. Thus the project-based mechanisms of the Kyoto protocol will be available for European business, even if the protocol did not enter into force.

Within this framework, the Member States have an three important tasks. First, they have to decide which quantity of emissions should be allocated to the installations participating in the ETS. This decision must take into consideration the burden sharing target of the country

and must list the policies and measures which are to be applied in the sectors which are not part of the ETS. However, in almost all countries business representatives made strong lobbying efforts to make sure that emissions trading will not impair their competitive position. This led to very generous allocations in some cases. Second, they have to draw up a list of all installations which are subject to emissions trading. Third, they have to decide how to allocate the total quantity to individual installations. The Directive sets some general rules according to which the allocation has to be made, but there is substantial scope for national priorities.

These decisions have to be written down in a “National Allocation Plan” (NAP) which was supposed to be notified to the Commission by the end of March 2004, in the case of the new Member States by the end of June 2004 for review and approval. As to date, all but two NAPs have been assessed by the EU. In some cases, the EU rejected parts of the submitted NAPs. In most cases, Member States modified their plans, in some cases complaints against the decision have been filed.

The National Allocation Plan (NAP) in Germany

Germany’s National Allocation Plan consists of two elements: the so-called Macroplan which defines the national emissions budget and determines the total quantity of allowances to be allocated and a Microplan for the intended allocation of allowances to operators of individual installations (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2004) and Bundesregierung (2004)).⁴

The starting point of the **Macroplan** is Germany’s commitment of the Kyoto protocol and the European burden sharing agreement to reduce its emissions of greenhouse gases by 21 % by 2008 to 2012 compared to 1990 levels. Up to now a 19 % reduction has been achieved already. [Quelle?] Taking into account the projected development of non CO₂ emissions, the German Government fixed the CO₂ target for the period 2005 to 2007 at 859 mill. tons – only 0,5 % less than 2000-2002 amounting to 863 mill. tons. Within these limits, the total quantity of allowances allocated to the trading sector are 499 mill. tons of CO₂, compared to 501 mill. tons in 2000-2002. This corresponds to a reduction of 0.4% and gives the trading sectors a comfortable position.

⁴ Federal Ministry for the Environment, Nature conservation and Nuclear Safety: National Allocation Plan for the Federal Republic of Germany 2005-2007. Berlin, 31 March 2004.

In the non-trading sectors, the CO₂ emissions have to be reduced from 362 mill. tons in 2000/2002 to 360 mill tons in 2005/2007. This also seems to be only a small reduction. But considering the fact, that the temperature adjusted emissions in 2000/2002 add up to approximately 373 mill. tons, the reduction rate (3,5 %) will be much higher than the rate for the trading sectors.⁵

The **Microplan** gives information on the intended allocation of allowances to operators of individual installations.⁶ This allocation has been guided by the following basic principles:

- For installations commissioned before 31 December 2002, the allowance allocated will be based on historical emissions in the reference period 2000-2002 (Grandfathering).
- For installations commissioned between 1 January 2003 and 31 December 2004, the allowance will be allocated on the basis of announced emissions.
- Allowances from installations which have been decommissioned can be transferred for four years to installations or extensions to installations commissioned from 1 January 2005 (Transfer rule).
- New installations will be allocated free of charge if they do not receive such a transfer (New entrant rule). A reserve of 3 Mt CO₂ is set aside for this purpose.

Furthermore, several special rules relating to early action, process-related emissions as well as for combined heat and power generation and a hardship clause have been designed to take account of special circumstances which according to the EU Directive may justify a more generous treatment.

In order to reconcile the Macroplan with the Microplan, a so-called compliance factors need to be applied. Since the trading sectors are to reduce emissions by 0,4%, a factor of 0.996 is applied to all allocations based on historical emissions. Since special rules increase the allocation to some installation and a reserve for newcomers is to be set aside, the allocation to other installation must be reduced by additional compliance factors. The effective reduction varies between 0 % and 7.5 %.

All in all the German NAP – as well as many of the NAP in other European countries – seems to be not very ambitious, especially concerning the allowances given to the trading

⁵ In contrast to the obligations given by the EU directive, no clear information is given in the German NAP which policies and measures will be implemented to guarantee that these targets will be achieved.

⁶ In total 1849 installations participate in the emissions trading system in Germany.

sectors, and not very clear in respect of the non-trading sectors. Nevertheless, special rules for many installations lead to relatively large reductions for others and potentially large cost differences. This creates ample scope for efficiency gains through trading.

Quantitative Impact assessment

Model, Data, and Experiments Description

In this study we use a version of the GTAP-E model (Burniaux and Truong, 2002), which is based on the latest version 6.2 of the standard GTAP model (Hertel, 1997). The model uses version 5.4 of the GTAP database which consists of 57 commodities/sectors and 85 regions which include the 25 European states. For the purpose of this study, we use an aggregation which includes all the 17 participating regions of the NAP scheme (see Table 1), and all the ‘allocated’ sectors (Table 2). The projected percentage changes in CO₂ emissions for the various sector for the period 2005-07 to satisfy the NAP are as shown in Table 3. Before these “NAP shocks” can be used, however, some modifications are necessary.

First, we notice that in the GTAP CO₂ emissions data base, a large percentage of CO₂ emissions attributed to Oil_Pcts (refined oil products) actually occur in the ROE or in electricity sector, rather than in Oil_Pcts sector itself (see Table 4). That is CO₂ emissions are assigned to the end-user (downstream) rather than producer (upstream). Hence, instead of shocking the emissions of Oil_Pcts with the NAP shocks, the NAP emissions associated with Mineral Oil Processing should be attributed to the ROE sector⁷ and then the NAP shock for ROE is re-calculated accordingly. These are shown in Table 5. From Table 5, we note that some of the shocks are positive (shaded areas). A non-negative emission shock would imply no abatement effort is involved, and this means the model will produce a negative abatement cost (or a subsidy) for this shock, a result which does not make much sense in practice. Therefore, to avoid this situation, we have chosen to shock, not the (positive) emissions, but rather the marginal abatement costs. In these cases, we assume that the marginal abatement cost (bcarbon tax) will be set to zero, and the resulting emissions can be positive but normally would be less than the actual NAP allocations.

