Economics of Greenhouse Gas Limitations

HANDBOOK REPORTS

The indirect costs and benefits of greenhouse gas limitations[1]

A. Markandya
University of Bath and Metroeconomica

[1] I would like to thank Ian Milborrow, Kirsten Halsnaes, John Christensen and members of the UNCEE steering group on the Economics of Greenhouse Gas Limitations for discussions on the material contained in this review paper. They are not responsible for any errors or omissions.

The indirect costs and benefits of greenhouse gas limitations.

Published by: UNEP Collaborating Centre on Energy and Environment,
Risø National Laboratory, Denmark, 1998.

ISBN: 87-550-2458-0

Available on request from:

UNEP Collaborating Centre on Energy and Environment
Risø National Laboratory
P.O. Box 49
DK 4000 Roskilde
Denmark
Phone: +45 46 32 22 88
Fax: +45 46 32 19 99

Cover photo: Noreen Beg

Information Service Department, Risø, 1998

TABLE OF CONTENTS

1 Introduction

There has been a considerable amount of work on the appraisal of different projects and programmes that reduce greenhouse gases (GHGs) (Haites and Rose, 1996; IPCC, 1996, UNEP, 1997 and UNEP, 1998). The focus of these studies has been on the proper methodologies for the estimation of the costs of GHG limitation, and on the correct methods for measuring the amount of GHGs reduced. Clearly, these are some of the central issues that need to be addressed in arriving at a policy for GHG mitigation; ideally one would choose those actions that reduce GHGs at least cost, and a measure of that is the cost per ton of carbon (or carbon equivalent) eliminated.

Although the cost (correctly measured) is one key component of the decision on which policies to select, it is not the only consideration. Other factors will enter the decision, such as the impacts of the policies on different social groups in society, particularly the vulnerable groups, the benefits of the GHG limitation in other spheres, such as reduced air pollution, and the impacts of the policies on broader concerns such as sustainability. In developing countries these other factors are even more important than they are in the industrialised countries. GHG limitation does not have as high a priority relative to other goals, such as poverty alleviation, reductions in employment, etc. as it does in the wealthier countries. Indeed, one can argue that the major focus of policy will be development, poverty alleviation etc. and that GHG limitation will be an *addendum* to a programme designed to meet those needs. Taking account of the GHG component may change the detailed design of a policy or programme, rather than being the main issue that determines the policy.[2]

The purpose of this report is to evaluate GHG limitation issues in a broader context. This includes the impacts of projects on vulnerable groups, the impacts on the environment more generally and the impacts on sustainability in a wider sense. It also offers some advice on how a decision-making framework can bring together these different dimensions. The structure of the guidelines is as follows. Section 2 introduces essential cost concepts and discusses the adjustments needed to the financial costs of different components, to arrive at the true economic costs. Section 3 looks at the macroeconomic impacts of different GHG limitation projects / policies. Section 4 discusses the way in which the sustainability concerns of such projects / policies can be monitored. Section 5 brings these different components together and looks at different methods of project selection. Section 6 provides a basic framework of impacts that are likely to arise in different GHG-related projects / policies, and what kind of method of estimation is available for these different impacts. Sections 7 to 9 go into greater depth on specific impacts. Sections 7 and 8 look at the employment and distributional effects respectively, and how they might be estimated. Section 9 evaluates the benefits in terms of changes in environmental damage resulting from GHG projects / policies. Section 10 provides three case studies in which the methods outlined in the report are applied. These case studies consider a biogas plant in Tanzania, a forestry project in the Russian Federation, and an energy efficiency project in Thailand. Section 11 concludes the report.

The report contains a number of examples of GHG limitation measures. Some of these are taken from actual projects and some are examples. They are intended to

---

[2] The World Bank recognises this different focus in many developing countries and has prepared guidelines for the valuation of GHG 'overlays' to projects in the energy and forestry sector (World Bank, 1997). Although useful in terms of putting GHG projects in a wider context, it does not address the kind of broader social and environmental issues that arise in such projects. It is these that are central to this paper.

demonstrate a method and should not be regarded as numerically correct estimates of the relevant impacts in the countries concerned. Where estimates of broader impacts can be used in any applications of this methodology, this is explicitly stated.

2 Adjustment to Financial Costs

2.1 General Conceptual Issues

Financial costs are based on actual payments for goods and services. In evaluating GHG projects, however, it is not enough to know what the financial costs are. It is the true economic value of the resources used in the mitigation project that is of interest. Financial costs will reflect this true economic value when market prices are based on competitive conditions, when there are no taxes or subsidies, and when households, firms and other agents have perfect information. This will not always, or even typically be the case. In this section, a discussion of the economic cost concept is provided. This is then employed to show the kind of adjustments that need to be made to financial costs, in order to derive the economic costs.

2.2 Economic Opportunity Cost or Economic Cost

The key idea behind an economic cost of something (call it *X*) is the value of the scarce resources that have been used in producing *X*. That, in turn, is measured in terms of the value of the next best thing which could have been produced with the same resources and is called *economic opportunity cost*.[3]

This notion of cost may differ greatly from the common notion of cost. For example, take the case of sequestering carbon by growing trees on a tract of public land. In estimating the costs of such a programme, what should be taken as the cost of the land? In some cases no 'cost' is attached, because the land is not rented out and no money actually flows from the project implementor to the owner (the State in this case). This, however, is incorrect in economic terms.

The cost of the land is to be measured in terms of the value of the output that would have been received from that land had it not been used for forestry. Such values may be direct (e.g. agricultural output), and / or indirect (e.g. recreational use).

