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## International Trading of Emission Rights

### Its Implications for Low-Carbon Growth in India

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#### INTRODUCTION

Developing countries, including India, have been absolved of any responsibility towards reducing emissions in the first commitment period, that is, 2008–12, of the Kyoto Protocol. This is not surprising as India's per capita carbon dioxide (CO<sub>2</sub>) emission is very low: only 1.36 tonnes per annum, which is less than one-third of the world average per capita emission of 4.39 tonnes per annum.<sup>1</sup> However, in absolute terms, India is the fifth largest emitter of fossil fuel-derived carbon dioxide, and its total emissions are growing rapidly. India is now under severe international pressure to accept binding commitments for emission reduction in the post–2012 phase of the Protocol, which it has managed to evade for the time being, as evinced at Copenhagen in December 2009. Interestingly, however, realization has deepened among social commentators, activists, and even policymakers that it would be in India's own interest to aspire and plan for a low carbon economic growth in the coming three or four decades. This chapter is inspired by this view, even though it deals with the implications for international trading of emission rights for India.

The Kyoto Protocol includes three mechanisms, namely (i) international emission trading (IET), (ii) Joint Implementation (JI), and (iii) Clean Development Mechanism

(CDM) to achieve GHGs emissions reduction most efficiently, that is, in the least cost manner. The latter two are referred to as 'project-based mechanisms' in that they generate emission reductions from projects. The difference between IET and the project-based mechanisms is that the former is contingent upon the setting of a quantitative restriction on emissions, while the latter are predicated on the idea of 'production' of emission reductions (regardless of whether there are emissions reduction targets or not). The JI has been formulated to encourage production of emission reductions in Annex-I (developed) countries,<sup>2</sup> while CDM is meant to promote production of emissions reduction in non-Annex-I (developing) countries. The development and operation of qualified CDM projects produces Certified Emissions Reductions (CERs) for the actual amount of emissions reduction achieved in the host developing country, which can be sold privately (voluntary primary market) or traded internationally in the secondary carbon emissions market.

However, notwithstanding the overlap across the three mechanisms, we are concerned here exclusively with cap-and-trade under IET. As of now, IET is of concern to Annex-I countries only. But it is most unlikely that the situation would remain that way, that is to say, the way

<sup>1</sup> These figures are taken from World Bank (2010).

<sup>2</sup> Annex-I countries refer to the OECD countries, the countries in Central and Eastern Europe, and the Russian Federation, which have agreed to emissions reduction obligations under the Kyoto Protocol. The specific emissions reduction commitments of these countries are listed in Annex-I of the Protocol, hence they are referred to as Annex-I countries.

climate policy stances of the Annex-I and the non-Annex-I countries are evolving, the latter group of countries will not remain mere bystanders for long. Indeed, in all likelihood, the developing countries would have a major role to play in the ongoing negotiations on climate change. As Chander (2004) cogently argues, 'they (developing countries) have a stake in the ongoing negotiations on the form and mechanism of emission trade. The negotiations on climate change should ultimately aim at fixing pollution rights or entitlements for each country according to some agreed upon equity principles, and the Kyoto Protocol can be and may be viewed as a step in this direction.' In other words, once emissions trade among Annex-I countries is institutionalized, the developing countries will be able to better assess the potential gains from such trade, and might be tempted to participate in a global emissions trade in the post-Kyoto phase of climate change negotiations.

If India were to participate in a global regime of tradable emission permits, how would the consequences for its economic and infrastructural growth be affected by the different modes of emission entitlements and what role can internal policy play in maximizing (or minimizing) the resulting gains (or losses)? Informed discussions are already taking place in Indian policy circles around this question. This chapter attempts to further analyse and estimate the *pros* and *cons* of the two main modes of allocation of emission permits, which represent the two opposing extremes of the range of emissions allocation schemes, which would most likely form the subject matter of a negotiation between the developed and developing countries. These two options at the extreme ends of the range of emissions allocation schemes are:

- Grandfathered Emissions Allocation (GEA) Scheme in which emission permits are allocated on the basis of the aggregate emissions level of a predetermined year (that is, the benchmark year), say 2010—which is 1546.44 million tonnes. Hence, under this scheme, the quota for aggregate emissions for each of the years in the period, 2010–40 is 1546.44 million tonnes, and
- Equal Per Capita Emissions Allocation Scheme (EPCEAS) in which the aggregate emissions entitlements for India for all the years are fixed at the level arrived at by multiplying the average global per capita emission (4.39 tonne per capita) with India's population for a benchmark year, say 2010—which is 1175.22 million. Specifically, this implies an aggregate emissions entitlement of 5159.22 million tonnes, that is,  $4.39 \times 1175.22$ —of CO<sub>2</sub> emissions for each

of the years in the period 2010–40. It may be noted that by taking a *given* average global per capita emission and by applying the 2010 population figure to each of the future years, the aggregate emissions allocated is maintained at an unchanged level over the years. Such a *static* equal per capita emissions allocation scheme would, as argued by Parikh and Parikh (1998), ensure equity between the developed and developing countries, and, simultaneously discourage the latter from allowing unrestrained growth in their populations.

