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MACROECONOMIC EFFECTS OF POWER SECTOR MODERNIZATION IN THE EU-25 COUNTRIES UNDER A POST-KYOTO-REGIME

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Overview

The electricity conversion sectors in the European countries face significant modernization requirements within the next decades. Approximately 75 % of today's generation capacity has to be replaced until 2030. For the new European member states the situation is even more serious with nearly 80 % of their capacity to be replaced within the next 25 years. Beside life time related decommissioning, various countries face additional policy induced replacement requirements due to e.g. nuclear phase-out. These issues impose a serious challenge to Europe's security of electricity supply, inducing enormous investment needs for the European countries. The European Commission estimates that 1.2 trillion € are necessary for modernization in the electricity sector /EU 2005/. If this investment expenditure will effectively take place, it will on average result in substantial higher power plant efficiency. The overall emissions of electricity generation are projected to decline, and therefore having impact on national and international climate policy.

Regardless of the exact long term emission caps that will be committed within a Post-Kyoto regime, the power conversion sector plays an important role in any current and future climate policy. Approximately one third of the emissions in the industrialized countries are caused by the combustion of fossil fuels for electricity generation. Furthermore, fossil fuels are very likely to remain the most important energy source for the next two or three decades, notwithstanding the increasing role of renewable energy sources in the long term. Consequently, higher efficiency standards induced by power plant investments can contribute to the success of future climate policy. This interrelation was for instance highlighted at the COP 11 in Montreal as well as in the strategy paper "Winning the Battle Against Global Climate Change" by the Commission of the European Communities and in the Asia Pacific Partnership on Clean Development and Climate.

Therefore, the aim of this paper is to analyze how a consequent modernization of the European power sector will influence the macroeconomic development in the countries of the EU-25. We quantify the effects on economic growth, and on CO_2 prices as well as efficiency induced changes in electricity production for several generation technologies until 2030.

Methods

For the analysis, the global Computable General Equilibrium (CGE) model NEWAGE-W has been used. NEWAGE-W is a dynamic multi-regional, multi-sectoral world model, covering among others each EU-25 member state separately. The current version uses the GTAP database Version 6 from 2005.

The analysis of power sector modernization as well as alternative climate policy measures requires a disaggregated view on the conversion sector. Therefore, a technology-based representation of the electricity generation portfolios has been implemented. Using physical capacity data for the various electricity generation technologies and specific information regarding cost structures for the different supply options, the electricity production sector in NEWAGE-W is represented by 16 different generation technologies supplying electricity within three load segments, i.e. base, middle and peak load, respectively. The power plant portfolios cover nuclear, hard and soft coal, gas, oil, hydro, wind, solar, biomass and geothermal technologies /Zürn et al 2005/, /Ellersdorfer, Fahl 2005/. Therefore, it is possible to analyze technology specific policies (e.g. a nuclear phase out, RES subsidization) and to model technology specific re-powering potentials.

Technological progress regarding the use of fossil fuels is taken into account by assuming autonomous energy efficiency improvements. The so called Autonomous Energy Efficiency Improvement (AEEI) index represents an overall increase in energy efficiency for all technologies applied for production and consumption. To capture the potentials for power plant modernization and hence efficiency gains in the electricity sector within the next 30 years, technology and country specific efficiency parameters have been calculated for implementation in the model. We assume that the technical innovations for efficiency improvements are available for each country. It has been considered that the countries' current power plants have different efficiency levels and that the generation portfolios differ in its age structures, thus facing different modernization potentials over time. Accordingly, country and technology specific decommission curves for the EU-25 had been implemented in the model.

Results

For the assessment of a possible contribution of power plant modernization reaching emission reduction targets and for quantifying the associated macroeconomic effects in the EU-25, two scenarios have been calculated. As a reference case, a business as usual scenario (BAU) takes the current Kyoto targets for the ratifying Annex B Countries and the burden sharing in the EU-25 into account. For a Post-Kyoto regime the individual emission reduction targets as ratified in the Kyoto protocol are considered to be retained after 2012. The results of the COP 11 indicate that the United States and the developing as well as the emerging countries are not obligated for concrete emission restrictions, so the assumption is made that emission restrictions apply only for those countries having currently ratified the protocol. The agreements on nuclear phase out are implemented for Germany. We compare the results of the reference case (BAU) to an efficiency scenario (SCEN), where the European electricity sectors are extensively modernized by replacing the generation capacities that will be decommissioned until 2030 with the most efficient power plant technology available.

The analysis shows that the modernization of the electricity sector will have positive impacts on the economic development and the achievement of climate policy goals within the EU-25 countries. The cumulative GDP of the EU-25 increases by approximately 439 bn € until 2030 compared to a situation without power plant modernization. The EU-15 countries contribute the greatest part in absolute terms. However taking into account the fact that the new member states account only for 5 % of total EU-25 GDP, the relative differences in GDP development are higher in the EU-10 than in the EU-15. CO_2 permission prices are lower in the efficiency scenario than in the reference case over the whole time period.

In general it can be shown that there is a increase in the electricity generation from natural gas, lignite and hard coal in the EU-25, due to the power plant modernization. There is a slight decrease in nuclear power generation as well as RES supply, showing diverse results for particular countries. Overall, efficiency induced reductions of CO_2 emissions in the EU-25 can be observed.

Conclusions

The COP 11, the strategy "Wining the Battle Against Global Climate Change", and the Vision Statement of the Asia-Pacific Partnership on Clean Development and Climate all demonstrate their expectation of technological development in the conversion sector. The preliminary results show that the use of modernized power plants has positive influences on the macroeconomic development in the EU-25 countries. Regarding the only small contribution of the power sector to overall GDP, it must be concluded that the efficiency improvement could only marginally compensate any negative effect of possible stricter climate policy goals. Nevertheless the modernization of the European electricity sector within the next 20 to 30 years is an adequate instrument to support the achievement of more ambitious climate policy goals and to lower their macroeconomic costs.

References

Ellersdorfer, I., Fahl, U. (2005): "Nuclear Case Study for NEWAGE-W". Report for the case study analysis within the Cascade Mints Part 2 Project, European Commission, 2005, Stuttgart.
European Union (2005): "Winning the Battle against Global Climate Change". Commission of the European Communities, 2005, Brussels.
International Energy Agency (2005): "Projected Costs of Generating Electricity – Update 2005", 2005, Paris.
Zürn, M., Ellersdorfer, I., Fahl, U. (2005): „Modellierung von technischem Fortschritt in NEWAGE-W". In: Ellersdorfer, I. (Hrsg.) und Fahl, U. (Hrsg.) „Ansätze zur Modellierung von Innovation in der Energiewirtschaft". Mensch und Buch Verlag, 2005, Berlin.