Often a resource is used and there is a financial flow associated with it. Working with the same example, the government may have leased the land to a farmer, who keeps livestock on it. If it is used for forestry the government often does not demand payment from the forestry authority. In that situation the 'opportunity cost' might be interpreted as a loss of revenue to the government. Although that is an opportunity cost to the government it is incorrect to take it as the *economic opportunity cost*. The reason is that the price of the original lease may not be equal to the opportunity cost of that land. Even assuming that the highest value use is livestock, the value of the land is the *net income* from livestock grazing, after deducting all expenses. Frequently the

[3] In UNEP(1998) a definition of opportunity cost is offered. The modified term economic opportunity cost is used here because there is a distinction between such a cost measured in terms of the true scarcity value of the economic activities forgone and the opportunity cost measured, for example, in terms of the financial value of the activities forgone. The text provides examples of this distinction.

leases are for much less than that, so the opportunity cost is not equal to the financial flow to the government.[4]

The key points of note with regard to opportunity cost are the following:

a) there may be an *economic opportunity cost* to the use of a resource even if there are no financial flows associated with that use; and

b) if there are any financial flows, the *economic opportunity cost* may or may not be equal to the value of those flows.

In designing mitigation and adaptation cost strategies the objective is to minimise the *economic opportunity cost* of the programme. *Economic opportunity cost* is sometimes called just the *economic cost* and is closely related to *social cost*. It is also related to the concept of *shadow price,* both of which are discussed below. For a more complete discussion of these concepts see Markandya, Halsnaes and Milborrow, (1997).

2.3 External Cost, Private Cost and Social Cost

The term *external cost* is used to define the costs arising from any human activity that are not accounted for in the market system. For example, emissions of particulates from a power station affect the health of people in the vicinity but there is no market for such impacts. Hence, such a phenomenon is referred to as an *externality*, and the costs it imposes are referred to as the *external costs.* These external costs are distinct from the costs that the emitters of the particulates do take into account when determining their outputs (e.g. prices of fuel, labour, transportation and energy). Categories of costs influencing an individual's decision-making are referred to as *private costs.* The total cost to society is made up of both the *external cost* and the *private cost*, and together they are defined as *social cost.*

Social Cost = External Cost + Private Cost

Estimation of mitigation and adaptation costs necessitates working with social costs.[5] Often, however, the data will only provide information on the private cost. In these situations a correction has to be made for the missing costs. For further material on external costs the reader is referred to Baumol and Oates (1988), and Tietenberg (1996).

In this report, the external costs of GHG projects have been looked at in Section 9 (and to some extent in Section 7). The focus here, therefore, is on the adjustment necessary to private costs. This is done using shadow prices which are discussed below.

2.4 Shadow Prices

The above discussion concluded that the proper cost to consider in GHG projects is one based on *economic opportunity cost*. As noted above, where markets operate competitively and efficiently, the prices will reflect the opportunity costs and can be used to estimate the correct costs. In many instances, however, this will not be the case, and some correction will need to be made. The corrected market price, which should be equal to the *economic opportunity cost* of the resource, is called the *shadow price.* One important case of this is analysed in Section 7 with respect to unemployment. In that

---

[4] It can be shown that, under competitive markets with no taxes, the market price-based costs will be equal to the economic opportunity costs. This is important in the estimation of opportunity costs from market data.

[5] Where the pricing of commercial goods is such that it includes both the *private cost* and the *external cost* (i.e. it is based *social cost*) it is referred to as *full cost pricing.*

section the benefits of employment are calculated, based on the money value of the change in status from 'unemployed' to 'employed'. The true opportunity cost of employment is then the difference between the two. For example, if a project uses labour that is paid a wage of $20 a day but the benefits of employment are $8, then the true *economic opportunity cost* of that labour is only $12, and the *shadow price* of labour is $12.[6] Adjustments to market prices to obtain shadow prices will be needed when:

- there are distortionary taxes and subsidies, so market prices deviate from economic opportunity costs; and
- there are monopolies and other market imperfections making the market price higher or lower than the shadow price.

The simplest way to correct for such distortions, *where the resources are tradable*, is to take the international prices of the resources. Assuming well functioning markets, these prices are seen to be 'optimal'. If a good is exported, for example, the export price can be taken, or where it is imported the import price can be taken. These prices should then be corrected for taxes and subsidies (i.e. the former should be deducted and the latter added).

Where the good is not traded, the shadow price should be calculated on the basis of the cost of producing the good with the inputs being valued at their economic opportunity cost. A method for doing this has been developed by Little and Mirrlees (1974), Ray (1984) and Squire and van der Tak (1975), and subsequently used by several researchers to estimate shadow prices in a number of developing countries.

When applying this framework to a project (e.g. wind powered irrigation for increased agricultural yields) three important shadow prices are typically required. They are the prices of capital, labour and foreign exchange. For these, detailed analysis of the relevant sectors is required. The prices of labour is dealt with in Section 7. For capital and foreign exchange, the analyst carrying out a GHG estimation is advised to obtain the relevant values from economists who have worked on the sectors concerned. The World Bank and other bodies involved with Global Environment Facility (GEF) projects appraise projects in most developing countries and would have a set of values that are used; these can presumably be accessed from their databases (as can the shadow prices for many inputs and outputs). For example, in the case of India, the Institute of Economic Growth in New Delhi has recommended a coefficient value of 1.4 for capital, materials and equipment, but a value of one for foreign exchange. The value of 1.4 indicates that capital is 40 percent more scarce than its market price would suggest, so that when estimating the costs of the project the capital value should be increased by that amount. A value of one for foreign exchange implies that the exchange rate is in market equilibrium and there is no need to make any other