It is well known that the developed countries favour the GEA scheme. However, it is morally perverse (Joshi and Patel 2009), and, as we shall see, economically extremely damaging to the growth and poverty-reduction objectives of the developing countries (for example, India). Naturally then, the developing countries have been vehemently opposed to it.

The developing countries, particularly China and India, are ardent advocates of the EPCEA scheme. The EPCEA is morally principled, and as we shall see, also hugely beneficial to the growth and poverty-reduction objectives of the Indian economy. But it is consistently opposed by the developed countries, which typically have high per capita emission and would, under the EPCEA regime, have to purchase permits from the developing countries, most of whom have low per capita emission. Annex-I countries would thus end up yielding massive financial transfers to the developing countries under such a scheme. In other words, EPCEA, despite being ethically unassailable, may not be politically feasible.

From India's viewpoint, the two emissions allocation schemes, GEA and EPCEA, correspond respectively to the lower and upper bounds on the gains from participation in a global regime of tradable emission permits. Obviously then, a quantitative assessment of the lower and upper bounds of the range of outcomes emanating from India participating in an IET regime would be a valuable policy input.

Moreover, the role of a key internal (domestic) policy, namely, enhancing energy efficiency in the economy, which can run concurrently and complementarily with India's participation in IET, needs to be understood.

This chapter, therefore, analyses the impact of India's participation in IET with GEA and EPCEA on carbon emissions, GDP, infrastructural development, and poverty in the Indian economy for a 'normal' and then an 'enhanced' rate of energy-efficiency improvement (EEI), with the help of a neoclassical type price-driven Computable General Equilibrium (CGE) model capable

of endogenously determining poverty, which is a major consideration in India. Additionally, with a view to drawing concrete policy implications, the chapter goes beyond the analysis of the modelling results, and specifically delves into the question of how much untapped potential there is in the Indian economy for the enhanced EEI assumed in select policy scenarios.

The rest of the chapter is organized as follows: an analysis of the results of four relevant policy scenarios with reference to the business-as-usual scenario, all developed through a CGE model of the Indian economy. This is followed by expounding on the issue as to how tangible measures can be undertaken to achieve increases in energy efficiency, and thus a low-carbon growth in India. The chapter concludes with suggestions related to policy implications of the results of the four relevant policy scenarios. The Appendix furnishes the data tables related to the policy scenarios.

### MODELLING THE POLICY SCENARIOS

A detailed description of the 11-sector CGE model used to generate the relevant policy scenarios mentioned here can be found in Ojha (2009).<sup>3</sup> Technical details, such as, equations of the model, parametrization, and data collection for the model, are furnished in Appendices 2 and 3 of Ojha (2005).

The CGE model for this analysis employs the basic data of the Indian economy for the year 1989–90, which have been sourced from the CSO–NAS<sup>4</sup> and the CSO–IOTT.<sup>5</sup> Other parameters and initial values of different variables have been estimated from the data available in various other published sources.<sup>6</sup>

Still other parameters such as the technological and the distribution parameters of the production functions employed in the CGE model are estimated using the method of calibration. The calibration method is a commonly used deterministic approach for calculating selected parameter values from a single-period benchmark ‘equilibrium’ data set.<sup>7</sup> Through calibration, certain model parameters are estimated in a CGE model on the basis of a single observation. While this is a definite shortcoming

of this approach, the overwhelming advantage is that it enables the replication of the benchmark equilibrium data set, which is required for the validation of the CGE model solution (Shoven and Whalley 1992).

A difficulty was encountered in finding a reliable estimate for the rate of EEI in the Indian economy. Energy-saving technological progress is incorporated in our model by making the autonomous energy efficiency improvement (AEEI) assumption used in other carbon emission reduction models, such as General Equilibrium Environmental Model (GREEN); (Burniaux et al. 1992) and Emissions Predictions and Policy Analysis (EPPA); (Babiker et al., 2001).<sup>8</sup> As in the EPPA and GREEN models, we also assume that AEEI occurs in all sectors except the primary energy sectors (coal, crude petroleum, and natural gas) and the refined oil sector. The GREEN model assumes a one per cent annual increase in energy efficiency, while in the EPPA model there is an even higher annual growth rate of energy efficiency, that is, 1.4 per cent initially, though it slows down over time according to a logistic function. However, we followed the GREEN model in assuming one per cent annual increase in energy efficiency, and found the model solution approximating reasonably well the observed data on sectoral and economy-wide energy use.

