VALUATION OF HEALTH BENEFITS OF WORLD BANK GUIDELINES FOR AIR EMISSIONS IN THERMAL POWER PLANTS

by

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CERTIFICATE

This is to certify that the thesis entitled **"Valuation of health benefits of World Bank guidelines for air emissions in thermal power plants"** being submitted by **Mr. Arun Kansal,** has been prepared under our supervision in conformity with the rules and regulations of the **Indian Institute of Technology, Delhi**. We further certify that the thesis has attained a standard required for the award of a degree of **Doctor of Philosophy** of the institute. This work, or any part thereof, has not been submitted elsewhere for the award of any other degree or diploma.

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ABSTRACT

Amongst all the infrastructure project investments, power sector has got the highest priority in India. The major share amongst the new capacity will be from coal and gas based thermal power plants (TPPs). Many of the TPPs are likely to come up near urban areas, posing a threat to the ambient air quality. As a part of its pollution prevention and abatement handbook, the World Bank (WB) has proposed environmental guidelines for the TPPs (http://inweb18.worldbank.org). The guidelines postulate adherence to maximum plant emission levels for achieving the site-specific emission standards. Proposed WB emission guidelines (WBEG) are specifically directed towards protecting the human health, reducing mass loading to acceptable levels, achieving emission standards based on commercially proven and widely used technologies and following the current regulatory and technological trends. The WBEG are stricter than the existing Central Pollution Control Board (CPCB) standards in India. Therefore, the implementation of WBEG may impose significant cost on TPPs in India. These costs may be fairly high (TERI, 1998) and therefore require justification for adoption by estimating *benefits* associated with these investments.

The study estimates the marginal health (morbidity) *benefit* of air pollution control in Delhi and the total health *benefits* of the regulatory intervention viz. adoption of the WBEG by TPPs of Delhi. The study is directed towards estimating the economic value of improving air quality. The study employs emission inventory and source apportionment techniques using industrial source complex- short term version-3 (ISCST3) for *point*, *area* and *line* sources to estimate the air pollution contribution

by TPPs. Synthesis of the literature and primary data collection for all elements of the *causal* chain of health risk has been performed.

Household health production function (*avertive behaviour*) has been used to value health cost of air pollution. The model requires the estimation of three simultaneous equations: household health production function, household *demand* functions for *mitigation* activities, and *avertive* activities. Primary survey has been done to collect the data regarding the health status, socio-economic and structural characteristics of households, awareness of households about effects of air pollution, health status (including chronic disease), *mitigating* and *avertive* activities, habits, pollution control measures etc. The effect of the air pollution at key receptors has been assessed for *mitigating* and *avertive* responses of the people.

The ISCST3 model has performed satisfactorily for total suspended particulates (TSP) and nitrogen oxides (NO_x)[1] at all receptor locations in Delhi. However, its performance is unsatisfactory for sulphur dioxide (SO_2) in 5 out of 7 receptor locations. Vehicle sources are found to be the major contributor of TSP and NO_x followed by TPPs. For SO_2, TPPs are the major contributor. A large number of initiatives have been adopted by the Government of India (GoI) for reduction of emissions from vehicular sources; whereas, the emission reduction measures from TPPs have been ignored. The study has revealed that the ambient air pollution due to TPPs is reduced by 62% to 85% all over Delhi by adopting the WBEG.

Annual *marginal benefits* for a representative household in Delhi due to reduction in exposure to air pollution by 1 $\mu g/m^3$ is estimated to be Rs 66.50 (US \$1.4778)[2] which amounts to Rs 15.90 (US \$0.353) per person. This estimate accounts

[1] NO_X as NO_2
[2] US \$1 = Rs 45.00

only for the effects of the improvement in air quality on health (morbidity). Total annual health *benefits* of WBEG for air emissions in TPPs are estimated at Rs 10583.79 billion (US $235.19 million) lower than the value estimated by Brandon, Hommann and Kishore (1995) which is in the range of US $86.40 to $216.13 per household for India. Their estimates are based on mechanical dose-response functions drawn from epidemiological studies done in developed countries.

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