

# Chapter 33

## Environmental Cost Studies and Their Application in Environmental Protection Planning for Electricity Production

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### ABSTRACT

*Different approaches may be used for estimating environmental costs of electricity generation, and the way they are applied may vary from situation to situation. The extent to which environmental costs should be considered as external costs (i.e. not borne directly by electricity producers) depends partly on the environmental protection policy of the country and on the control instruments that are implemented. Damage costs can be assessed by two approaches: “top-down” (which relies on aggregated data) and “bottom-up” (requires the use of site-specific data). This chapter describes external costs of electricity and impact pathway method for their calculation. This method links burdens to the environment caused by power generation chains with physical impacts they cause and assigns monetary values to those impacts. Calculated external costs can be applied in various environmental policy case studies. Two such applications are illustrated: cost-benefit analysis of imposing stricter NO<sub>x</sub> emission standard and inclusion of external costs in power system expansion planning.*

### INTRODUCTION

Different approaches may be used for estimating environmental costs of electricity generation, and the way they are applied may vary from situation to situation. The extent to which environmental costs should be considered as external costs, i.e. not borne directly by electricity producers, depends partly on the environmental protection policy of the country and on the control instruments that are implemented.

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Under a ‘command and control’ regime involving emission limits, the costs of residual discharges are not internalized and should appear as adders. On the other hand, where a system of emission trading is in force, the environmental costs already are internalized, at least partly, through the trading costs, and the calculation of additional costs depends on the extent to which the rules that permit emission trading reflect variation in marginal damage from source to source. Adders for pollutants subject to emission taxes should take into account the difference between marginal damage costs and marginal revenues raised by the tax.

Assuming that all impacts from electricity generation chains could be quantified, the overall environmental cost of discharges could, in theory, be calculated by estimating the associated damage costs. However, most studies carried out so far highlight the wide range of uncertainties prevailing in assessing physical impacts as well as in placing values on those impacts. Owing to those uncertainties, and to the lack of reliable data, the costs of emission abatement are sometimes used as proxies for external environmental costs, although this approach generally is opposed by economists.

While it is difficult, and perhaps even impossible, to quantify all the impacts from an energy chain, its environmental costs may be calculated with a reasonable degree of accuracy by estimating a few dominant impacts. However, the identification of the dominant impacts is based partly on judgmental assessment, and the main impacts differ according to local conditions such as population density, economic development and characteristics of the sites, e.g. presence of historical monuments, recreational areas or natural parks.

The use of damage costs to estimate environmental adders was applied in several countries.

Damage costs can be assessed by two approaches: ‘top-down’ and ‘bottom-up’. The ‘top-down’ approach, which relies on aggregated data, has been the dominant technique up to now, because it is easier to apply. It gives reasonable estimates for average damage costs, but it has some limitations with respect to application of the results to a specific location. Moreover, the use of aggregated data may conceal gaps in the detailed scientific and economic data. On the other hand, the ‘bottom-up’ approach requires the use of site specific data, and its results might not be representative of average situations.

Described analyses of environmental externalities are based primarily on the methodical approach that was developed in connection with the international research project ExternE.

The ExternE has made thorough analyses of various fuels and technologies in the electricity sector with methodology and results published in 1995, 1999 and 2004 (NewExt: Externe 2004). ExternE is funded by the European Commission and in its first phase also by the US Department of Energy, DOE. The methodology of ExternE is widely accepted by the scientific community and is according to ExternE considered as “the world reference in the field”.

To the extent possible, ExternE applies a life-cycle approach assessing environmental impacts in all stages of the “fuel chain” – from fuel extraction, over fuel transport, conversion at the power plant and decommissioning of plants and waste handling. In the ExternE analyses all important environmental impacts are quantified, including climate change issues, health impacts from air pollution, accidents (including occupational accidents), impacts on agricultural yield of air pollutions, corrosion of building, noise and visual impacts. Some impacts however like acidification and eutrophication of ecosystems are not monetized due to lack of satisfactory data.

The results from ExternE indicate that climate changes and air pollution constitute the most important environmental costs, and that the costs are primarily related to the energy production phase (stack emissions). To this should be added a number of issues specific to nuclear power: health impacts related to the emissions from radioactive mine tailings may constitute a significant externality. Moreover, the

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