Finally, a sequence of equilibria based on a time series data of the exogenous variables—two primary ones being the aggregate real investment and the available labour supply—of the model is obtained for the period 1990–2040. From the sequence of equilibria, the growth paths of selected variables of the economy—such as, GDP, aggregate consumption, sectoral outputs, CO<sub>2</sub> emissions, and poverty ratio—with five-year time intervals, are delineated to describe the business-as-usual (BAU)/reference scenario. The policy scenarios are then evaluated with respect to the BAU scenario.

Using our Computable General Equilibrium model, we develop alternate policy scenarios for India’s participation in IET under GEA and EPCEA, firstly, with normal (1.0 per cent) and, secondly, with enhanced (1.2 per cent) annual rates of growth in AEEI, for the 30 year

<sup>3</sup> There are five energy (infrastructural) sectors—electricity, coal, refined oil, natural gas, crude petroleum and six non-energy sectors—agriculture, transport, energy-intensive goods, other intermediates, consumer goods, and services.

<sup>4</sup> Central Statistical Organization—National Accounts Statistics (CSO–NAS) of India, various issues from 1989–90 to 1992–3.

<sup>5</sup> Central Statistical Organization (1997: Input-Output Transactions Table 1989–90) (CSO–IOTT).

<sup>6</sup> Full information on the data sources is available in Appendix 3 of the author’s SANDEE working paper (Ojha 2005).

<sup>7</sup> Note that the data reported for the Indian economy in the CSO–NAS and CSO–IOTT are assumed to be representing equilibrium flows for the concerned year.

<sup>8</sup> Note GREEN and EPPA are respectively acronyms for General Equilibrium Environmental Model and Emissions Prediction and Policy Analysis.

period, 2010–40. In all, there are four policy scenarios, as mentioned earlier.

For the policy scenarios 1a and 1b, concerned with GEA, the emission quota is fixed for all the years at the (aggregate) emissions level of the year 2010, which is 1546.44 million tonnes at the annual rates of AEEI at 1.0 per cent and 1.2 per cent respectively. For the policy scenarios 2a and 2b, concerned with EPCEA, the emissions are capped for all the years at 4.39 tonnes per capita using the population in the benchmark year 2010, which amounts to an aggregate emissions level of 5159.22 million tonnes again at the annual rates of AEEI at the same per cent figures already mentioned earlier.<sup>9</sup>

The four policy scenarios are summarized in Table 9.1 given below.

It follows that, while the policy scenarios 1a and 2a are instrumental in defining the lower and upper bounds of the outcomes possible from India's participation in IET, the policy scenarios 1b and 2b serve to delineate what we may term as the augmented lower and upper bounds of the same.

### Policy Scenario 1a

In this policy scenario, India participates in international emissions trading with GEA. Hence, its emissions quota is fixed at 1546.44 million tonnes—which is the 2010 level of CO<sub>2</sub> emissions in the BAU scenario—for all the

years in the period 2010–40. However, there is scope for going beyond this limit through purchase of emission permits in the international market at the prevailing world market price, which would in effect induce a transfer of wealth out of India. In this scenario, India is a net buyer of tradable permits throughout the period, that is, 2010–40, as its CO<sub>2</sub> emissions after 2010 are far in excess of the fixed quota of 1546.44 million tonnes. Expectedly, GDP will decline as compared to the BAU scenario.

The GDP loss in scenario 1a relative to the BAU scenario over the 30 year period is in the range of 2.40 to 3.60 per cent. Taking a (simple) average of 30 years, GDP declines by 2.69 per cent (Table 9A.1). Infrastructural requirements diminish, and, therefore, outputs of the infrastructural sectors—electricity, coal, refined oil, natural gas, crude petroleum, and transport—decline over the 30-year period in the range of 2.5 to 5.5 per cent (Table 9A.2). Poverty increases significantly in scenario 1a. The number of poor people will increase by 3.11 per cent in 2015 and by 7.01 per cent in 2040 (Table 9A.1). For the whole 30-year period, the cumulative emissions will decline by 5.09 per cent (Table 9A.3).

In short, there are high costs imposed on the Indian economy due to losses in GDP, infrastructural outputs, and poverty reduction in case of its participation in IET with GEA based on India's 2010 emissions level.

TABLE 9.1 The Policy Scenarios

	<i>Annual Rate of Energy Efficiency Improvement (in per cent)</i>	<i>Policy Instrument</i>	<i>CO<sub>2</sub> Emission Restriction</i>
Policy Scenario 1a (GEA)	1.0	Internationally Tradable Permits	Total CO <sub>2</sub> emissions fixed at the 2010 level of emissions
Policy Scenario 2a (EPCEA)	1.0	Internationally Tradable Permits	4.39 tonnes CO <sub>2</sub> of per capita (population of benchmark year 2010)
Policy Scenario 1b (GEA)	1.2	Internationally Tradable Permits	Total CO <sub>2</sub> emissions fixed at the 2010 level of emissions
Policy Scenario 2b (EPCEA)	1.2	Internationally Tradable Permits	4.39 tonnes CO <sub>2</sub> of per capita (population of benchmark year 2010)

*Note:* Carbon emissions are (12/44) times the carbon dioxide emissions.

