GREENHOUSE GAS IMPLICATIONS IN LARGE SCALE INFRASTRUCTURE INVESTMENTS IN DEVELOPING COUNTRIES

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Meaningfully addressing global climate change concerns necessarily entails curbing the greenhouse gas (GHG) emissions of key developing economies. In 2002 China and India together accounted for roughly 18% of global CO_2 emissions, the leading human cause of climate change. These countries' growth in GHG contribution outpaces that of the U.S. and the European Union (E.U.), and by 2020 they will together account for one quarter world's CO_2 emissions (Figure 1). Engaging China and India in climate change agreements is difficult because climate concerns understandably take a backseat to the priority these countries place on development. Traditional approaches to involving reluctant countries in international climate policy have proven incapable of enticing or coercing the cooperation of these countries.

Presently, the Kyoto Protocol's Clean Development Mechanism (CDM) is recognized as the principal international apparatus for engaging developing countries in GHG abatement. However, poor oversight and governance, as well as gaming have plagued the CDM, and we anticipate that the mechanism's ultimate impact on developing countries' baseline emissions will be modest (Figure 2). Furthermore, those changes that the CDM exacts are marginal and do not create game-changing technology or infrastructure necessary to curb developing world emissions in the long run. For example, in practice, CDM projects have not adequately addressed developing countries' reliance on coal. And as of December 2005, less than a quarter of the CDM market was devoted to projects aimed at reducing CO_2 emissions (Figure 3).

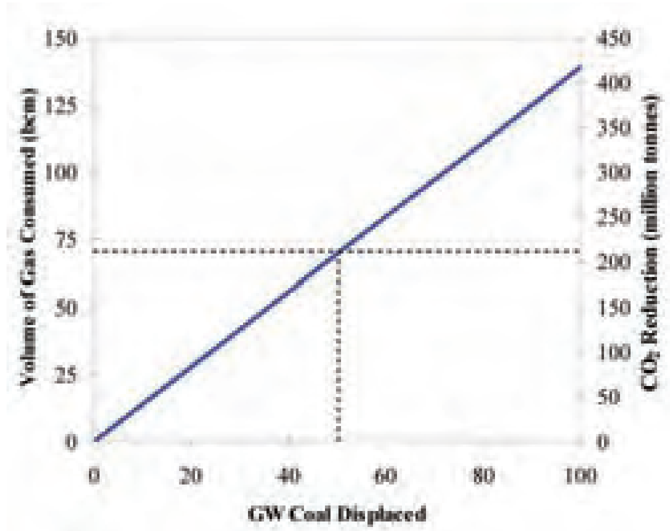


Figure 1: Implications of Coal Displacement in China in 2020

"DEVELOPMENT FIRST"

We assert that effectively engaging developing countries in climate change abatement regimes requires infrastructure investments that accommodate the high energy demands of economic growth and development. Espousing this theory of "development first", we formulate here two possible "deals" that could occur in China and India with assistance from the developed world. Both plans are built on the assumption that these countries will participate in a CO_2 abatement program only if the program assists (or at least accommodates) their unhindered procurement of the energy needed to foster economic and population growth.

INDIA

India's total primary energy consumption was 376 million tonnes of oil equivalent (Mtoe) in 2004 and is expected to reach 829 Mtoe by 2020. As with China, coal dominates India's electricity landscape, accounting for about 60% of total installed capacity. Table 1 details India's projected capacity.

We explore the carbon implications of the recent deal between India and the U.S. to share and implement nuclear energy technologies. While there are a range of assumptions of the amount of new capacity this technology transfer could provide by 2020, we analyze a middle-of-the-road estimate of 30 GW of new nuclear capacity. Under this scenario, nuclear would save 218 million tonnes of CO_2 if it displaced only coal capacity, and 83 million tonnes if it replaced exclusively gas. In practice, nuclear capacity would likely replace a mix of both coal and gas, and the emissions reduction would fall within this range.

