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The fundamentals of the future international emissions trading system

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ABSTRACT

The study aims to analyze the sectoral marginal abatements cost curves for a number of EU countries as well as to examine the efficiency aspects and the economic impacts for the major sectors of the ETS under different carbon market configurations in 2010 and 2020. To produce a consistent and realistic assessment, we employ sources such as GHG National Inventories, NAPs and POLES world energy model to constitute the sectoral base year and 2010, 2020 emission levels in different countries and regions. We then use the market analysis tool ASPEN, which enables to derive supply and demand from sectoral MACCs produced with the POLES model, and to evaluate the economic impacts on the carbon market participants. The paper shows that, in compliance with the Kyoto targets, the benefits of an enlarged carbon market are significant, since more than 50% of the abatement in the short term have to be achieved in ETS sectors, which may indeed use CDM or JI credits. A second major conclusion is that in 2020 the new flexibility margins provided by the adjustment of investments in new capacities compensate for the increase in pressure towards stronger emission reductions. This reduces the relative importance of the enlarged carbon market.

0. Introduction

International cooperation through the market-based Kyoto protocol mechanisms is crucially important for greenhouse gas (GHG) emissions abatement policies if in the future a significant number of countries remain subject to a system of emission quotas, in a 'cap-and-trade' regulation system (Criqui, 2002). The European Union was the first region to set up a broad carbon market: the European Emissions Trading System (EU ETS), which started functioning by the first of January 2005.[1] Additionally, the European Parliament adopted the 'linking directive',[2] which opens the ETS to other carbon trading systems as well as to Kyoto 'project-based' mechanisms, i.e. the Clean Development Mechanism (CDM) and Joint Implementation (JI).[3] The CDM and JI are considered to be key options to engage countries outside the EU in the international climate change process and in the emerging international carbon market.[4]

Given the size already reached by the EU ETS, the system could constitute the very heart of the global carbon market for many years and serve as a reference for other markets. Furthermore and in parallel with the EU ETS policy, the European Commission proposes a quantity objective of 20% reduction of GHG emissions in Europe in 2020 based on the 1990 emission levels, which might be extended to 30% reduction if an international agreement justifies (Council of the EU, 2007). It thus clearly shows its commitment to long-term actions aiming at stabilization in GHG concentrations.

Meanwhile, the value of the global emission markets might be as high as € 200 billion by 2010 according to the leading carbon market analyst Point Carbon (2004). Besides the growing popularity of CDM and JI projects, the domestic *cap-and-trade* systems are under discussion or already operating in Norway, Switzerland, Canada, Japan, Australia, New Zealand and north Eastern US States (Reinaud and Philibert, 2007). In that context, the estimation of CO_2 prices for 2010 and beyond is becoming a key risk-management issue for utility analysts.

While a number of studies have tried to project the prices for GHG emissions in the Kyoto period (for a complete survey, see Springer and Varilek, 2004), the levels identified differ widely, from 3 to 74 $/t$CO_2$. This is basically due to business-as-usual emissions projections and differences in the models' features, but also because of the importance of no-regret measures,[5] the

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[1] Directive 2003/87/EC.
[2] Directive 2004/101/EC.
[3] In the analytical results given in this paper, "JI" countries refer to Russia, Ukraine, Bulgaria, Romania, Albania, Bosnia-Herzegovina, Croatia, Macedonia, Serbia and Montenegro. "CDM" countries refer to all non-Annex B countries of the Kyoto protocol.
[4] "Carbon" and "CO_2" are utilized interchangeably throughout the article.
[5] No-regret measures (or negative-cost options) are measures for which benefits (i.e. energy cost savings) exceed costs. Common examples include the

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availability of project-based credits and the sectors participating in the market. Additionally, the majority of studies search to determine the carbon prices needed to achieve the Kyoto targets in global economies of different countries, with the exceptions of Angers (2006) and Klepper and Peterson (2006) who differentiate between energy intensive or ETS and non-energy intensive or non-ETS sectors. As an example, in order to derive the ETS carbon price, Klepper and Peterson (2006) use emissions allowances based on the first National Allocation Plans under the ETS for their emission limits. It is, however, known today that the allocation endowments have been too generous in the first phase of ETS (e.g. Ellerman and Joskow, 2008), which, if taken into account, modifies the reduction shortfall under the ETS. The same remark applies to the study by Angers (2006), which also analyses the efficiency aspects of linking different cap-and-trade systems in 2020. Finally, none of the studies cited have attempted to look at the economic impacts on different sectors of the ETS nor do they perform an extensive analysis of the sectoral marginal abatement cost curves (MACCs).