<sup>9</sup> To capture sensitivity of results to different permit price levels, each of the four scenarios are worked out for two alternate exogenously given permit price levels—(a) US\$20 and (b) US\$30 per tonne of carbon dioxide emitted, which is Rs 332 and Rs 498 per tonne respectively at the 1989–90 exchange rate of Rs 16.60 per dollar. But the results of the four scenarios—1a, 2a, 1b, 2b—reported here are for the permit price equal to US\$20 per tonne of carbon emitted. In reality, the permit price will be determined within a global trading system of permits, which, for example, has been modelled by Ellerman et al. (1998) or by Edmonds et al. (1993) in the Second Generation Model (SGM). However, ours is a country-specific model concerned with how India is poised to gain or lose from an internationally tradable permits regime. Moreover, under the 'small-country' assumption, India's sale or purchase of permits does not affect the latter's world market price. For India, therefore, the world market price of permits can be treated as exogenously given (Fisher-Vanden et al. 1997 and Murthy et al. 2000).

### Policy Scenario 2a

In this scenario, India participates in international emissions trading in partnership with EPCEA. Hence, the per capita carbon emission quota is fixed at 4.39 tonnes. This translates into an aggregate emission quota of 5159.22 million tonnes (that is, 4.39 times the 2010 population of 1175.22 million) for each of the 30 years, 2010–40.

The precise procedure followed in this scenario is to fix an upper limit of 5159.22 for total emissions. However, the upper limit on emissions becomes binding only in 2032 in this scenario. Till then, India has surplus emission permits which it sells in the international market. This leads to a transfer of wealth into India, which in turn boosts GDP and poverty reduction. Beyond 2032, the Indian economy turns around from being a seller to a buyer of emission permits in the international market. However, the GDP continues to be higher in comparison to those of the BAU scenario, even after this turnaround. This is mainly due to the higher capital stock with which the economy is endowed as a result of cumulatively larger accretions to this stock over the years in scenario 2a.

The gross domestic product gains in scenario 2a relative to the BAU scenario over the 30-year period are in the range of 5.50 to 10.00 per cent. Taking the average for 30 years, GDP increases by 7.44 per cent (Table 9A.1). Infrastructural requirements increase, and, therefore, outputs of all infrastructural sectors rise over the 30-year period in the range of four per cent to 10 per cent (Table 9A.2). Poverty decreases significantly in scenario 2a. The percentage of poor people will decrease by 6.36 per cent in 2015 and by 1.62 per cent in 2040 (Table 9A.1). For the whole 30-year period, the cumulative emissions will increase by 6.18 per cent (Table 9A.3).

Further, India stands to gain substantially in terms of the gross domestic product, infrastructural development, and poverty alleviation, while maintaining its CO<sub>2</sub> emissions below the stipulated maximum till 2032.

### Policy Scenario 1b

In this scenario, India participates in international emission trading with GEA, and concomitantly, enhances the energy efficiency in the domestic economy, so that the annual growth rate of energy efficiency increases from 1.0 per cent (which prevailed in the scenario 1a) to 1.2 per cent. Expectedly, GDP and other losses in this simulation will be of lower orders of magnitude, in comparison to policy scenario 1a.

The gross domestic product losses in scenario 1a relative to the BAU scenario over the three decades, 2010–40, are

in the range of 2.00–3.00 per cent. Taking the average for 30 years, GDP declines by 2.25 per cent (Table 9A.1). Infrastructural requirements diminish, and, therefore, outputs of all infrastructural sectors—electricity, coal, refined oil, natural gas, crude petroleum, and transport—decline over the 30-year period in the range of 2.25 per cent to 3.50 per cent (Table 9A.2). Poverty increases significantly in this scenario and the number of poor people increases by 3.04 per cent in 2015, and by 5.32 per cent in 2040 (Table 9A.1). For the three decades, the cumulative emissions decline by 24.49 per cent (Table 9A.3).

### Policy Scenario 2b

In policy scenario 2b, India participates in international emissions trading with the EPCEA scheme, and simultaneously, boosts its growth rate of AEEI from 1.0 per cent per annum (which prevailed in scenario 2a) to 1.2 per cent per annum. So, in effect, this simulation is nothing but a bolder version of simulation 2a. Significantly, the Indian economy remains a seller of emission permits in the international market all through the three decades, 2010–40, in scenario 2b.