We now carry out three experiments. In Experiment 1 (“No Trading”), we ‘shock’ the emissions of each designated sector of each region by the projected percentage changes – except for the positive percentage changes - to satisfy the NAP requirement, and let the model estimate the required carbon tax (marginal abatement cost) which will result for each sector. In Experiment 2 (“Sectoral Trading” only), we allow all designated sectors of each region with a NAP allocation to trade in emissions with each other. This will result in a uniform MAC across all trading sectors for each region but the MAC will be different for different regions. In Experiment 3 (“Regional Trading”), we allow not only domestic

⁷ In the case of Germany, however, the emissions of CO₂ from Oil_Pcts are transferred to “Oth_Ind” rather than the ROE sector. This implies that there is some mis-classification with respect to the “Oth_Ind” for the case of Germany in the NAP classification. When this is done, the large positive shock of the Oil_Pcts sector (+23 per cent) is merged with the large negative shock of the “Oth_Ind” sector (-98.1 percent) to produce a combined negative shock of -49.4 percent (from 148.4 to 75.0 MtC) which seems to be a reasonable figure, and this is then attributed to the “ROE” sector. The “Oth_Ind” now takes on a shock of -0.28 percent, which is the average for Germany as a whole. In other words, the assumption here is that NAP allocation for “Oil_Pcts” and “Oth_Ind” should actually apply to “ROE”, with the “Oth_Ind” being re-classified as ‘industries not elsewhere classified’.

(sectoral) trading, but also regional trading. This will result in a uniform MAC across all NAP sectors and regions. The changes in MACs between the three experiments are used to measure the potential gains (reduction in MAC) that can result from either domestic trading, or from domestic plus regional trading. The results of the Experiments are shown in Table 6. All costs are reported in 1995US\$.

Figure 1 Standard GTAP-E Production Structure

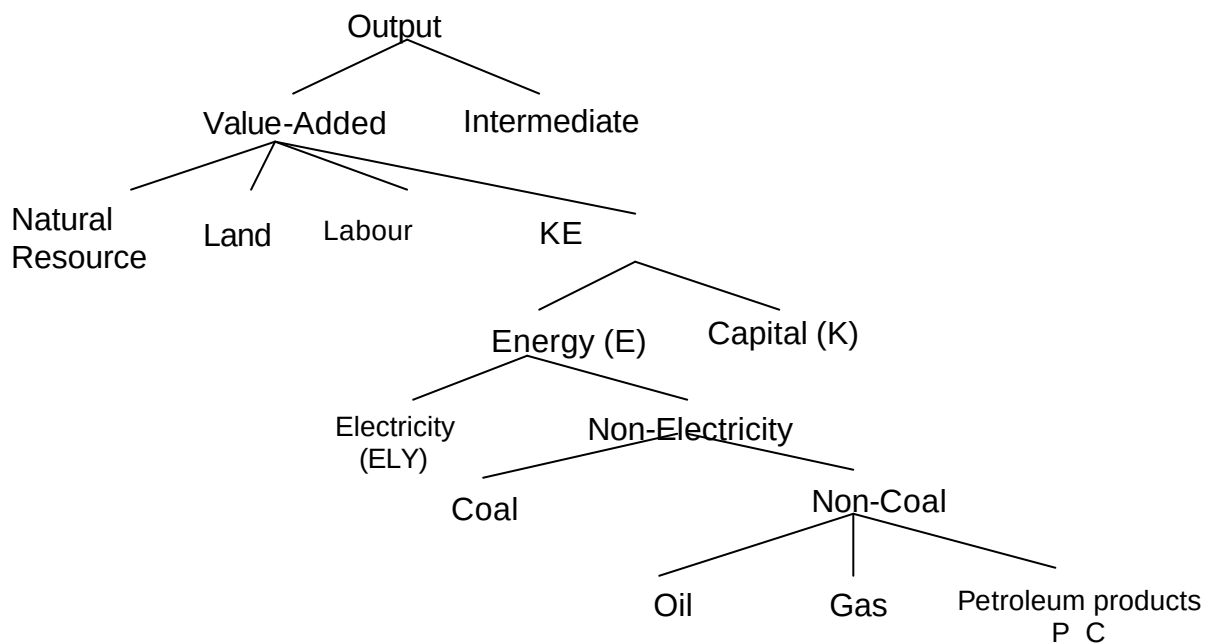


Table 1 Categorisation of Regions/Countries

	Description
aut	Austria
bel	Belgium
dnk	Denmark
fin	Finland
fra	France
deu	Germany
gbr	United Kingdom
irl	Ireland
ita	Italy
lux	Luxembourg
nld	Netherlands
prt	Portugal
esp	Spain
swe	Sweden
cze	Czech Republic
hun	Hungary
pol	Poland
CHIND	China and INdia
JPN	Japan
USA	United States

RoW	Rest of the World
-----	-------------------

Table 2 Categorisation of Sectors

	Description
COAL	Coal Mining
OIL	Crude Oil
GAS	Natural Gas Extraction
ELectricity	Electricity
OIL_Pcts	Refined Oil Products
METALS	Metals products
MIN_PROD	Mineral Products
PAPER	Paper
MOTOR_EQUIP	Motor machine & equipment
CONSTR	Construction
TEXTILE	Textile
OTH_IND	Other Industries
ROE	Rest of the economy

**Table 3 Percentage change in emissions for period 2005-2007
according to the NAP(*)**

\Sector Region	ELec tricity	Oil_ Pcts	Metals	Min_ Prod	Paper	Motor_ Equip	Constr	Textile	Oth_ Ind	ROE
aut	-8.9	-7.9	-3.5	-4.3	-3.6	-4.9	-4.6	-5.9		
bel	-27.4	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3
dnk	-26.2	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1
fin	-12.5	16.6	5.6	20.3	1.7					
fra	8.1	5.5	-2.7	-0.3	16.5					
deu	-3.1	-2.6	-0.5	-0.4	-1.0	-2.6	-2.6	-2.6		
gbr	-8.7	-0.9	-18.4	-5.7	-3.3	-3.3	-2.9	-2.5		
irl	-6.8	-0.2	-18.4	-5.7	-3.3					
ita	-2.2	5.6	0.6	3.3	1.5					
lux	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0
nld	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8
prt	-6.2	4.7	96.1	-1.2	5.4					
esp	-6.5	-3.6	-2.9	-5.4	-4.5					
swe	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9
cze	-4.5	-4.3	-4.6	-4.5	-4.1					
hun	-3.1	-5.1	-5.1	-5.1	-5.1					
pol	6.5	13.9	6.3	16.0	9.6					

