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CO_2 emission trading within the European Union and Annex B countries: the cement industry case

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Abstract

The cement industry is the third largest carbon emitting industrial sector in the EU. This article presents the foreseeable technological evolution of the cement industry under business as usual circumstances, and examines the effects on the sector of carbon trading. For those purposes a global dynamic simulation model of the cement industry (CEMSIM) has been developed. The model is composed of a series of interconnected modules on cement consumption and production, international trade and capacity planning. This study quantifies the benefits achieved from emission trading in different markets (EU15, EU27 and Annex B), derived both from the revenues of emission trading, and from the lower compliance costs. The magnitude of the potential carbon leakage effect is also assessed.

Keywords: Cement industry; CO_2; Emission trading; Simulation model

1. Introduction

Emission trading is one of the international flexible mechanisms of the Kyoto Protocol on climate change to reduce greenhouse gas emissions in a cost-efficient way. Overall compliance costs of meeting a given carbon reduction target are lower under an international emission market than in the case of segmented or isolated markets. The European Union is to set up a carbon emission market for the power and energy-intensive industrial sectors (such as steel, cement, and pulp and paper) in 2005,[1] i.e. 3 years before the start of the commitment period of the Kyoto Protocol (2008–2012). This will be the first multi-country carbon emission market in the world.

This article presents a global simulation model (CEMSIM—Cement Simulation Model)[2] to quantitatively analyse the future development of the cement sector and the impacts of different carbon trading schemes on it. The cement industry is one of the largest energy consuming sectors. Indeed, the building material sector—whose emissions are dominated by the cement production—is the third largest CO_2 emitting industrial sector world-wide and in the European Union.[3] According to the importance of the cement industry many studies in the literature have dealt with its future

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[1] Directive 2003/87/EC, 13 October 2003 (European Commission, 2003a). See also European Commission (2000b, 2003b).

[2] The cement industry model has been prepared with the aim to complete the POLES energy model (Prospective Outlook for the Long-term Energy System, (European Commission, 1996)), which is a partial equilibrium model of the world energy system. Besides the comprehensive energy supply and transformation modules, the POLES model has a module on the large energy-intensive industries (such as iron and steel, etc.). These modules are under revision in order to attain more detail on the carbon emission trade amongst the sectors covered by the EU proposal. The steel module has been the first to be reviewed (Hidalgo et al., 2003).

[3] According to the 1990 emission levels (Capros et al., 2001).

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prospects. The IEA Greenhouse Gas R & D Programme study (see International Energy Agency (IEA), 1999) has global coverage and assesses the development of the sector in the 2020 horizon. Its main focus is on the CO_2 reduction potential of the sector, examining the energy efficiency improvement options. Its main finding is that under a business as usual scenario global emissions from the industry almost double in the 1995–2020 period. They conclude that assuming considerable technological improvements, the increase in carbon emissions could be limited to 35%.

Two other references of the literature are country-specific, focusing on large cement consuming regions of the world. Worrell et al. (2000) describe the energy efficiency improvement potentials in the US cement industry, based on a detailed national technology database. These authors set up an energy conservation curve, and estimate an 11% energy saving potential for the country. Liu et al. (1995) follow a different approach for China and estimate a 30% energy intensity improvement potential. Their results are based on three different scenarios concerning the technology and efficiency of the new plants.

Rotman and Kelmanzky (1997) estimated a function of cement demand in Argentina using regression analysis. They conclude that income, the construction price index, and cement consumption lagged one period are significant variables. According to their findings the income and lagged consumption are the most important variables, while the price of construction is less influential.

The CEMSIM model is composed of a series of interconnected modules on cement consumption and production, international trade and capacity planning. Those variables are calculated using behavioural equations. The model covers 51 regions of the world, including all 15 EU countries,[4] which enables to simulate the interactions of the different national emission trading markets. In the present modelling exercise the effects of three alternative policy scenarios are examined, differing in market coverage and equilibrium carbon prices.

The dynamic recursive simulation model is taking into account rich technological details. Several technology options are considered concerning the future development of the industry. Feasible retrofitting options and emerging technologies are included in the technology database, which contains detailed information on investment, variable and retrofitting costs. This database, and in particular the retrofitting options, provide with the foundation of the marginal abatement cost curves for the industry, which is the core element of the emission trading simulations. Emission reductions are not based on static abatement cost curves, as in many similar models, but on a dynamic system where the interaction among price variations, international trade, technology options and economic logic drive the actions of the market participants.

This article has the following structure. Section 2 gives a short description of the cement industry and introduces the retrofitting options for the sector. Section 3 describes the main characteristics of the CEMSIM model. Section 4 presents the results of the reference and the emission trading scenarios, with a detailed sensitivity analysis. Finally, Section 5 concludes.

2. The cement industry overview

Cement is a basic material for building and civil engineering construction. Since cement production and consumption are directly related to almost all economic activities, they closely follow economic trends. The world production of cement grew from 594 million tonnes in 1970 to over 1500 million tonnes by 1997, showing an uninterrupted and steady growing trend (CEMBUREAU, 1999b, 2002). Table 1 presents the shares of cement production and consumption for different world regions in 1997.

The European Union has a production and consumption share of around 11%. China alone accounts for one third of world production. The difference between the global consumption and production data indicates the size of net foreign trade, which accounts for 7% of cement consumption. It is noticeable that in all regions cement demand is mostly satisfied domestically. Transportation costs are relatively high compared to the cement price, which makes the transport of the cement expensive on long ranges. Furthermore, the raw material of cement production can be found everywhere, reducing the role of international trade. Cement is hardly transported for more than 150 km inland. However bulk transportation by sea is economically feasible, and

Table 1
Share of cement production and consumption in 1997

Regions	Production (%)	Consumption (%)	Per capita consumption (kg)
EU15	11.3	10.9	446
Rest of Europe	5.5	4.8	363
FSU	2.6	2.8	137
Africa	4.2	4.6	91
North America	6.1	6.8	348
Latin America	7.5	7.2	271
China	33.2	32.9	404
India	5.3	5.1	82
Rest of Asia	18.1	19.2	270
OECD Pacific	6.5	5.7	568

[4] Luxembourg and Belgium are merged together, while all other EU countries are modelled individually.