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Journal of Cleaner Production 13 (2005) 57–70
Journal of Cleaner Production
www.elsevier.com/locate/jclepro

Cleaner production as climate investment—integrated assessment in Taiyuan City, China

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Received 6 March 2003; accepted 21 August 2003

Abstract

Taiyuan, one of the most polluted cities in the world, is the first cleaner production demonstration city in China. We assess energy related cleaner production projects in Taiyuan from the point of view of climate change and integrated assessment. In the assessment we develop a rather detailed methodology that relies on a battery of chained models All of the projects improve energy efficiency and reduce emissions. Still, we find that their environmental health benefit differs substantially. The projects are treated similarly from point of view of funding and the regularatory process. Yet, we find that their cost differs substantially, and there is no proportionality between costs and benefits. The finding could supplement explanations of cleaner production progress that rely on financial and institutional barriers. We also ask if the positive attitude to cleaner production in China may help the country introduce greenhouse gas saving projects under another name. It turns out that some, but not all of the projects we analyse have significant greenhouse gas reduction potential. The possibility for foreign funding as CDM projects is discussed.

Keywords: Environment; China; Co-benefit; Integrated assessment; Climate; CDM

1. Introduction

It is well known that greenhouse gas reducing investments can yield additional environmental benefits, sometimes called co-benefits ([1]; [4], [11]; [15]; [22]; [24]; [42]). These benefits may be especially large in developing countries. However, the methodology for estimating co-benefits of greenhouse gas reducing investments, called integrated assessment, is crude at some points. Using refined methodology this paper adds new evidence to the literature on integrated assessment of greenhouse gas reducing investments in the developing world.

Specifically, our objective in this paper is to estimate co-benefits of specific cleaner production projects in Taiyuan, the capital of Shanxi Province, China. Cleaner production projects improve production efficiency and eliminate waste within the process rather than at the end of pipe. Such projects are well suited for studying the co-benefits of greenhouse gas reductions since they tend to emphasize energy efficiency, technological upgrading and other measures that cut across a range of pollutants including CO_2, particle emissions and SO_2. But cleaner production projects are also interesting in a political perspective. They tend to receive rather more positive attention in the developing world than projects that go by the name of climate change. For instance, an international declaration on cleaner production has more than 1700 signatories, of which most are from the developing world. Twenty-four developing and transition countries, including China, India and other traditional climate skeptics, have at the moment established National Cleaner Production Centers to promote the practice of cleaner production [37]. If one can show that some cleaner

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doi:10.1016/j.jclepro.2003.08.005

production projects are climate change projects by another name that even bring substantial co-benefits, it may remove some of the reluctance to climate change abatement that is found in developing countries.

Also, since cleaner production projects often reduce emissions of greenhouse gases they could be eligible for international funding through the Clean Development Mechanisms (CDM) of the Kyoto protocol. In order to qualify for such funding the projects must contribute to sustainability. The NGO community, especially, is eager to follow up on this point (see e.g., [18]). For these reasons as well, emphasizing co-benefits is essential.

The co-benefits that we estimate are compared to our estimate of ordinary costs. It is sometimes claimed that cleaner production projects are low-cost or no-cost options with a large benefit potential. It is the hope generated from such claims that is driving the establishment of Cleaner Production Centers in many countries. Yet, at least in China, implementation of cleaner production projects has been somewhat slow. This could indicate that project costs are higher than imagined, or it could indicate credit barriers or other barriers of an institutional nature. In any case it makes the costs of cleaner production projects an interesting object of study in its own right.

To discuss the co-benefits of cleaner production projects in relation to costs and CO_2-potential we rely on the impact pathway approach to environmental benefit estimation. This bottom-up approach estimates the monetary equivalent of environmental benefits. Starting from emission reductions associated with projects, and using a chain of models, one is moving forward towards end-points of physical health damage with associated monetary values. Adding over the end-points gives total monetary co-benefit. Subtracting the monetary value of environmental benefits from costs gives the net costs of CO_2 reductions related to cleaner production projects.

The impact pathway approach is becoming increasingly popular in studies of environmental improvements in China and elsewhere. Early forerunners include the ExternE project ([13], [14]) and the U.S. EPA project on the benefits and costs of the clean air act ([38], [39]). However, in China the physical and economic conditions are different from those in the US or Europe. An early application in China is Aunan et al. [4] who used the impact pathway approach to study clean coal technologies in Shanxi Province. Compared with Aunan et al. we consider specific projects planned or under implementation in Taiyuan and refine the model of air pollution dispersion. One advantage of this refinement is to analyze the distinction between low-stack and high-stack emissions, which turns out to matter a great deal for the co-benefit outcome.

The paper is structured as follows. Section 2 briefly reviews the environmental status of Taiyuan and the Cleaner Production programme there. Section 3 describes our approach and methodology. The methodology is applied to six representative cleaner production projects in section 4. Our conclusions are given in section 5.

2. Taiyuan: Environmental status and cleaner production plans

2.1. Environmental status of Taiyuan

Taiyuan City, the 3 million metropolitan area that is the capital of China's Shanxi Province, is generally recognized as one of the most polluted cities in the world. China's State of the Environment Report for 1999 [32] classifies it as the most polluted city in China. In 1998 the average annual concentration of SO_2 and TSP (total suspended particulates) was 278 $\mu g/m^3$ and 498 $\mu g/m^3$ respectively. These concentration levels are approximately five times higher than the thresholds for health risk set by the WHO and the EU. By year 2000 measured SO_2 concentrations had fallen to 200 $\mu g/m^3$ and measured TSP concentrations to 400 $\mu g/m^3$, but the situation is quite volatile and measurements are uncertain [16].

The reasons for Taiyuan's pollution problems may be found in the fact that more than 3/4 of industrial GDP is from polluting, heavy industries. The extent of state owned enterprises with old-fashioned technology and low productivity also matters. More than half of production is from state owned enterprises, and three quarters of urban workers of Taiyuan work in these enterprises ([27]; [33]). As a third factor industrialization in rural areas has increased coal consumption in town and village enterprises resulting in high emissions encircling the city.

It also adds to Taiyuan's pollution problems that the city is located in a basin surrounded by mountains on three sides and frequent inversions and low wind velocities enhance the concentrations of pollutants. The climate is dry and dust-mixed winds worsen the pollution problem [36].

2.2. Cleaner production in Taiyuan

In one of the efforts to improve the environmental situation, Taiyuan in 1999 became China's first cleaner production demonstration city. To implement its cleaner production program, Taiyuan intends to invest 1.5 billion Yuan (180 million USD) over the years to come. So far most of the projects are still at the planning stage, but some have recently secured funding. In addition to investment projects, the cleaner production campaign in Taiyuan, like in many other cities, has emphasized workshops for city officials and leaders, setting up cleaner production working groups in selected demonstration enterprises and developing local legislation for cleaner