(*) (Allocated emissions – Projected Emissions)/(Projected Emissions) * 100

**Table 4 Modified NAP shocks to represent percentage changes in emissions for period 2005-2007
applied to GTAP-E model Experiments**

\Sector Region	ELec tricity	Oil_ Pcts	Metals	Min_ Prod	Paper	Motor_ Equip	Constr	Textile	Oth_ Ind	ROE
aut	-8.9	-7.9	-3.5	-4.3	-3.6	-4.9	-4.6	-5.9		
bel	-27.4	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3
dnk	-26.2	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1
fin	-12.5									
fra			-2.7	-0.3						
deu	-3.1	-2.6	-0.5	-0.4	-1.0	-2.6	-2.6	-2.6		
gbr	-8.7	-0.9	-18.4	-5.7	-3.3	-3.3	-2.9	-2.5		
irl	-6.8	-0.2	-18.4	-5.7	-3.3					
ita	-2.2									
lux	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0
nld	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8
prt	-6.2			-1.2						
esp	-6.5	-3.6	-2.9	-5.4	-4.5					
swe	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9
cze	-4.5	-4.3	-4.6	-4.5	-4.1					
hun	-3.1	-5.1	-5.1	-5.1	-5.1					
pol										

Results

Table 6 shows the percentage change in emissions for all sectors and regions in Experiment 1. These should be the same as in Table 5, except for the *positive* percentage changes which are determined endogenously by the model in this Experiment when we set the MAC (carbon tax) to zero for the sectors which have positive NAP percentages. Table 7 shows the corresponding MAC for Experiment 1. These MACs can range from a low value of less than a dollar per ton of Carbon equivalent (\$/tC), to nearly a thousand dollar (ROE, deu) depending on the magnitude of the emission changes required (a few percentage point to nearly –50% as in the case of (ROE, deu)).

Table 8 shows the percentage change in emissions for all sectors and regions in Experiment 2, and Table 9 shows the changes from Experiment 1 to Experiment 2. A positive change will imply a sector will increase its emissions with trading, and a negative change will imply the reverse. Table 10 shows the corresponding changes in MAC from Experiment 1 to Experiment 2. A positive change will imply a sector will sell emissions at a higher price than its own MAC, and a negative change will imply a sector will buy emissions at a lower price than its own MAC. In general, with domestic trading, the MAC will lower, in some cases, quite significantly for most sectors, as can be seen by a comparison of the last column of Table 10 (which shows the uniform regional MAC in the case of domestic trading) with the levels of MACs in Table 7. The maximum level of MAC is 82.8 \$/tC for Belgium, and the lowest is 0.5 \$/tC for the UK.

Table 11 shows the further percentage change in emissions for all sectors and regions from Experiment 2 (Domestic Trading only) to Experiment 3 (Domestic plus Regional Trading), and Table 12 shows the corresponding further changes in MAC level. Finally, Table 13 compares the results of Experiment 2 and Experiment 3.

In this paper, we have concentrated mainly on the MAC and emissions levels of various sectors, to examine how the sectors can achieve the objectives of the NAP. The results indicate that if there is no sectoral trading, the cost of achieving the NAP will be high for some sectors and in some regions. Domestic sectoral trading is thus essential for the achievement of the NAP. With further regional integration of the domestic trading plans, the cost of achieving the objective of the NAP will be further reduced, as can be shown by the results in this paper.

**Table 5 Percentage change in emissions for period 2005-2007
in Experiment 1 (No Emissions Trade)**

\Sector Region	ELec tricity	Oil_ Pcts	Metals	Min_ Prod	Paper	Motor_ Equip	Constr	Textile	Oth_ Ind	ROE
aut	-8.9	-7.9	-3.5	-4.3	-3.6	-4.9	-4.6	-5.9	0.4	-1.6
bel	-27.4	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3
dnk	-26.2	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1
fin	-12.5	1.5	2.3	0.7	2.1	2.7	0.8	1.3	1.6	0.8
fra	1.0	0.9	-2.7	-0.3	0.3	0.2	0.1	0.2	0.3	0.1
deu	-3.1	-2.6	-0.5	-0.4	-1.0	-2.6	-2.6	-2.6	-1.0	-1.1
gbr	-8.7	-0.9	-18.4	-5.7	-3.3	-3.3	-2.9	-2.5	1.1	1.2
irl	-6.8	-0.2	-18.4	-5.7	-3.3	1.2	-0.1	0.5	2.8	0.6
ita	-2.2	0.4	0.7	0.5	0.7	0.6	0.6	0.7	0.7	0.3
lux	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0
nld	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8
prt	-6.2	0.4	0.5	-1.2	0.2	0.4	0.1	0.1	0.4	0.1
esp	-6.5	-3.6	-2.9	-5.4	-4.5	-0.4	-1.3	0.1	-1.7	-1.1
swe	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9
cze	-4.5	-4.3	-4.6	-4.5	-4.1	0.5	-0.9	1.3	1.0	-1.0
hun	-3.1	-5.1	-5.1	-5.1	-5.1	0.0	-0.4	0.5	0.3	-0.7
pol	1.9	0.8	1.0	0.7	0.9	0.9	0.4	1.0	0.5	0.2

**Table 6 Marginal Abatement Cost (\$/tCeq)
in Experiment 1 (No Emissions Trade)**

\Sector Region	ELec tricity	Oil_ Pcts	Metals	Min_ Prod	Paper	Motor_ Equip	Constr	Textile	Oth_ Ind
aut	12.9	6735	4.8	11.8	3.6	7.2	11.2	7.4	0.0
bel	43.8	96513	6.0	17.7	12.1	22.1	24.2	13.6	29.5
dnk	27.2	946054	1.3	4.3	0.2	0.2	36.9	0.1	0.6
fin	28.1	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
fra	0.0	0	3.9	2.6	0.0	0.0	0.0	0.0	0.0
deu	5.6	4686	2.4	1.7	2.5	7.1	11.5	6.3	0.0
gbr	8.6	8081	1.5	1.4	0.1	0.0	1.0	0.0	0.0
irl	4.6	152024	94.5	13.6	2.6	0.0	0.0	0.0	0.0
ita	4.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
lux	2.1	535	4.1	5.0	3.1	1.6	2.3	3.7	2.6
nld	14.6	100200	6.6	37.4	4.6	0.7	0.0	1.7	55.6
prt	7.3	0	0.0	5.4	0.0	0.0	0.0	0.0	0.0
esp	8.6	833850	4.9	25.9	12.3	0.0	0.0	0.0	0.0
swe	21.4	78182	41.8	65.5	61.0	54.4	105.1	73.2	36.5
cze	3.1	4669	4.0	8.8	4.5	0.0	0.0	0.0	0.0
hun	3.2	104123	6.5	15.0	6.9	0.0	0.0	0.0	0.0
pol	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