The gross domestic product gains in this scenario relative to the BAU scenario over the three decades is in the range of 7.00–10.00 per cent. Taking the average for 30 years, GDP increases by 8.10 per cent (Table 9A.1). Infrastructural requirements increase, and, therefore, outputs of all infrastructural sectors—electricity, coal, refined oil, natural gas, crude petroleum, and transport—rise over the 30-year period in the range of 5.5 per cent to 10.0 per cent (Table 9A.2). Poverty decreases significantly in this scenario. The percentage of poor people decreases by 6.41 per cent in 2015, and by 3.79 per cent in 2040 (Table 9A.1). For the 30-year period, the cumulative emissions decrease by 15.90 per cent (Table 9A.3).

## AN APPRAISAL OF POLICY SCENARIOS

From the results of scenarios 1a and 1b, it follows that the lower bound and the augmented lower bound of (average) GDP gains from India's participation in IET are -2.69 per cent and -2.25 per cent respectively. The inference which is unequivocally implied is that India should shun outright any persuasion to partake in international emissions trading based on grandfathered emissions allocation.

Likewise, according to the results of scenarios 2a and 2b, the upper bound and the augmented upper bound of (average) GDP gains from India's participation in IET are 7.44 per cent and 8.10 per cent respectively. Clearly then, India should look forward to join IET with EPCEA.

Apart from the gross domestic product gains involved, another important aspect of the outcomes of the policy scenarios is the decline in carbon emissions achieved. In this regard, scenario 2a fails to a great extent, because the increase in GDP comes with an increase in emissions. Cumulative emissions for the 30-year period increase by 6.18 per cent in scenario 2a. So, scenario 2b is a real winner because not only are the GDP gains higher, but alongside there is a decline in cumulative emissions by 16 per cent. *This is a crucial result of our modelling exercise, because it highlights the paramount importance of the domestic policy of enhancing energy efficiency.* Not only does the latter play a vital role in reducing carbon emissions, but also helps in augmenting GDP gains by prolonging the period for which India remains a net seller of internationally tradable emission permits and allows us a greater bargaining power in any multilateral negotiation.

### Energy-Efficient (Low Carbon) Growth in Infrastructure

In our appraisal of policy scenarios above, especially scenarios 2a and 2b, we have noted that EEI translates readily into carbon savings, thus enabling a low carbon economic (*read* infrastructural) growth, and at the same time enhancing GDP gains from its participation in international trading of emission rights with the equal per capita emission entitlements scheme. Motivated by the need to provide energy security to its people, India has already been engaged in efforts towards the promotion of energy efficiency in its economy much before global warming caused by anthropogenic emissions of GHGs became a burning issue. Hence, what is required under the present circumstances, wherein every nation is beckoned to ostensibly contribute to climate change mitigation, is that India intensifies its prevailing efforts towards EEI. It is, therefore, imperative that we make a broad assessment of the latent potential of EEI in the Indian economy, before drawing the relevant policy conclusions from our modelling exercise. To this we now turn.

Most (95 per cent) of the carbon emissions in the Indian economy are energy-related (Garg and Shukla 2002). At the same time, it is well established by now that coal will remain as the mainstay of India's commercial energy basket through the next two or three decades (TERI 2006; Rai and Victor 2009; and Chikkatur and Sagar 2009). This, however, does not bode well for energy security in the Indian economy because: (i) it is being realized that

India's coal reserves are limited, which will not suffice for the existing and the prospective needs of thermal power plants over their lifetime, say 50 years,<sup>10</sup> (ii) coal prices in the future will rise due to higher cost of extraction from deeper domestic reserves and/or due to increasing import dependence in the most likely eventuality of increasing international coal prices, and (iii) poor quality of Indian coal (owing to high ash and moisture content and low calorific value), which is getting worse over time, resulting in an increasing amount of coal required to produce a given amount of electricity. In other words, the present technology and efficiency of India's thermal power plants is far below the internationally acceptable standards. This is manifested in the existing sub-critical pulverized coal technology of most Indian thermal power plants. It is obvious then that there exists immense scope for improving the energy efficiency and thereby lowering carbon emissions intensity (that is, carbon emissions per unit of output) in thermal power generation in the Indian economy.

The fly-ash contained in the coal mined in India acts as an insulator in the boiler, and reduces the heat transmitted from the burnt coal to the boiler tubes. All this considerably lowers thermal efficiency of the electricity generating process. Even a simple modification in the technique of thermal electricity production such as the use of clean coal, which is coal obtained after beneficiation—a process which filters out the ash content of the coal—will thus lead to a significant improvement in the thermal efficiency.

