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## ANALYSIS

# Impacts of EU carbon emission trade directive on energy-intensive industries — Indicative micro-economic analyses

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## ABSTRACT

The cost impacts from the European emission trading system (ETS) on energy-intensive manufacturing industries have been investigated. The effects consist of direct costs associated to the CO<sub>2</sub> reduction requirements stated in the EU Directive, and of indirect costs of comparable magnitude that originate from a higher electricity price triggered by the ETS in the power sector. The total cost impacts remain below 2% of the production value for most industries within the ETS in the Kyoto period. In the post-Kyoto phase assuming a 30% CO<sub>2</sub> reduction, the total cost impact may raise up to 8% of production value in the heaviest industry sectors. In steel and cement industries the cost impacts are 3–4 fold compared to the least affected pulp and paper and oil refining. Electricity-intensive industries outside the ETS will also be affected, for example in aluminum and chlorine production the indirect cost impacts from ETS could come up to 10% of production value already in the Kyoto period. As industry sectors are affected differently by the ETS some correcting mechanisms may be worthwhile to consider in securing the operation of the most electricity-intensive sectors, e.g. balancing taxation schemes that may include as income source a levy on the wind-fall profits of the power sector due to ETS. A future improvement in ETS for industries within the scheme could be scaling of the emission reduction requirement so that the relative total emission reduction costs are at about the same level.

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## 1. Introduction

The United Nations Framework Convention on Climate Change (UNFCCC) from year 1992 initiated global cooperation on mitigating climate change through stabilizing the man-made greenhouse gas concentration in the atmosphere (United Nations Framework Convention on Climate Change, 1997). The so-called Kyoto Protocol was signed in 1997 as a result of the UNFCCC aiming at reducing the developed country (so-called Annex 1) greenhouse gas (GHG) emissions

by 5.2% from the 1990 level by 2008–2012 through the protocol. The Kyoto Protocol allows using supplemental instruments in addition to domestic measures in meeting the targets, namely so-called flexible mechanism which include Joint Implementation (JI), Clean Development Mechanisms (CDM) and Emission Trading (ET). The Kyoto Protocol has entered into force in 2005, i.e. it's legally binding. USA and Australia have not ratified the Protocol.

The European Union has committed to an 8% emission reduction where the obligation has been distributed among

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**Table 1 – Some key parameters for energy-intensive industries in Europe (EU-25)**

	Value added, billion €	Workforce, % of the manufacturing sector	Final energy consumption, Mtoe	Electricity use, TWh
Manufacturing	1525	100 (=35 million)	310	764
Pulp and paper	150	7.5	35	123
Chemicals	165	5.5	52 (+73 non-energy)	190
Basic metals	190	14.5	98	192

the member states. To enforce the implementation of the Kyoto targets, the EU launched the Emissions Trading Directive in 2003 in which plant-specific CO<sub>2</sub> caps were introduced to the larger energy production and energy-intensive industry sectors (e.g. cement, oil refining, pulp and paper, steel), i.e. the big GHG emitters (European Union, 2003). Around 45% of the EU's total CO<sub>2</sub> emissions are covered by the Directive (European Commission, 2005a). Each member state allocated from its own emission quota a certain amount of CO<sub>2</sub> allowance units which were allocated to the industries belonging to the reach of the Directive corresponding to their initial emission levels. The facility specific allowed CO<sub>2</sub> emissions are thus bound to the emission permits. For the period 2005–2007 at least 95% of the national allowances had to be distributed free of charge, 2008–2012 this drops to 90%. For the trading period 2005–2007, a total of 6572.4 million tCO<sub>2</sub> emission allowances have been allocated. The number of emission allowances to be allocated freely will most likely decrease over time in order to meet the ultimate targets of GHG reductions which may call for up to 70% reductions in global CO<sub>2</sub> emissions (European Union, 2003).

The EU emission trading system (ETS) established enables trade with the emission allowances and their price has varied between 8 and 30 €/tCO<sub>2</sub>. Companies not being able to present adequate number of emission allowances vis-à-vis realized emissions are subject to a 40 €/tCO<sub>2</sub> penalty which will increase to 100 €/tCO<sub>2</sub> during the 2008–2012 period. The companies can employ the flexible mechanisms in this context to reduce their emission burden.

For industries within the ETS, the EU cap-and-trade scheme imposes extra costs and may in worst place even affect the competitiveness of energy-intensive industries in Europe. On the other hand, ETS allows companies to use credits from Kyoto's project-based mechanisms and the EU market for emission trading created may offer an effective way for EU Members to reduce emissions. These questions are most topical now when the EU is planning the post-Kyoto targets for GHG reductions. Initial talks hover around 15–30% reductions by 2020. Therefore investigating the economic impact of the ETS for the energy-intensive industries is highly justified.

The economic impacts of the Kyoto Protocol on macro scale and on the power sector have been discussed in previous papers (Bode, 2006; IEA, 2000; Johnson and Heinen, 2004; Khanna; 2001; Zhu and van Ierland, 2006). The carbon emissions of manufacturing industries in different countries are also well known (Schipper et al., 2001). In this paper a comprehensive analysis is presented on the cost effects of the Emission Trading Directive on energy-intensive industries starting with the Kyoto level and moving then to more stringent cases. The approach is based on micro-economic analyses in which the ETS is turned into a new expense for the

industry and this is compared to other relevant expenses and figures of merit. The focus is on heavy and energy-intensive industries and in particular the sectors covered by the ETS. Only primary cost effects from ETS are considered, i.e. effect on the price of purchased electricity and the direct CO<sub>2</sub> emission reduction cost. Secondary effects such as possible price increases in raw materials or in other input factors were not considered here.

## 2. The value of energy in industries

The total GDP of European Union is 10,000 billion € (1 €=1.2 \$) The manufacturing industries provide some 15% of this and employ some 35 million people. About one fifth of all energy and one third of all electricity in Europe is used in manufacturing. Europe is an important producer of basic industrial commodities and raw materials: 22% of all steel, 28% of paper, and 13% of fertilizers in the world originates from EU-25. Table 1 gives strategic numbers for some of the central energy-intensive industry sectors (European Commission, 2004).

The EU ETS puts a tangible cost on CO<sub>2</sub> emissions. Industries and installations belonging to ETS will have a direct cost from their CO<sub>2</sub> emissions. The energy producers with combustion installations with a rated thermal input exceeding 20 MW are part of the ETS. Depending on several factors such as the marginal costs of alternatives, own production mix, competition, etc., the CO<sub>2</sub> costs of the power sector may be transferred into the electricity selling prices which in turn will impose additional costs to energy-intensive manufacturing industries. For example all chemical or metal industries may be affected indirectly through the use of electricity albeit only ferrous metals and oil refineries are included from these industry sectors in the ETS.

The relative importance of energy and electricity for some energy-intensive sectors has been estimated in Table 2 (European Commission, 2005b,c). For comparison numbers from Finland, which has the most energy-intensive manufacturing industries in the OECD, EU-25, and USA are given. The weight of energy may vary inside the same industry sector depending on the process solutions used and energy effectiveness. The cost of

**Table 2 – Cost of energy in % of production value**

Sector	Finland		EU-25		USA
	Energy	Elec.	Energy	Elec.	Energy
Manufacturing	3.8	1.4	4.5	2.5	n.a.
Pulp and paper	7.6	4.4	5.1	4.1	4.6
Chemicals	5.9	3.8	6.9	5.8	5.0
Basic metals	4.5	2.7	8.0	5.1	7.7 (steel)

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