**Table 7 Percentage change in emissions for period 2005-2007
in Experiment 2 (Domestic Emissions Trade) and MAC**

\Sector Region	ELec tricity	Oil_ Pcts	Metals	Min_ Prod	Paper	Motor Equip	Constr	Textile	Oth_ Ind	MAC (\$/tCeq)
aut	-7.1	-1.1	-6.9	-2.3	-7.2	-4.7	-3.1	-5.2	-0.6	10.67
bel	-21.9	-1.3	-24.3	-8.3	-13.4	-6.6	-6.7	-12.6	-5.6	32.28
dnk	-19.7	-2.0	-55.4	-15.9	-80.2	-55.9	-2.9	-76.0	-78.2	19.78
fin	-8.3	-2.1	-8.5	-3.5	-8.1	-3.4	-2.2	-4.1	-2.5	19.32
fra	0.3	0.0	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.40
deu	-3.2	-0.4	-2.8	-1.8	-2.3	-1.3	-0.8	-1.6	-0.4	5.56
gbr	0.1	-0.1	-7.1	-1.7	-31.9	-41.7	-1.5	-41.3	0.2	0.35
irl	-4.8	-0.2	-0.8	-1.1	-5.0	-5.0	-1.1	-2.6	-1.8	2.80
ita	-0.9	-0.1	-0.8	-0.1	-0.9	-0.9	-0.2	-0.2	-0.1	1.90
lux	-11.0	-0.5	-4.3	-3.9	-7.0	-11.9	-6.5	-5.2	-8.7	4.06
nld	-3.2	-0.6	-7.7	-1.0	-12.3	-49.3	-30.7	-29.8	-0.5	6.13
prt	-5.1	-0.6	-3.5	-1.5	-0.6	-1.2	-0.5	-0.8	-2.7	6.10
esp	-7.6	-0.8	-5.7	-1.8	-3.2	-3.0	-4.3	-3.4	-1.2	10.29
swe	-31.7	-4.0	-15.8	-11.2	-10.4	-12.5	-6.8	-9.7	-16.4	57.89
cze	-4.8	-0.4	-3.3	-1.1	-2.1	-1.4	-0.8	-2.1	-2.3	3.29
hun	-3.7	-0.6	-2.8	-1.1	-2.7	-3.3	-1.0	-2.1	-1.3	4.15
pol	1.9	0.0	1.1	0.7	1.0	0.9	0.5	1.1	0.6	-0.16

**Table 8 Percentage change in emissions for period 2005-2007
in Experiment 3 (Regional Emissions Trade) and MAC**

\Sector Region	ELec tricity	Oil_ Pcts	Metals	Min_ Prod	Paper	Motor Equip	Constr	Textile	Oth_ Ind	MAC (\$/tCeq)
aut	-1.5	-0.3	-1.5	-0.6	-2.0	-1.2	-0.7	-1.4	0.0	2.96
bel	-2.4	-0.2	-2.7	-0.7	-1.3	-0.6	-0.6	-1.2	-0.4	2.96
dnk	-2.5	-0.2	-26.0	-5.7	-63.9	-48.4	-0.5	-65.6	-46.7	2.96
fin	-1.0	-0.2	-1.0	-0.4	-1.1	-0.5	-0.3	-0.5	-0.3	2.96
fra	-2.8	-0.2	-1.9	-0.5	-1.1	-1.3	-0.3	-0.9	-1.5	2.96
deu	-1.7	-0.2	-1.5	-0.9	-1.2	-0.7	-0.4	-0.9	-0.2	2.96
gbr	-2.9	-0.1	-27.9	-15.5	-66.9	-67.2	-7.2	-68.8	0.1	2.96
irl	-4.7	-0.2	-0.8	-0.5	-4.8	-5.1	-1.1	-2.6	-1.3	2.96
ita	-1.5	-0.3	-1.7	-0.5	-1.8	-1.7	-0.7	-0.8	-0.5	2.96
lux	-8.0	-0.4	-3.3	-3.2	-5.7	-9.6	-5.4	-4.2	-7.1	2.96
nld	-1.4	-0.2	-3.7	-0.1	-6.1	-32.5	-30.3	-16.6	-0.1	2.96
prt	-2.6	-0.3	-1.7	-0.7	-0.3	-0.6	-0.2	-0.4	-1.4	2.96
esp	-2.3	-0.2	-1.7	-0.5	-0.9	-0.8	-1.3	-0.9	-0.3	2.96
swe	-2.1	-0.3	-0.8	-0.4	-0.4	-0.5	-0.4	-0.4	-0.8	2.96
cze	-4.4	-0.3	-3.0	-1.1	-2.0	-1.2	-0.7	-1.9	-2.1	2.96
hun	-2.6	-0.4	-2.0	-0.9	-2.0	-2.4	-0.8	-1.5	-1.0	2.96
pol	-3.2	-0.4	-2.5	-1.6	-1.9	-1.8	-1.4	-2.0	-1.1	2.96

Table 9 Changes in the levels of emissions from Experiment 1 (No Trade) to Experiment 2 (Domestic Emissions Trade) (MtC)

