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Estimation of carbon baselines for power generation in India: the supply side approach

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Abstract

In this paper, attempt has been made to develop framework for estimating realistic baseline for carbon emissions from power generation in India till the end of the Eleventh Five Year Plan Period (2010–2011). This is done through development of a realistic generation plan till 2010–2011, taking into account new Greenfield projects, capacity augmentation/addition plans and commissioning schedule of new projects and incorporating the impacts of government imposed norms for energy conservation in baseline estimate. Such a supply side framework for estimation of baselines is useful for developing countries like India where the electricity markets are supply constrained. Also, the paper demonstrates the evaluation of additional emission reductions over and above the business as usual baseline by identification and quantification of future possibilities of changes in specific coal consumption and auxiliary consumption of around 70 existing thermal power plants using data envelopment analysis (DEA).

Keywords: Baselines; Power sector; India

1. Introduction

Electricity generation accounted for 37% of the global energy related CO_2 emissions in 1998 (IEA, 2000a). According to estimates made by the International Energy Agency (IEA), growth in power generation is expected to be significant from 1997 to 2020, averaging 2.6% p.a. for transition economies and 4.1 percent p.a. for developing countries (IEA, 2000b). In India, electricity consumption has more than doubled in the past one decade. While economic growth was around 5.5% per annum in 1990–1997, electricity consumption grew at 7% per annum.

In absolute terms, India is the world's sixth largest emitter of energy related CO_2, contributing to 3.3% of world CO_2 emissions. With development, the composition of India's energy consumption is shifting more from primary fuels towards transformed energy sources, viz. electricity. India's major source of power is thermal power plants, mainly because of India's abundant domestic reserves of coal.[1] In 1998 India's installed generation capacity was 101154 MW of which 72% was thermal and 60% was coal-based thermal. India's energy-related emissions have been growing rapidly, almost doubling between 1980 and 1990 and power generation is considered to be one of the largest emitting sectors of the economy. Accordingly, it is important to develop carbon emission inventory, databases and models through which the effectiveness of carbon mitigation projects can be appropriately estimated for the power generation industry.

The power sector has a larger scope of hosting efficiency improvement projects and is relatively well suited to benchmarks pertaining to technology and efficient norms of energy consumption (Tellus Institute, 1999). There is significant potential for emission reduction in power sector if developing countries like India adopt different policies and planning methods for

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[1]India is the third largest producer of coal in the World after China and USA with total coal reserves of around 200 billion tons.

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power generation. Implementation of new technologies, other than those included in business-as-usual (BAU) projections can also produce lower emissions. Different types of electricity projects can be undertaken in the context of the Kyoto mechanisms, like the following:

1. Installing a new plant (i.e. greenfield);
2. Renovation and modernization of old plants;
3. Fuel switching which might require minor or major replacement of equipment;
4. Housekeeping-type projects, like improvement of processes that do not involve installing generation equipment; and
5. Alternative models of efficient generation such as cogeneration.

However, many of the above initiatives have already been undertaken in India without any investments under clean development mechanism (CDM)/joint implementation (JI) framework. In addition, some autonomous efficiency improvements can be expected in power generation over the future years. Hence, one needs to exercise caution while developing BAU reference case for future carbon emissions. This paper makes attempts to develop a framework for baseline estimation for the Indian power sector and also to study the range within which future emissions from power generation and consumption in the country will realistically lie.

Institutions like the Organization for Economic Co-operation and Development (OECD), IEA, the US Environmental Protection Agency (USEPA), US Department of Energy, the United Nations Environment Program (UNEP) and others have sponsored research and case studies to develop alternative methods of electricity baselines (OECD/IEA, 2000; Ellis and Bosi, 1999; Sathaye et al., 2001; Lazarus et al., 1999, 2000). These reports have raised a number of issues related to standardization of baseline, validation of baselines, geographical aggregation, dynamics and stringency. The findings of the various reports clearly indicated "a clear need for more work and discussions in order to reach concrete baseline recommendations for different types of possible JI and CDM projects".

A key difficulty in operationalizing the mechanism of CDM lies in ensuring that the carbon emission mitigation from a project be "additional" to the levels achieved in normal "BAU" condition. Here the BAU condition would imply the scenario "which would have happened anyway". The key question is: how can we know that a project will produce "reductions in emissions that are additional to any that would have occurred in the absence of the certified project activity"? (Article 12 of the Kyoto Protocol). Clearly to assess additionality, it is imperative to establish a BAU case capturing events that would have happened anyway. Such a case would give BAU emission baseline. It is important to note that such a baseline is essentially a prospective estimate of projected level of emissions and hence would be computed using the BAU level of prospective policy, operational, regulatory parameters and prospective techno-commercial state of business.

The current study proposes a supply side framework for estimation of BAU carbon emission baselines from power generation in India. While it is common to use the demand side framework to estimate the baselines, supply side framework is particularly useful to developing countries like India where energy markets are supply constrained. To the extent that it is necessary to capture BAU conditions in a baseline, Government of India "GoI" norms have been used for the input parameters that feed into the computation of emission levels. Once a BAU baseline has been determined, such a framework enables evaluation of additionality of specific carbon mitigating projects. To demonstrate this, the possibility of "additional" emission reduction has been explored in the same framework by deriving best practice frontier[2] of primary fuel consumption and auxiliary consumption involved in power generation.

The current study would help in calculating additionality of any investment targeted at reduction in emissions and the framework proposed in the study may be used for baseline estimation by the investing country.

Future carbon emissions can be estimated in a number of ways and taking into account a number of parameters. Also, projects in the power sector encompass activities that would either affect power supply or demand, including new generating units, retrofits at existing facilities, off-grid electricity provision, energy efficiency and cogeneration installations. In this paper, the trajectory of carbon emissions in the Indian power sector is evaluated from the supply side of the market using detailed data for capacity addition plans in the existing power plants and installation of new power plants, considering the ongoing and upcoming capacity expansions plans of central and state government utilities as well as other greenfield projects of independent power producers (IPPs) till the end of the Eleventh Five Year Plan period (2011–2012). Indian power markets are generally supply constrained. Therefore, the emission baselines or the trajectory of future carbon emissions from power generating industries needs to consider both supply side factors as well as demand side factors.

It is widely recognized that improving the management and operational practices and strengthening and upgrading the physical infrastructure of power generation and supply systems can contribute to the much-needed reductions in emissions. It was found on the

[2]As has been demonstrated later in the paper, the current GoI norms are liberal than the best practice level.