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Bachelor Thesis

BSc Environmental Sciences

Regionalisation of External Cost Factors:

Methodological Considerations and Application to the World Energy Council (WEC/PSI) scenarios

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Abstract

The global energy system is mainly based on fossil fuels. The combustion of these fuels emits pollutants to the atmosphere, which negatively affect environment and society. These effects – such as health issues and the loss of biodiversity – can be economically quantified as monetary losses and are called externalities or external costs.

In this thesis I determined the externalities of the global energy system for 15 airborne pollutants. To calculate the value of the external costs, I linked the amount of emissions produced by the energy system with so-called external cost factors. These external cost factors indicate the externalities caused by the release of one ton of a specific pollutant, and were already calculated during the NEEDS project for Europe.

In order to model the external costs of the global energy system, I first transferred the external cost factors of NEEDS to the 15 world regions of the WEC/PSI scenarios Jazz and Symphony. To perform this transfer I conducted several adjustments including GPD differences and growth, population densities and urbanisation rates. The WEC/PSI scenarios were calculated with the GMM model of PSI, which is a partial equilibrium bottom-up model of the MARKAL family and projects the global energy-mix up to the year 2050, differentiated into 15 world regions.

As a next step, I linked the external cost factors, which were now specific for the regions, time periods, pollutants and scenarios, to the emissions produced in Jazz and Symphony. These emissions are not only the ones from final combustion but consider the whole life cycle of the technologies. They could be determined because the GMM model has been linked with LCA data from ecoinvent[1].

The results of the regionalisation show that the mean of the external cost factors in the year 2050 is higher by factor 1.94[2] in Symphony (SD=0.57[2]) and 1.60[2] in Jazz (SD=0.44[2]) compared to the NEEDS values for the EU in 2010. The highest external cost factors occur in India[2] (Jazz) and in the US[2] (Symphony). The ex-post calculations show that the global energy system is responsible for externalities of 5.58*1012 US$[2] in the year 2010 which is about 9 percent[2] of the world's GDP. To minimise these externalities, a stronger focus must be set on promoting clean sources of energy.

[1] This part of the work was oriented towards practically demonstrating that given such linking it is possible to propagate through the model external costs based on life-cycle burdens. Since the GMM-LCA model as such is still under development and at this stage has some deficiencies the numerical results on aggregated scenario-specific external costs are not necessarily representative and will change once the final model is implemented.

[2] These factors are subject to reservations due to the not yet resolved issues with the GMM-LCA model. Resolution of these issues was beyond the scope of the present thesis. Once the model will be properly implemented it is expected that the aggregated external costs of Jazz will be substantially higher than those of Symphony as the latter to a much higher extent employs environmentally friendly technologies.