\SectorRegion	Elec tricity	Metals	Min_ Prod	Paper	Motor_ Equip	Constr	Textile	Oth_ Ind	ROE
aut	0.083	0.043	-0.036	0.038	-0.011	0.000	0.001	0.001	-0.001
bel	0.423	0.057	-0.508	-0.071	-0.011	-0.004	-0.004	-0.005	-0.001
dnk	0.629	0.017	-0.047	-0.085	-0.046	-0.056	0.006	-0.020	-0.161
fin	0.330	-0.017	-0.097	-0.025	-0.079	-0.005	-0.003	-0.002	-0.001
fra	-0.086	-0.044	0.132	0.022	-0.002	-0.002	0.000	0.000	-0.005
deu	-0.085	0.131	-0.193	-0.148	-0.026	0.030	0.017	0.005	0.008
gbr	4.829	0.044	0.512	0.279	-0.347	-0.621	0.014	-0.207	-0.032
irl	0.081	0.000	0.040	0.037	0.000	-0.004	0.000	-0.001	-0.002
ita	0.472	-0.023	-0.069	-0.053	-0.021	-0.022	-0.002	-0.009	-0.003
lux	-0.010	0.000	0.002	0.002	0.000	-0.001	0.000	0.000	0.000
nld	0.756	0.266	0.001	0.229	-0.012	-0.145	-0.045	-0.024	0.009
prt	0.051	-0.007	-0.006	-0.003	-0.002	-0.001	-0.001	-0.002	-0.001
esp	-0.238	0.100	-0.065	0.214	0.010	-0.013	-0.002	-0.017	0.002
swe	-0.533	0.037	-0.015	0.015	0.019	0.002	0.012	0.002	-0.001
cze	-0.063	0.009	0.050	0.048	0.004	-0.003	0.000	-0.005	-0.051
HUN	-0.041	0.021	0.014	0.034	0.001	-0.002	0.000	-0.001	-0.008
POL	-0.016	-0.005	0.005	0.001	0.000	0.000	0.000	0.000	0.000

Table 10 Changes in Marginal Abatement Cost (\$/tC) from Experiment 1 (No Trading) to Experiment 2 (Domestic Emissions Trade)

\SectorRegion	Changes in MAC from No trading to Domestic Trading								
	Elec tricity	Metals	Min_ Prod	Paper	Motor_ Equip	Constr	Textile	Oth_ Ind	ROE
aut	-2.20	-6724	5.88	-1.17	7.04	3.49	-0.55	3.23	10.67
bel	-11.49	-96481	26.29	14.59	20.21	10.15	8.06	18.71	2.81
dnk	-7.38	-946034	18.45	15.49	19.53	19.61	-17.11	19.63	19.13
fin	-8.80	19	19.32	19.32	19.32	19.32	19.32	19.32	19.32
fra	0.40	0	-3.47	-2.18	0.40	0.40	0.40	0.40	0.40
deu	-0.02	-4681	3.13	3.88	3.09	-1.54	-5.96	-0.77	5.56
gbr	-8.22	-8080	-1.15	-1.10	0.30	0.32	-0.62	0.32	0.35
irl	-1.84	-152022	-91.71	-10.82	0.16	2.80	2.80	2.80	2.80
ita	-2.10	2	1.90	1.90	1.90	1.90	1.90	1.90	1.90
lux	1.97	-531	-0.05	-0.98	1.00	2.43	1.76	0.33	1.48
nld	-8.48	-100194	-0.49	-31.25	1.51	5.46	6.11	4.40	-49.43
prt	-1.19	6	6.10	0.70	6.10	6.10	6.10	6.10	6.10
esp	1.71	-833839	5.39	-15.59	-2.04	10.29	10.29	10.29	10.29
swe	36.52	-78124	16.11	-7.59	-3.08	3.49	-47.23	-15.33	21.35
cze	0.17	-4666	-0.72	-5.51	-1.20	3.29	3.29	3.29	3.29
HUN	0.92	-104119	-2.32	-10.83	-2.77	4.15	4.15	4.15	4.15
POL	-0.16	0	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16	-0.16

Table 11 Changes in the levels of emissions and of MAC from Experiment 2 (Domestic Emissions Trade) to Experiment 3 (Regional Emissions Trade).

\Sector Region	Change in the level of emissions (MtC) from Experiment 2 to Epxriment 3									Change in MAC (\$/tC)
	ELec tricity	Metals	Min_ Prod	Paper	Motor Equip	Constr	Textile	Oth_ Ind	ROE	
aut	0.268	0.005	0.057	0.033	0.016	0.004	0.001	0.003	0.000	-7.71
bel	1.511	0.017	0.579	0.182	0.016	0.019	0.018	0.008	0.015	-29.32
dnk	1.666	0.006	0.029	0.098	0.010	0.009	0.004	0.003	0.071	-16.82
fin	0.579	0.009	0.068	0.018	0.055	0.002	0.002	0.001	0.000	-16.36
fra	-0.356	-0.007	-0.096	-0.036	-0.016	-0.019	-0.002	-0.004	-0.027	2.56
deu	1.370	0.010	0.115	0.096	0.022	0.014	0.003	0.004	0.003	-2.60
gbr	-1.610	-0.003	-0.938	-0.961	-0.425	-0.411	-0.058	-0.147	-0.004	2.61
irl	0.004	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.16
ita	-0.245	-0.005	-0.039	-0.032	-0.012	-0.012	-0.001	-0.005	-0.001	1.05
lux	0.005	0.000	0.003	0.002	0.000	0.000	0.000	0.000	0.000	-1.10
nld	0.288	0.015	0.071	0.030	0.016	0.059	0.001	0.015	0.001	-3.18
prt	0.117	0.002	0.003	0.010	0.001	0.000	0.001	0.001	0.000	-3.14
esp	1.119	0.021	0.094	0.074	0.018	0.011	0.002	0.012	0.003	-7.33
swe	0.887	0.014	0.123	0.060	0.054	0.017	0.011	0.003	0.009	-54.93
cze	0.084	0.000	0.011	0.001	0.000	0.000	0.000	0.000	0.002	-0.33
HUN	0.081	0.001	0.005	0.002	0.000	0.000	0.000	0.000	0.002	-1.19
POL	-2.766	-0.002	-0.153	-0.136	-0.020	-0.023	-0.010	-0.014	-0.010	3.12

**Table 12 Percentage change in emissions and Marginal Abatement Costs for period 2005-2007
in Experiment 2 (Domestic Trade Only) and Experiment 3 (Domestic plus Regional Trade)**

\Sector Region	Change in CO ₂ Emissions (%)		Marginal Abatement Cost (\$/tCeq)	
	Experiment 2: Domestic Emissions Trade Only	Experiment 3: Domestic Plus Regional Emissions Trade	Experiment 2: Domestic Emissions Trade Only	Experiment 3: Domestic Plus Regional Emissions Trade
aut	-5.00	-1.16	10.67	2.96
bel	-11.11	-1.15	32.28	2.96
dnk	-17.87	-5.95	19.78	2.96
fin	-6.25	-0.75	19.32	2.96
fra	0.09	-0.92	0.40	2.96
deu	-2.17	-1.15	5.56	2.96
gbr	-4.61	-11.77	0.35	2.96
irl	-3.93	-3.86	2.80	2.96
ita	-0.61	-1.15	1.90	2.96
lux	-5.00	-3.94	4.06	2.96
nld	-7.79	-4.73	6.13	2.96
prt	-2.49	-1.26	6.10	2.96
esp	-3.71	-1.09	10.29	2.96
swe	-13.91	-0.80	57.89	2.96
cze	-3.71	-3.36	3.29	2.96
HUN	-2.69	-1.88	4.15	2.96
POL	1.45	-2.59	-0.16	2.96

References

Babiker M., Reilly J., Viguiet L. "Is International Emissions Trading Always Beneficial?", MIT report 93, 2002.

