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The efficiency of international cooperation in mitigating climate change: analysis of joint implementation, the clean development mechanism and emission trading for the Federal Republic of Germany, the Russian Federation and Indonesia

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Abstract

This paper presents results of an analysis of the flexible instruments joint implementation, clean development mechanism and emission allowance trading with regard to achieving CO_2 emission reduction targets economically. The analysis is based on the development and application of energy and material flow models for the considered countries, the Federal Republic of Germany as a host country with quantified emission reduction targets as well as the Russian Federation and Indonesia as potential partners. In this approach, a transparent and credible baseline for the calculation of emission credits is determined by developing consistent national emission reduction strategies for each country. The efficiency of international cooperation is subsequently analysed by linking the national models using a decomposition algorithm. Different assumptions with respect to the economic and political framework as well as regarding the impact of transaction costs associated with cooperation projects are considered. The model results show substantial potentials to limit emission reduction expenditures by multilateral cooperation. The most favourable types of cooperation projects for the considered countries are CO_2 sequestration and power plant projects.

Keywords: Joint implementation; Clean development mechanism; Emission trading; Greenhouse gas emission reduction

1. Introduction

At the UN Conference on Environment and Development in Rio de Janeiro in 1992, 154 countries signed the UN Framework Convention on Climate Change (UNFCCC) which lays down measures to reduce the anthropogenous emissions of greenhouse gases (GHG). The Kyoto Protocol (see United Nations, 1997a) was a crucial step in the refining of the UNFCCC as it sets legally binding emission targets for a basket of six greenhouse gases. These targets apply to most OECD countries and countries with economies in transition (Annex I countries) and refer to the period 2008–2012. To reach the targets, countries may take recourse to flexibility mechanisms/Kyoto mechanisms, namely joint implementation (JI, Article 6 of the Kyoto Protocol), the clean development mechanism (CDM, Article 12), and international emissions trading (Article 17). JI and CDM are based on the concept of allowing one country (investor/donor) to fulfil its reduction targets by carrying out reduction measures on the territory of another country (host). JI applies to investments in Annex I countries, CDM to investments in GHG abatement in developing countries. The resulting emission reduction is then distributed among the partners using an emission crediting system. In addition, the emission credits have to be approved by national and international bodies. In contrast, emission trading is based on a supranational system of fully tradable certified emission reductions.

Although first experiences with JI/CDM-projects have been gathered in the last few years, the following questions remain open:

- What are the differences with regard to the cost of a reduction of greenhouse gas (GHG) emissions — in

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particular CO_2 — between individual countries or groups of countries?
- Which potentials for JI/CDM projects can be derived from these cost differences and
- which project types should be given preference as future JI/CDM projects?
- Which additional transaction costs arise in conjunction with JI/CDM projects?
- Which expenditures are incurred to cover the financial risks associated with the projects?
- What influence do expenditures for transactions and risk coverage have on the efficiency of the instrument JI/CDM?
- What are the options to solve the present problems in making the instrument operational, especially with regard to the determination of the reference project/the baseline[1] and the organisation of incentive systems?

The aim of this study is to analyse the problems outlined by these questions from the point of view of the Federal Republic of Germany (FRG) as a potential investor country for JI/CDM projects and to derive conclusions and recommendations for the structure and implementation of JI/CDM.

The analyses carried out in this article are composed of several elements. In the first step, an optimising energy model is presented as a methodology for the elaboration of national emission reduction strategies. To integrate international cooperation approaches into national strategies, national energy models are linked using a decomposition algorithm.

In the second part of the article important problems and possible solutions in the practical implementation of JI/CDM are identified. Then a national reduction strategy for the FRG will be developed and compared to a reduction strategy incorporating JI/CDM projects — including the expenditures for transactions and coverage of project risks. The Russian Federation as an example of an Eastern European country in transition (JI partner country) and Indonesia as an example of an Asian country with a forecast high growth in energy demand (CDM partner country) are selected as typical potential host countries.

Further considerations and an outlook constitute the last part of the article. With the Kyoto-Protocol having prepared the ground for the introduction of an international emission trading, JI/CDM will be compared to this instrument and first conclusions regarding an emission allowance trade will be drawn.

[1] The baseline represents the reference development without JI/CDM, based on which the criteria of additionality and quantifiability called for in the UNFCCC are assessed.

2. Methodology

2.1. The PERSEUS model

For the elaboration of national emission reduction strategies, the optimising energy and material flow model PERSEUS (programme package for emission reduction strategies in energy use and supply) is subsequently designed and applied. In this model, possible technical reduction options are represented and linked in a bottom-up approach, making it possible to consider the interdependencies between individual measures. For example, the cost-efficiency of the rational use of electricity depends on the structure of the electricity supply system. For instance, if structural changes of the system (e.g., due to a switch from coal to gas or renewable energy carriers induced by a JI/CDM project) lead to half the CO_2 emission factor for end use electricity, the emission reduction caused by the rational electricity use project will be halved. Because of this fact the resulting mitigation cost per ton of CO_2 of the project will double.

The PERSEUS model is based on a detailed representation of energy conversion technologies and the interconnecting flows of energy (i.e., electricity and heat) and material (i.e., primary energy carriers, emissions of pollutants and greenhouse gases). The complete energy sector — starting from the resources via several energy-conversion steps up to the supply of final energy — is modelled in a consistent approach (see Fig. 1).

Technologies and flows are characterised by technical (e.g., efficiency, lifetime), economic (e.g., investment, fixed and variable costs) and environmental (emission factors) parameters. The model employs a mixed-integer linear programming approach and has been implemented using the algebraic modelling language GAMS (general algebraic modelling system) developed for the World Bank (see Brooke *et al.*, 1988). PERSEUS determines the "optimal" structure of the future energy system of a country[2] for a typical time horizon between 20 and 40 years. Target function of the optimisation is the minimisation of all decision-relevant expenditure within the whole supply system over the time horizon using the net present value method. The variables of this multi-periodic linear optimisation model are energy and material flows as well as new energy conversion capacities. Decision-relevant expenditure comprises fuel costs as well as other variable costs related to all the energy flows, variable costs depending on the process activities in energy conversion units, as well as fixed costs of all generation capacities and investment in new generation capacity. Investment

[2] The models of the PERSEUS family can also be used to elaborate decision support on other levels, e.g., for regions (Fichtner, 1999), utilities (Göbelt *et al.*, 2000) or multi-company resource recovery networks.