Katja Schumacher and Ronald D. Sands

ECONOMIC COMPARISON OF GREENHOUSE GAS MITIGATION OPTIONS IN GERMANY

K. Schumacher: German Institute for Economic Research (DIW Berlin)
Königin-Luise-Strasse 5, 14195 Berlin, Germany
Phone: +49-30-89789675, Fax: +49-30-89789113, Email: kschumacher@diw.de
R. D. Sands: Joint Global Change Research Institute
8400 Baltimore Avenue, Suite 201, College Park, Maryland 20740, USA
E-mail: ronald.sands@pnl.gov

Overview

At least four classes of greenhouse gas mitigation options are available: energy efficiency, fuel switching, introduction of carbon dioxide capture and storage along with electric generating technologies, and reductions in emissions of non-CO_2 greenhouse gases. These options vary by cost, timing, and our ability to represent them in an economic analysis. Our objective is to provide a balanced analysis of these classes, across a variety of carbon policy scenarios, for Germany. Policy scenarios are represented as a response to varying levels of a carbon price, either applied economy-wide or targeted at energy-intensive sectors of the economy.

Methods

Our approach is to use a computable general equilibrium (CGE) economic model as a core model and integrating tool. Our model presents a flexible tool for simulating greenhouse gas emissions that can accommodate a wide variety of assumptions about electricity technologies, carbon prices, fuel prices, and baseline energy consumption. Our methodology relies on engineering descriptions of electricity generating technologies and how their competitive positions varies with a carbon price or change in fuel price. Moreover, it allows for reduction of emissions of non-CO_2 gases, which adds a set of mitigation opportunities not usually included in energy-economic modeling efforts.

Specifically, we use the Second Generation Model (SGM; Edmonds et al., 2004; Sands, 2004), an economy-wide computable general equilibrium model that embodies energy and other greenhouse gas mitigation possibilities. Energy efficiency options are represented in the standard CGE format, where non-energy inputs substitute for energy inputs within economic production functions, or system of consumer demand equations, as the price of energy increases relative to other goods. The electric power sector provides substantial opportunities for fuel switching and the deployment of advanced electricity generating technologies in both a projected baseline and in alternative carbon policy scenarios. Opportunities for reductions in emissions of the non-CO_2 gases; methane, nitrous oxide, and the F-gases; are handled differently. Here, we use exogenous projections and marginal abatement cost curves derived from an Energy Modeling Forum study.

Due to the size and structure of its economy, Germany is one of the largest carbon emitters in the European Union. However, Germany is facing a major renewal and restructuring process in electricity generation. Within the next two decades, up to 50% of current electricity generation capacity may retire because of end-of-plant lifetime and the nuclear phase-out pact of 1998. We simulate the potential role of coal integrated gasification combined cycle (IGCC), natural gas combined cycle (NGCC), carbon dioxide capture and storage (CCS), and wind power from the present through 2050.

We exercise our modeling framework for Germany under various hypothetical policy scenarios: (1) all sectors of the economy face a common carbon price; (2) carbon incentives are targeted to the electric power and energy-intensive industries (i.e. those covered by the EU emissions trading scheme); and (3) with and without consideration of non-CO_2 greenhouse gas mitigation options. The carbon policies are represented with a set of constant-carbon-price experiments covering a range of carbon prices high enough so that CCS technologies can at least break even..

Results

This study is designed to provide an economic comparison across a range of greenhouse gas mitigation scenarios for Germany. The scenarios vary across the available mitigation options and coverage of the economy. The following results are available for the scenarios:

- Analysis of structural and aggregate economic effects across the various mitigation options over time at various carbon prices.
- Simulation of production, energy consumption and prices, and greenhouse gas emissions in Germany in five-year times steps from 1995 through 2050, for 18 economic sectors.
- A comparison of the reductions in greenhouse gas emissions across the various mitigation options over time at various carbon prices.
- How the carbon price varies to meet a fixed emissions target as coverage of the economy and the set of mitigation options is expanded.

Conclusions

This study builds on previous analysis by Schumacher and Sands (2005), where the primary extensions here are the inclusion of non-CO_2 greenhouse gases and a broader set of carbon policies. The non-CO_2 greenhouse gas mitigation options are generally considered to be end-of-pipe options that can be deployed relatively quickly on both new and existing capital equipment. The rate that other greenhouse gas mitigation options can deploy is generally limited by the rate that existing capital stocks retire. The carbon policy scenarios in this study are designed to provide insights on the European Union emissions trading system, where carbon incentives are targeted at specific energy sectors.

References

Edmonds, J.A., H.M. Pitcher, and R.D. Sands. 2004. Second Generation Model 2004: An Overview. Pacific Northwest National Laboratory.

Sands, Ronald D. 2004. "Dynamics of Carbon Abatement in the Second Generation Model." Energy Economics 26 (4): 721-738.

Schumacher, Katja and R.D. Sands. 2005. "Innovative energy technologies and climate policy in Germany," Energy Policy (in press).