Babiker M., Viguiet L., Reilly J., Ellerman D., Criqui P. "The Welfare Costs of Hybrid Carbon Policies in the European Union", MIT report 74, 2001.

Böhringer C., Hoffmann T., Lange A., Löschel A., Moslener U., Discussion Paper No. 04-40 "Assessing Emission Allocation in Europe: An Interactive Simulation Approach", 2004.

European Commission (2001): Commission of the European Communities: Proposal for a Directive of the European Parliament and the Council establishing a scheme for greenhouse gas emission allowance trading within the Community and amending council directive 96/61/EC, COM (2001) 581 final. Brussels: Commission of the European Communities, 2001

European Commission (2003) Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC. Official Journal of the European Union. L 275/32, 25.10.2003

European Commission (2004): Emissions trading - National allocation plans. Final national allocation plans and available drafts of national allocation plans.
http://europa.eu.int/comm/environment/climat/emission_plans.htm

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (2004): National Allocation Plan for the Federal Republic of Germany 2005-2007. Berlin, 31 March 2004, Translation: 07 May 2004.
http://www.bmu.de/files/pdfs/allgemein/application/pdf/nap_kabi_en.pdf

Grütter J., Kappel R., Staub P.. "Simulating the Market for Greenhouse Gas Emission Reductions: The CERT Model", 2002.

Kappel R., Staub P., Grütter J., "Users Guide CERT version 1.2.", 2001.

**Table 6 Percentage change in emissions for period 2005-2007
in Experiment 1 (No Emissions Trade)**

\Sector Region	ELec tricity	Metals	Min_ Prod	Paper	Motor_ Equip	Constr	Textile	Oth_ Ind	ROE	Total for region
aut	-8.9	-3.5	-4.3	-3.6	-4.9	-4.6	-5.9	-5.7	-7.9	-7.22
bel	-27.4	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-5.3	-27.4	-22.54
dnk	-26.2	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-7.1	-26.2	-24.32
fin	-12.5	2.8	1.2	2.7	-7.5	-7.5	-7.5	-7.5	1.3	-6.42
fra	0.9	-2.7	-0.3	1.2	1.3	0.5	1.1	0.8	0.6	0.40
deu	10.0	-39.2	-33.2	-9.7	-0.3	-0.3	-0.3	-0.3	-49.4	-14.31
gbr	-8.7	-18.4	-5.7	-3.3	-3.3	-2.9	-2.5	-8.6	-0.9	-5.84
irl	-6.8	-18.4	-5.7	-3.3	-6.2	-6.2	-6.2	-6.2	-0.9	-4.69
ita	-2.2	1.5	1.3	2.0	-0.1	-0.1	-0.1	-0.1	0.9	-0.31
lux	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0	-5.00
nld	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.8	-7.79
prt	-6.2	0.9	-1.2	0.8	-3.5	-3.5	-3.5	-3.5	0.7	-2.60
esp	-6.5	-2.9	-5.4	-4.5	-5.6	-5.6	-5.6	-5.6	-3.6	-4.94
swe	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.9	-13.91
cze	-4.5	-4.6	-4.5	-4.1	-4.5	-4.5	-4.5	-4.5	-4.3	-4.47
HUN	-3.1	-5.1	-5.1	-5.1	-3.7	-3.7	-3.7	-3.7	-5.1	-3.91
POL	1.1	1.3	0.9	0.6	0.7	0.5	0.6	0.7	0.5	0.99

**Table 7 Marginal Abatement Cost (\$/tCeq)
in Experiment 1 (No Emissions Trade)**

\Sector Region	ELec tricity	Metals	Min_ Prod	Paper	Motor_ Equip	Constr	Textile	Oth_ Ind	ROE
aut	13.8	6.0	21.6	5.9	14.3	15.9	18.1	43.7	27.0
bel	51.6	7.3	26.0	16.3	38.7	28.0	23.8	25.8	313.4
dnk	29.0	0.5	5.5	0.9	0.4	50.6	0.5	5.0	168.1
fin	27.6	0.0	0.0	0.0	39.9	63.5	37.5	43.2	0.0
fra	0.0	4.3	5.5	0.0	0.0	0.0	0.0	0.0	0.0
deu	0.0	83.5	146.0	17.5	8.1	7.7	5.6	7.2	942.7
gbr	5.3	0.4	1.8	0.2	0.1	0.1	0.1	63.9	0.1
irl	5.7	91.4	19.5	6.2	11.3	36.8	15.4	29.6	3.2
ita	5.1	0.0	0.0	0.0	3.1	3.1	5.1	5.4	0.0
lux	3.6	9.1	11.6	17.3	18.1	33.2	16.4	16.4	38.1
nld	16.9	8.4	48.6	20.4	0.4	8.2	4.4	50.1	4.9
prt	7.5	0.0	7.3	0.0	17.5	38.0	27.2	11.9	0.0
esp	9.7	6.6	33.5	15.6	20.4	20.1	18.4	41.7	34.9
swe	14.4	41.5	34.2	51.0	19.5	118.3	73.1	40.0	113.8
cze	3.3	4.2	11.5	5.1	6.2	16.6	4.9	6.2	15.2
hun	3.8	7.1	17.5	8.4	5.6	12.6	7.2	11.5	15.4
pol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