The clean coal technologies or the advanced thermal power technologies are deservedly high priority items in the policy agenda for energy-efficiency improvement in the Indian economy. It is heartening to note that the process of adoption of more efficient coal-power technologies such as ultra-super-critical (USC) and integrated gasification combined cycle (IGCC) has already begun. With some international cooperation, which India should not shy away from, this process can easily be intensified (Chikkatur and Sagar 2009).

Besides the power sector, there is scope for reducing coal-based energy in various energy-intensive industries such as steel, ceramics, brick kilns, and cement.

Energy security demands that oil-based energy also be economized in India to reduce the latter's high dependence on oil imports. Oil-based energy is mostly employed in the domestic transport sector and fortunately there is considerable scope for saving oil-based energy in this sector. Increasing the share of public transport and

<sup>10</sup> As per the Integrated Energy Policy (IEP) 2030 scenario of GoI (2006).

rail-driven locomotion, usage of alternative fuels such as CNG and energy-efficiency improvements in vehicles would lead to substantial energy savings translating readily into almost commensurate carbon savings.

In the 'residential and commercial' sector too, there exists huge scope for energy-efficiency improvement. Using efficient motors in space conditioning and replacing light bulbs and tube lights with CFLs will go a long way towards energy savings and consequent carbon savings. While desirable change in this direction is already taking place, the pace of improvement needs to be enhanced, which can be done easily if the government works proactively in the matter.

The above list of technological upgradations and improvements for enhancing energy efficiency is by no means exhaustive, but it does represent the larger part of the feasible set of energy-saving (climate-friendly) technological policy options in India.

A related question in the matter of energy-efficiency improvement is whether energy sector reforms are consistent with the effort directed towards technological upgradation with a view to boosting energy efficiency. The answer to this question is, in our view, in the affirmative.

Oddly, energy efficiency in India is found to be improving even in the pre-reform era—from 1970s to the 1990s—when state monopoly in production and underpricing of electricity was the order of the day. Measured in terms of \$PPP, energy intensity in India declined from 0.28 toe/\$1000 of GDP in 1980 to 0.19 toe/\$1000 of GDP in 2002, a decrease of approximately two per cent per annum, which exceeds the world average reduction in energy intensity of 1.5 per cent during the period 1980–2002. Clearly, energy efficiency in this period was rising despite (and not because of) the bureaucratic control and management of the exclusively government-owned power sector. The decline in energy intensity in the country since 1970–71 (which got accelerated during the 1980s) has been in a large measure due to the increase in the share of commercial energy *vis-à-vis* non-commercial energy in total energy consumption. On an average, commercial energy sources are at least twice as efficient as non-commercial sources in the delivery of energy services. Moreover, the increasing service orientation of the Indian economy has contributed significantly to the decline in energy intensity (Ahluwalia and Goyal 2009).

It follows that if the trend of EEI was an ascending one within an energy sector subjected to all kinds of commands and controls all through the 1980s and 1990s, then with the initiation of reforms with the (new) Electricity Act, 2003 by the Indian Parliament (GoI

2003), the future in India holds in store even greater scope for EEI. It may be mentioned here that many critics of the reforms in the power sector do not tire of pointing out that these reforms do not go far enough to usher in a market-oriented environment in which efficiency is automatically and irreversibly promoted. But this is an extreme view. The fact of the matter is that, in an acutely energy-deficient economy such as India, the power sector cannot be entirely market-driven. Moreover, realistically speaking, the transition from a state-controlled monopolistic and monolithic power sector to a competitive, forward-looking, and dynamic power sector has to be a gradual one. The new liberalized policy regime for the power sector is after all still an evolving one. It has already taken a major stride forward by envisaging open access, by introducing greater transparency, a level playing field for both public and private enterprises, and by rationalizing the pricing policy for power. All these in themselves portend large gains for energy efficiency in the Indian economy. The clock is ticking towards the eventual emergence of a market-based energy sector, which will be the harbinger of even more rapid progress for energy efficiency in India.

Last, but not the least, the National Solar Mission to be launched under India's NAPCC and its forthcoming three-stage nuclear power programme, is bound to result in a major stride towards energy-efficiency improvement.

The host of energy-efficiency improvement measures outlined above, if implemented effectively, can enable India to benefit immensely from international trading of emission rights within a favourable emissions allocation scheme in which India turns out to be a net seller of emission permits for a considerably long period. Conversely, participation in international emissions trading based on such a beneficial emissions allocation scheme will provide the country with the much needed flow of funds from abroad, which in turn would facilitate its energy-efficiency improvement programmes. In other words, there is clearly a bilateral causation at work between international emissions trading and the promotion of energy efficiency in the Indian economy. The two will, in all likelihood, reinforce each other.

## CAVEATS AND POLICY GUIDELINES

To the discerning reader, it would have already occurred that the bilateral causation between the pace of energy-efficiency improvement and the inflow of funds generated by the international emissions trading is not captured in our CGE model—the latter treats the rate of energy efficiency improvement as autonomous. In

fact, overcoming this limitation of the model is the main motivation for including the extended discussion on the relation between the two earlier.