Our study, therefore, complements these researches by (i) providing an analysis of sectoral marginal abatements cost curves for a number of European countries and (ii) by addressing the efficiency aspects and the economic impacts for the major sectors of the EU ETS[6] under different carbon market configurations. A static and competitive equilibrium environment is assumed, for a given set of sectoral targets by country or world region in 2010 and 2020. As a number of variables have a significant impact on the fundamentals of the demand and supply of carbon allowances, this type of exercise has to formulate a whole set of consistent hypotheses, including

- the tightness of the sectoral objectives in the ETS system, which to a large extent refers to second NAPs under the ETS for 2010 and to the suggested reduction by the Commission of 21% of verified 2005 ETS emissions for 2020, but also the tightness of allocation in other carbon trading systems;
- the availability and costs of credits originating from the CDM and JI projects.

To explore the economic impacts of various organizations of global carbon markets and key variables mentioned above, we use the market analysis tool ASPEN, which enables to derive supply and demand from sectoral MACCs produced with the reference scenario of POLES world energy model. ASPEN then computes the market-equilibrium price, the flows of CDM/JI credits, the quantities exchanged and the reduction costs for each country in each sector for different global carbon market configurations.

The paper develops as follows: in Section 1, we first describe the approach chosen for sectoral endowments of CO_2 emission allowances for different countries or regions in 2010 and 2020; in Section 2, we actually display and discuss the MACCs derived from the POLES Reference scenario; then in Section 3, we proceed with the ASPEN software and introduce the five scenarios representing consistent configurations of the future carbon market; Section 4 later delivers and analyses the main results of this study; lastly, we present our main conclusions in Section 5. The paper shows in particular that, in compliance with the Kyoto targets, the benefits of an enlarged carbon market are significant, since more than 50% of the abatement in the short term have to be achieved in EU ETS sectors (and especially electricity sector), which may indeed use the CDM or JI credits. A second major conclusion is that in 2020 the new flexibility margins provided by the adjustment of investments in new capacities compensate for the increasing pressure towards stronger emission reductions. This reduces the relative importance of the enlarged carbon market.

1. The sectoral CO_2 allocations for 2010 and 2020

The assumptions that influence the demand and supply of allowances are major elements for the assessment of carbon price. The countries and regions of the POLES world energy model described in Annex 1 define the participants to the carbon market in our exercise. We take into account 25 European countries, 11 Annex B countries or regions and 16 non-Annex B countries or regions. In this exercise, only the energy-related CO_2 emissions (around 80% of total GHG emissions) are taken into account and their sectoral representation is the following: *industry*, *energy*, *transport* (road, aviation and other transport) and *others* (residential, services and others).

National Inventories, which have to be annually submitted by the parties to the United Nations Framework Convention on Climate Change (UNFCCC), provide a detailed sectoral representation of CO_2 emissions in a common format. We used these inventories to establish the base year (usually 1990) sectoral emissions, whenever possible. For the countries or regions that do not produce such inventories, we use statistics from the US Energy Information Administration (EIA).

1.1. CO_2 allowances for EU 25: 2010 and 2020

The fact that European countries—along with the other parties who ratified the Kyoto protocol—do have legal obligations to fulfill their objectives in the period 2008–2012 provides part of the assumptions on the allocations in 2010: these assumptions have to fit with the reduction objectives under the Kyoto protocol. Additionally, the national reduction obligation has to be split domestically between the ETS and non-ETS sectors—like transport, buildings and small industries. The distribution among the sectors appears to be very important since generous endowments in the ETS sectors will imply higher abatement costs for the non-ETS sectors (and vice-versa), as long as the Kyoto objectives are strictly met.

The starting point for the sectoral CO_2 emissions distribution was the establishment of a database of the NAPs for the second phase of the ETS in 2008–2012. As for the non-ETS sectors, the latest national GHG emission inventories were employed to constitute their sectoral shares to be inserted in the CO_2 emission quota for 2010, as allowed by national Kyoto targets.

Concerning the post-Kyoto period, the European Commission in its Strategic Energy Review package of 2007 proposed a 20% reduction of the GHG emissions by 2020, for which, according to the Commission, the key economic instrument will remain the ETS. Additionally, it indicated that the reduction of 21% on ETS sectors and 10% on non-ETS sectors should be applied relative to 2005 emission levels (EC, 2008). Taking these considerations into account, we come up with the sectoral CO_2 allowances for EU-25 as summarized in Table 1 (refer to Annex 2 for the country-level allocations).

According to Table 1, Kyoto objectives for European countries represent a shortfall of 331 $MtCO_2$ and the target assumptions for 2020 correspond to a reduction of 774 $MtCO_2$ relative to the base year emission levels. However, if the 2005 national GHG

(*footnote continued*)
introduction of high-efficiency light bulbs, improved cooking stoves or building renovations.

[6] We assume that the ETS covers all industrial and energy (electricity, heating, other transformation) sectors. The assumption implies a deviation of 5% between verified 2005 ETS emissions and CO_2 emissions provided in National 2005 GHG Inventories in sections of *Energy industries* and *Manufacturing industries and construction*.