**Table 8 Percentage change in emissions for period 2005-2007
in Experiment 2 (Domestic Emissions Trade)**

\Sector Region	Elec tricity	Metals	Min_ Prod	Paper	Motor_ Equip	Constr	Textile	Oth_ Ind	ROE	TOTAL
aut	-9.8	-10.8	-3.6	-11.5	-6.0	-4.9	-5.6	-1.6	-5.2	-7.22
bel	-40.3	-44.3	-17.8	-27.2	-14.0	-16.0	-23.3	-19.6	-9.9	-22.54
dnk	-29.7	-66.5	-19.6	-77.4	-56.3	-5.3	-74.8	-56.0	-12.5	-24.32
fin	-8.3	-8.3	-3.4	-8.6	-3.6	-2.3	-4.0	-3.3	-2.1	-6.42
fra	-0.2	-0.2	0.3	0.2	0.1	0.0	0.2	-0.1	0.0	0.00
deu	-20.7	-17.4	-10.8	-16.5	-7.4	-6.6	-9.1	-4.3	-4.3	-14.31
gbr	0.0	-20.5	-1.9	-24.0	-39.3	-7.4	-32.1	0.5	-10.9	-5.84
irl	-7.0	-1.5	-1.5	-4.8	-3.2	-1.9	-1.9	-0.6	-3.1	-4.69
ita	-0.4	-0.3	0.4	-1.2	-0.1	-0.1	0.5	0.4	-0.4	-0.31
lux	-21.2	-7.3	-5.5	-3.6	-3.5	-1.8	-3.9	-3.6	-1.6	-5.00
nld	-2.3	-7.2	-0.6	-1.7	-70.6	-8.1	-17.2	1.1	-11.3	-7.79
prt	-5.1	-3.6	-1.5	-0.6	-1.3	-0.5	-0.8	-2.2	-0.6	-2.60
esp	-9.6	-7.2	-2.2	-4.0	-3.8	-3.8	-4.2	-1.5	-1.4	-4.94
swe	-30.8	-14.2	-15.8	-12.5	-18.8	-6.3	-9.3	-14.9	-6.5	-13.91
cze	-5.6	-4.3	-1.3	-3.1	-2.8	-1.1	-3.6	-2.7	-1.0	-4.47
HUN	-5.2	-4.4	-1.7	-3.8	-4.5	-1.5	-3.2	-1.9	-1.9	-3.91
POL	0.1	-0.1	0.0	-0.3	-0.4	-0.4	-0.3	0.0	-0.3	0.00

**Table 9 percentage increases (+ve) or decreases (-ve) in the levels of emissions from Experiment 1
(No Trade) to Experiment 2 (Domestic Emissions Trade)**

\Sector Region	Elec tricity	Metals	Min_ Prod	Paper	Motor_ Equip	Constr	Textile	Oth_ Ind	ROE
aut	-0.9	-7.3	0.7	-7.9	-1.2	-0.2	0.2	4.1	2.6
bel	-12.9	-38.9	-12.5	-21.8	-8.6	-10.6	-17.9	-14.3	17.5
dnk	-3.6	-59.5	-12.5	-70.3	-49.3	1.8	-67.8	-48.9	13.7
fin	4.2	-11.1	-4.6	-11.3	3.9	5.2	3.5	4.2	-3.4
fra	-1.1	2.4	0.6	-1.1	-1.2	-0.5	-0.9	-0.9	-0.6
deu	-30.6	21.8	22.5	-6.8	-7.1	-6.3	-8.8	-4.0	45.1
gbr	8.7	-2.1	3.9	-20.7	-36.0	-4.5	-29.6	9.1	-10.0
irl	-0.2	17.0	4.3	-1.5	3.0	4.3	4.3	5.7	-2.2
ita	1.8	-1.8	-0.9	-3.2	0.1	0.0	0.6	0.5	-1.4
lux	-16.2	-2.3	-0.5	1.4	1.5	3.2	1.1	1.4	3.4
nld	5.5	0.6	7.2	6.1	-62.8	-0.3	-9.4	8.9	-3.5
prt	1.1	-4.5	-0.2	-1.4	2.2	3.0	2.7	1.3	-1.2
esp	-3.1	-4.3	3.2	0.4	1.9	1.8	1.4	4.1	2.2
swe	-16.8	-0.3	-1.8	1.4	-4.9	7.6	4.6	-1.0	7.4
cze	-1.2	0.3	3.2	1.0	1.7	3.4	0.9	1.8	3.4
HUN	-2.1	0.8	3.4	1.3	-0.8	2.3	0.6	1.9	3.2
POL	-1.0	-1.3	-0.9	-0.9	-1.1	-0.8	-0.9	-0.7	-0.8

Table 10 Changes in Marginal Abatement Cost (\$/tC) for a sector from Experiment 1 (No Trading) to Experiment 2 (Sectoral Trading only)

\Sector Region	Changes in MAC from No trading to Domestic Trading									Uniform regional MAC (\$/tC)
	Elec tricity	Metals	Min_ Prod	Paper	Motor_ Equip	Constr	Textile	Oth_ Ind	ROE	
aut	3.8	17.6	11.6	-4.0	11.7	3.3	1.7	-0.5	-26.1	17.6
bel	31.2	82.8	75.5	56.8	66.5	44.1	54.8	59.0	57.0	82.8
dnk	3.4	32.5	32.0	27.0	31.6	32.1	-18.1	32.0	27.5	32.5
fin	-7.2	20.4	20.4	20.4	20.4	-19.5	-43.1	-17.1	-22.8	20.4
fra	1.6	1.6	-2.7	-3.9	1.6	1.6	1.6	1.6	1.6	1.6
deu	35.8	35.8	-47.8	-110.3	18.3	27.7	28.1	30.2	28.6	35.8
gbr	-4.9	0.5	0.0	-1.3	0.3	0.4	0.3	0.4	-63.5	0.5
irl	-0.8	4.9	-86.5	-14.6	-1.3	-6.4	-31.9	-10.5	-24.7	4.9
ita	-3.2	1.9	1.9	1.9	1.9	-1.2	-1.2	-3.2	-3.5	1.9
lux	8.7	12.4	3.3	0.8	-4.9	-5.7	-20.9	-4.1	-4.0	12.4
nld	-9.0	7.8	-0.6	-40.7	-12.5	7.5	-0.4	3.4	-42.2	7.8
prt	-0.6	6.9	6.9	-0.4	6.9	-10.6	-31.2	-20.3	-5.0	6.9
esp	4.3	13.9	7.3	-19.5	-1.7	-6.4	-6.2	-4.5	-27.8	13.9
swe	28.8	43.1	1.6	8.9	-7.9	23.6	-75.2	-30.0	3.1	43.1
cze	2.0	5.3	1.1	-6.3	0.2	-0.9	-11.3	0.4	-1.0	5.3
HUN	3.1	6.9	-0.2	-10.6	-1.5	1.3	-5.7	-0.3	-4.6	6.9
POL	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9

Table 11 percentage increases (+ve) or decreases (-ve) in the levels of emissions from Experiment 2 (Domestic Emissions Trade) to Experiment 3 (Domestic Plus Regional Emissions Trade).