Moreover, the usual caveat about the results generated from a CGE model based upon restrictive assumptions, which may not hold in the real world, applies. However, the model is useful in giving an overall sense of the co-movement of the related variables in the business of policymaking for a low carbon growth in the Indian economy—that has valuable lessons for the policymakers (Bergman 2005).

In the context of international emissions trading, the first milestone to arrive at in the policy-maker's journey is a consensus on the type of emissions allocation scheme. As we have already seen, the EPCEA scheme, though a favourite of the developing countries, is unacceptable to the developed countries, and the GEA scheme, which the developed countries habitually propose, is doomed to outright rejection by developing countries. So, some thought has to be spared for 'intermediate' arrangements between these two extremes. Interesting suggestions on intermediate emission allocation regimes have been made by many analysts (Joshi and Patel 2009 and Jacoby et al. 2008). However, we have not undertaken a detailed evaluation of the various intermediate options on emissions allocation schemes for IET, with a view to identifying and recommending *the* best possible option for India.<sup>11</sup>

Instead, we will proffer a generic rule of thumb to evaluate the worth of an intermediate option from India's viewpoint. As we have seen above, the GEA for India implies a commitment to restrict total emissions for all years up to 2040 to 1547 million tonnes, the benchmark year being 2010. Similarly, under the EPCEA based on the benchmark population of the year 2010, India is obliged to maintain 4.39 tonnes of per capita carbon emission, which effectively translates into an upper limit on total emissions of 5159 million tonnes for all the years up to 2040. It is thus easy to see that with some effort, all conceivable intermediate emissions allocation regime options can be mapped on a continuum of total emissions commitment, beginning with 1547 million tonnes (GEA) and ending with 5159 million tonnes (EPCEA) for the next three decades for India, if the benchmark year is 2010. Proximity to the latter figure is what should incline Indian

policymakers towards a proposed emissions allocation regime—which may not exactly be the equal per capita emissions allocation but something that is nearly the same—in the real-world bargaining.

## CONCLUSION

Internationally pressurized or not, it would be in India's own interest to aspire and plan for a low carbon path of economic growth in the coming three or four decades. Planning for climate change mitigation in India should not rule out but in fact include the possibility of participating in a global regime of tradable emission permits. However, India should move cautiously towards its participation in such a regime, first by ascertaining that the international emissions trading regime is based either on equal per capita emissions allocation, or if that is not possible, on some criterion which comes close to it. Second, to reap the harvest of international emissions trading with equal per capita emissions allocation, India must be able to maintain the status of a net seller of emission permits for a long period of time. To ensure this, a proactive domestic policy drive for enhancing energy efficiency must be pursued concurrently with its participation in an international trading emissions regime. This will protract the period for which India remains a net seller of emission permits and amplify both GDP and poverty reduction gains. Most significantly, it will facilitate low carbon economic growth in the Indian economy, as energy savings transmute eventually into carbon savings. The other way round, participation in international emissions trading would generate an inflow of funds from abroad, which can be used for financing the energy-efficiency improvement programmes of the Indian economy. That is to say, participating in a global trading regime of emission permits and pursuing an energy-efficiency improvement programme at home are mutually supportive for India.

It follows that, by combining participation in an international emissions trading regime with faster energy efficiency improvement, not only will India reap handsome climate policy dividends by enabling low carbon growth in the domestic economy, but also significantly contribute to mitigation of global warming. This is truly a *win-win* policy scenario. If India can work towards a scenario like this, it can actually transform a crisis into an opportunity.

<sup>11</sup> In any case, such an exercise may well turn out to be futile, as the real world of bargaining is known to throw up surprises.

