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THE DISPROPORTIONATE COST PRINCIPLE UNDER VARIABLE ENVIRONMENTAL AND TECHNICAL SETTINGS

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ABSTRACT

As a new feature under the European Union's Industrial Emissions Directive, plant operators can apply for less strict emission limit values on the basis of the disproportionate cost principle, comparing environmental benefits to (private) costs. This study aims to assess to what extent the proportionality of emission abatement options depends on different environmental and technical settings. Through a cost-benefit analysis, private costs of retrofitting and operating a DeNOx at a typical coal-fired power plant at varied Western European locations are confronted with associated monetised environmental benefits, quantified with the tool EcoSenseWeb. Results are shown to be sensitive to the environmental setting and the operating time per year. Further methodological development is needed to make the assessment more robust.

INTRODUCTION

In the European Union (EU), emissions from industrial installations are largely addressed by requiring that best available techniques (BAT) are implemented. The current Industrial Emissions Directive (IED, Directive 2010/75/EU) sets stricter emission limit values (ELVs) for existing combustion plants to be respected from 2016 onwards than previous regulation. As a new feature, plant operators can apply for less strict ELVs on the basis of the disproportionate cost principle, comparing environmental benefits to (private) costs.

This study aims to present a way how to quantify environmental benefits related to reductions in air pollutant emissions in economic terms. It shall also be assessed to what extent the proportionality of abatement options depends on different environmental and technical settings.

METHODS

Cost-Benefit Analysis

Through a cost-benefit analysis (CBA), private costs of installing and operating the BAT at a given industrial site are confronted with associated monetised environmental benefits, following the net present value rule (cf. Pearce, Atkinson, & Mourato, 2006):

$$\left\{ \sum_{i,t} B_{i,t} * (1+s)^{-t} - \sum_{i,t} C_{i,t} * (1+s)^{-t} \right\} > 0 \quad (\text{Eq. 1})$$

where i : affected individuals, t : time horizon (in years), B : benefits, C : costs and s : discount rate.

While assessing private costs is common practice, assessing environmental benefits (through reduced external costs) is more complex and requires adapted approaches.

External costs and their quantification

According to the prominent EU-funded Externalities of Energy (ExternE) project series, an external cost is defined to arise “when the social or economic activities of one group of persons have an impact on another group and when that impact is not fully accounted, or compensated for, by the first group” (European Commission, 2005, p. 9).

External costs are quantified with help of a state-of-the-art tool for point sources in Europe, i.e. EcoSenseWeb (Preiss & Klotz, 2008). External costs from NO_x, SO₂ and particles are assessed following the marginal damage cost or impact pathway approach (European Commission, 2005; Pearce et al., 2006). Local as well as regional scale modelling results are used (2010 background emissions and default meteorology) while assuming equal toxicity of different primary and secondary particles on human health. Given the uncertainty in assessing associated impacts, greenhouse gas emissions are valued at 19€ per tonne of CO₂ emitted, according to the marginal abatement cost approach (cf. European Commission, 2005).

DeNOx retrofit at a hard-coal fired power plant

A hard-coal fired power plant unit has been investigated at three different sites, i.e. Brussels (BE), Cartagena (ES) and Helsinki (FI), varying in terms of population density, background emissions and meteorological conditions. The plant parameters remain constant. It is equipped with flue gas desulphurisation and an electrostatic precipitator for the abatement of particles. When installing the DeNOx retrofit (selective catalytic reduction, SCR), some technical parameters change (Table 1) while providing the same service of 2700 GWh/a for 20 years. More details are provided in Bachmann and van der Kamp (in preparation).

Table 1: Differences in technical characteristics

		Without DeNOx	With DeNOx
Net Electricity sent out	[MW]	600	597
Full load hours per year	[h/a]	4500	4523
NO _x emissions	[mg/Nm ³]	820	200
CO ₂ emissions	[tons/a]	2187000	2197935
CH ₄ emissions	[tons/a]	27.0	27.1
N ₂ O emissions	[tons/a]	59.4	59.7

According to EGTEI (2012) and following the two-stage discounting procedure by Kolb and Scheraga (1990), employing an interest rate of 7% and a social discount rate of 4% (cf. European Commission, 2009), the annualised private costs of installing a SCR and primary

abatement measures at a coal-fired power station amount to 6844012 €₂₀₀₀ per year or 0.25 € cent₂₀₀₀ per kWh.