\Sector Region	Elec tricity	Metals	Min_ Prod	Paper	Motor_ Equip	Constr	Textile	Oth_ Ind	ROE
aut	5.4	6.2	1.9	5.7	3.2	2.8	3.0	1.0	2.7
bel	33.8	36.9	15.6	23.4	12.3	13.9	20.4	17.3	8.7
dnk	21.2	7.4	8.4	14.0	4.5	2.7	8.6	31.2	2.7
fin	5.6	5.6	2.2	5.2	2.1	1.3	2.5	1.9	1.2
fra	-7.8	-5.3	-1.7	-3.4	-3.6	-0.8	-2.6	-3.4	-1.1
deu	15.6	13.2	8.2	12.2	5.7	4.9	7.0	3.4	3.3
gbr	-13.3	-21.6	-30.1	-46.6	-30.9	-5.4	-38.8	0.5	-10.6
irl	-3.2	-1.1	1.7	-1.1	-1.4	-0.7	-1.0	2.8	-1.4
ita	-3.6	-5.0	-1.8	-7.6	-3.6	-3.3	-2.4	-2.1	-2.7
lux	4.1	1.8	1.5	0.9	0.9	0.5	1.0	0.9	0.5
nld	-1.6	-1.3	-0.2	-1.9	-1.7	-0.9	-2.3	-1.5	-0.7
prt	-1.8	-1.2	-0.5	-0.4	-0.4	-0.2	-0.3	-0.7	-0.2
esp	3.5	2.6	0.8	1.4	1.4	1.4	1.5	0.6	0.5
swe	20.3	10.5	10.2	7.9	7.9	4.2	7.0	11.6	4.5
cze	-5.5	-4.2	-1.6	-2.8	-2.3	-1.0	-3.1	-2.8	-0.8
HUN	-2.5	-1.8	-1.0	-1.5	-1.5	-0.8	-1.3	-1.2	-0.8
POL	-9.4	-7.8	-4.7	-5.7	-6.2	-3.6	-6.4	-3.5	-2.5

Table 12 Changes in Marginal Abatement Cost (\$/tC) for a sector when there is Regional Emissions Trade

\Sector Region	Changes in MAC from Domestic Trading only (Experiment 2) to Domestic Plus Regional Emissions Trading (Experiment 3)									Uniform regional MAC (\$/tC)
	Elec tricity	Metals	Min Prod	Paper	Motor Equip	Constr	Textile	Oth Ind	ROE	
aut	4.9	-9.0	-3.0	12.6	-3.1	5.3	6.9	9.1	34.7	8.61
bel	-22.6	-74.2	-66.9	-48.2	-57.9	-35.5	-46.2	-50.4	-48.4	8.61
dnk	5.2	-23.9	-23.4	-18.4	-23.0	-23.5	26.7	-23.4	-18.9	8.61
fin	15.8	-11.8	-11.8	-11.8	-11.8	28.1	51.7	25.7	31.4	8.61
fra	7.0	7.0	11.3	12.5	7.0	7.0	7.0	7.0	7.0	8.61
deu	-27.2	-27.2	56.4	118.9	-9.6	-19.0	-19.5	-21.5	-20.0	8.61
gbr	13.5	8.2	8.6	9.9	8.3	8.2	8.3	8.2	72.1	8.61
irl	9.4	3.7	95.1	23.2	9.9	15.0	40.5	19.1	33.3	8.61
ita	11.8	6.7	6.7	6.7	6.7	9.9	9.8	11.8	12.1	8.61
lux	-0.1	-3.8	5.3	7.8	13.5	14.3	29.5	12.7	12.6	8.61
nld	17.6	0.8	9.2	49.3	21.1	1.2	9.0	5.2	50.8	8.61
prt	9.2	1.7	1.7	9.0	1.7	19.3	39.8	28.9	13.6	8.61
esp	4.3	-5.3	1.3	28.2	10.3	15.0	14.8	13.1	36.4	8.61
swe	-20.1	-34.5	7.0	-0.3	16.5	-15.0	83.8	38.6	5.5	8.61
cze	6.6	3.3	7.5	14.9	8.4	9.5	19.9	8.2	9.6	8.61
HUN	5.5	1.7	8.8	19.2	10.1	7.3	14.4	8.9	13.2	8.61
POL	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	8.61

Table 13 Percentage change in emissions and Marginal Abatement Costs for period 2005-2007 in Experiment 2 (Domestic Trade Only) and Experiment 3 (Domestic plus Regional Trade)

\Sector Region	Change in CO ₂ Emissions (%)		Marginal Abatement Cost (\$/tCeq)	
	Experiment 2: Domestic Emissions Trade Only	Experiment 3: Domestic Plus Regional Emissions Trade	Experiment 2: Domestic Emissions Trade Only	Experiment 3: Domestic Plus Regional Emissions Trade
aut	-7.2	-3.3	17.57	8.61
bel	-22.5	-3.3	82.79	8.61
dnk	-24.3	-10.2	32.48	8.61
fin	-6.4	-2.2	20.42	8.61
fra	0.0	-2.8	1.63	8.61
deu	-14.3	-3.5	35.78	8.61
gbr	-5.8	-19.7	0.45	8.61
irl	-4.7	-6.6	4.91	8.61
ita	-0.3	-3.5	1.90	8.61
lux	-5.0	-3.8	12.39	8.61
nld	-7.8	-8.8	7.84	8.61
prt	-2.6	-3.6	6.89	8.61
esp	-4.9	-3.2	13.95	8.61
swe	-13.9	-4.6	43.12	8.61
cze	-4.5	-8.8	5.27	8.61
HUN	-3.9	-5.8	6.88	8.61
POL	0.0	-7.7	1.86	8.61