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## APPENDIX 9A

TABLE 9A.1 Policy Scenarios: Selected Macro-variables

	<i>Policy Scenario 1a</i>						
	<i>GDP (%age diff. from BAU Sco.)</i>	<i>Cons. (%age diff. from BAU Sco.)</i>	<i>CO<sub>2</sub> Emissions (%age diff. from BAU Sco.)</i>	<i>Per Capita Emission based on 2010 popln. (in tonnes per capita)</i>	<i>Poverty Ratio (in per cent)</i>	<i>No. of Poor (in million)</i>	<i>No. of Poor (%age diff. from BAU Sco.)</i>
2010	0.00	0.00	0.00	1.32	15.30	179.80	0.00
2015	-2.42	-2.71	-3.49	1.69	7.92	100.04	3.11
2025	-3.17	-3.94	-4.41	2.96	1.48	21.03	4.98
2035	-3.46	-3.82	-6.17	5.05	0.23	3.52	6.13
2040	-3.56	-3.99	-5.98	6.63	0.08	1.33	7.01
30-year average	-2.69	-3.06	-4.29				4.36
	<i>Policy Scenario 2a</i>						
2010	9.84	9.36	9.23	1.44	14.01	164.63	-8.43
2015	8.28	7.19	7.51	1.89	7.19	90.85	-6.36
2025	7.36	6.06	6.68	3.30	1.35	19.07	-4.79
2035	6.55	5.86	5.62	5.68	0.21	3.19	-3.63
2040	5.52	4.30	5.34	7.43	0.08	1.22	-1.62
30-year average	7.44	6.57	6.75				-5.04
	<i>Policy Scenario 1b</i>						
2010	0.00	0.00	0.00	1.32	15.30	179.80	0.00
2015	-2.18	-2.52	-6.06	1.54	7.92	99.97	3.04
2025	-2.78	-3.19	-14.46	2.20	1.47	20.82	3.94
2035	-2.86	-3.13	-28.73	2.93	0.23	3.48	5.12
2040	-2.47	-2.33	-41.85	3.01	0.08	1.31	5.32
30-year average	-2.25	-2.49	-17.46				3.69
	<i>Policy Scenario 2b</i>						
2010	9.84	9.36	9.23	1.44	14.01	164.63	-8.43
2015	8.48	7.31	3.98	1.83	7.19	90.81	-6.41
2025	7.87	7.09	-4.87	2.94	1.33	18.90	-5.66
2035	7.45	6.91	-19.96	4.21	0.21	3.16	-4.56
2040	7.40	6.88	-35.05	4.38	0.07	1.20	-3.79
30-year average	8.10	7.40	-8.37				-5.73

TABLE 9A.2 Policy Scenarios: Infrastructural Outputs

	<i>Policy Scenario 1a</i>							
	<i>percentage difference from the BAU scenario</i>							
	<i>GDP</i>	<i>Electricity</i>	<i>Coal</i>	<i>Natural Gas</i>	<i>Refined Oil</i>	<i>Crude Petroleum</i>	<i>Transport</i>	<i>Energy-Intensive industries</i>
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	-2.42	-2.71	-3.06	-2.78	-3.07	-2.86	-2.94	-3.68
2025	-3.17	-3.54	-3.94	-3.60	-3.83	-3.58	-3.73	-4.41
2035	-3.46	-4.05	-4.59	-3.87	-4.15	-3.96	-4.05	-4.94
2040	-3.56	-4.31	-4.62	-3.84	-3.91	-4.25	-4.03	-5.03
30-year average	-2.69	-3.12	-3.56	-3.05	-3.14	-3.14	-3.12	-3.87
	<i>Policy Scenario 2a</i>							
2010	9.84	9.43	8.80	9.55	9.24	9.50	9.15	8.81
2015	8.28	7.94	7.55	7.82	7.77	7.87	7.70	7.23
2025	7.36	6.82	6.35	6.87	6.67	7.05	6.98	6.24
2035	6.55	6.28	5.70	5.97	6.16	6.04	6.23	5.18
2040	5.52	4.98	4.38	5.29	4.89	5.07	5.11	4.04
30-year average	7.44	7.01	6.51	6.99	6.91	7.04	6.91	6.25
	<i>Policy Scenario 1b</i>							
2010	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2015	-2.18	-2.51	-2.57	-2.78	-2.74	-2.59	-2.51	-2.40
2025	-2.78	-3.18	-3.50	-3.29	-3.02	-3.14	-3.17	-3.12
2035	-2.86	-3.41	-3.12	-3.45	-3.14	-3.06	-3.16	-3.23
2040	-2.47	-3.09	-2.69	-2.83	-2.83	-2.87	-2.74	-3.22
30-year average	-2.25	-2.67	-2.60	-2.64	-2.65	-2.59	-2.58	-2.66
	<i>Policy Scenario 2b</i>							
2010	9.84	9.51	9.25	9.26	9.18	9.33	9.17	8.19
2015	8.48	8.26	7.43	7.93	8.13	8.09	7.77	7.05
2025	7.87	7.23	6.72	7.41	7.27	7.21	7.60	6.27
2035	7.45	6.92	6.61	6.91	7.13	7.10	7.16	6.09
2040	7.40	6.73	6.47	7.19	6.80	6.88	7.11	5.81
30-year average	8.10	7.55	7.05	7.63	7.55	7.63	7.61	6.60

Table 9A.3 Cumulative CO<sub>2</sub> Emissions for the period 2010–40

		<i>(in million tonnes)</i>
<i>BAU Scenario</i>	<i>29405.89</i>	<i>%age diff. from BAU. Sco</i>
Sco. 1a	27909.57	-5.09
Sco. 2a	31221.95	6.18
Sco. 1b	22203.36	-24.49
Sco. 2b	24730.47	-15.90