RESULTS

Annual environmental benefits and costs are compared in the following, the net present value being positive if benefits exceed costs.

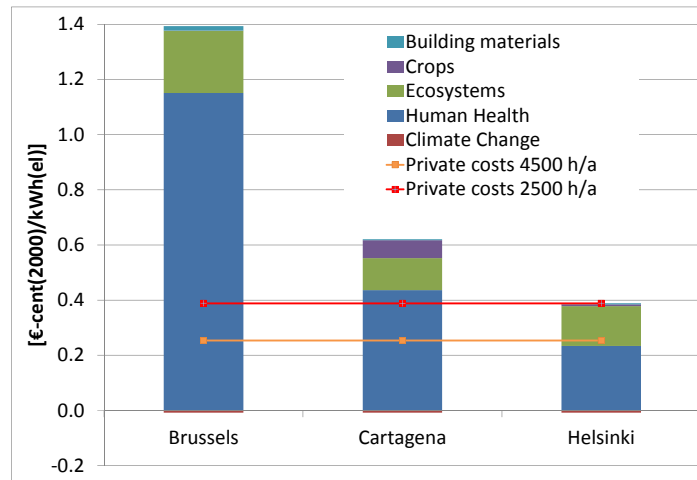


Figure 1. Annual external costs (bars) and private costs (lines) of a coal-fired power plant located at three sites: default case (lower line, orange); reduced full load hours (upper line, red)

Variation of site

The DeNOx retrofit can generally be assessed to be efficient at all investigated sites, i.e. the disproportionate cost criterion does not apply (Figure 1, 4500 h/a case). Nonetheless, the environmental setting substantially changes the magnitude of quantified environmental benefits.

Variation of full-load hours

Due to an increasing share of fluctuating power generation, for instance, the operation hours per year may be reduced from 4500 to 2500 and thus the overall electricity produced. Accordingly, the annualized private costs per kWh increase while the avoided external costs per kWh remain the same (Figure 1, 2500 h/a case). For the locations with the highest and lowest environmental benefits, the result suggests that less full load hours combined with less impacted people may make the DeNOx investment disproportionate. For Brussels, however, the decrease in full load hours does not alter the CBA result.

DISCUSSION

The study shows that the CBA results are sensitive to the environmental setting and key technical assumptions (e.g. full load hours). Besides, the results are subject to limitations (e.g. insufficient coverage of certain impacts, e.g. on biodiversity or ecosystem services, consistency issues, and questions on the ability of EcoSenseWeb to reliably estimate external

costs from peak-load operation) and depend on methodological assumptions (e.g. particle toxicity) and other uncertainties as further discussed in Bachmann and van der Kamp (in preparation).

From an application point of view, the following can be noted. First, the IED is currently transposed into Member State legislation. To what extent the disproportionate costs criterion will apply in practice depends on the national context. Secondly, no EU-wide standard to calculate environmental benefits exist at present, noting related initiatives for standardisation in the past (Holland, Hunt, Hurley, Navrud, & Watkiss, 2005; UBA, 2008). Scientific progress is constantly made that should be considered accordingly. Thirdly, the IED is concerned also with emissions other than classical air pollutants. Related site-specific assessments are currently hardly available.

CONCLUSIONS

The disproportionate cost criterion of the EU's IED was tested for an emission abatement measure at a coal-fired power plant hypothetically located at three different sites. Site-specific external costs, assessed with the tool EcoSenseWeb, are a central input to the CBA. The measure is generally assessed not to lead to disproportionate costs. When reducing the operating time, the investment may become inefficient at sites with lower population exposure. Further methodological development is needed to make the assessment more robust and comprehensive, at best to be carried out in a harmonized way at EU level.

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