Table 1: India Reference Scenario

	Installed Capacity (GW)[1]	
	2002	2020
Coal	69	127
Gas	13	45
Nuclear	3	9
Total Capacity[2]	116	252

[1] Source: World Energy Outlook 2004

[2] Total capacity includes coal, gas, oil, nuclear, hydro, and renewables.

We make the following assumptions about the load factor and carbon intensity of coal, gas, and nuclear plants in India (Table 2).

The carbon implications of new nuclear capacity are determined by calculating the annual energy produced by the nuclear plants and estimating the displaced CO_2 emissions from coal and natural gas. Note that 30 GW of nuclear capacity displaces 32 GW of coal capacity, owing to coal's lower load factor (Table 3).

The CO2 implications of replacing coal or gas with a range of installed nuclear capacities are provided in Figure 2. Assuming nuclear will displace a mixture of coal and gas, the carbon reductions for any given nuclear capacity will fall between these two lines.

CONCLUSION

The deals modeled in this paper are meant to demonstrate that well-structured investments in energy infrastructure in developing countries have the potential to bring about massive reductions in CO2 emissions (Figure 2). Such investment deals show promise not only because they represent viable means of carbon mitigation; we argue that, in helping these countries achieve their energy and development goals, these deals represent the only feasible way of engaging reluctant countries in emissions reductions.

Table 2: India Nuclear Deal Load Factor and Carbon Intensity Assumptions

	Nuclear	*Subcritical Coal	CCGT
Load Factors	0.90	0.85	0.90
Emissions rate (tonne CO_2/GWh)	0	920	350

*CCGT: Combined Cycle Gas Turbines

Table 3: Emissions Reductions Implications of India Nuclear Deal

	Nuclear Replaces Coal	Nuclear Replaces Gas
Displaced Capacity (GW)	32	30
Total Generation (TWh)	237	237
CO_2 Emissions Reductions (million tonnes CO_2/year)	218	83

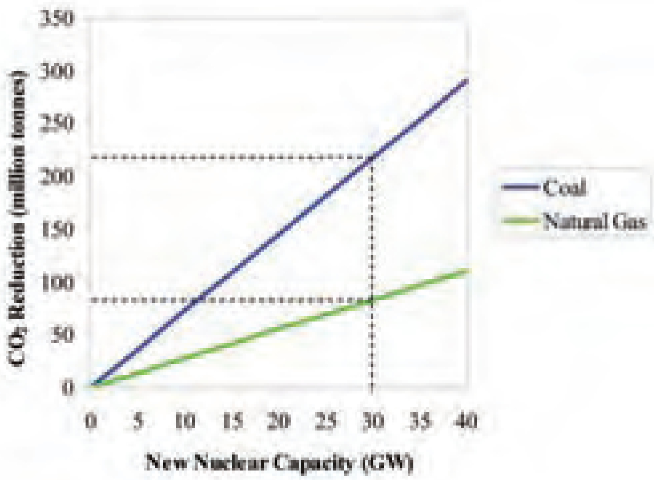
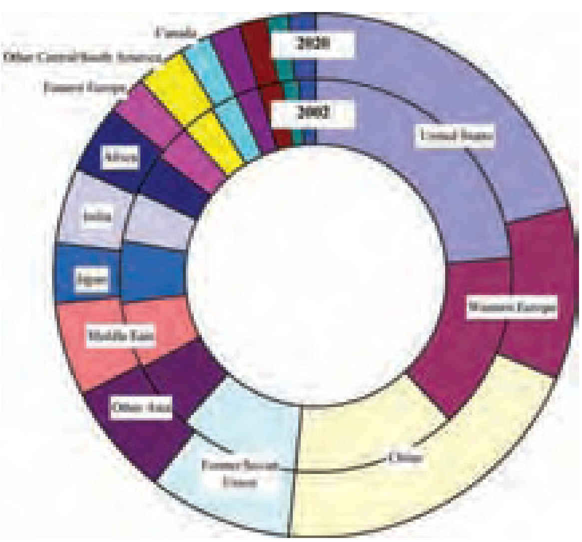


Figure 2: Carbon Implications for Indian Nuclear Deal

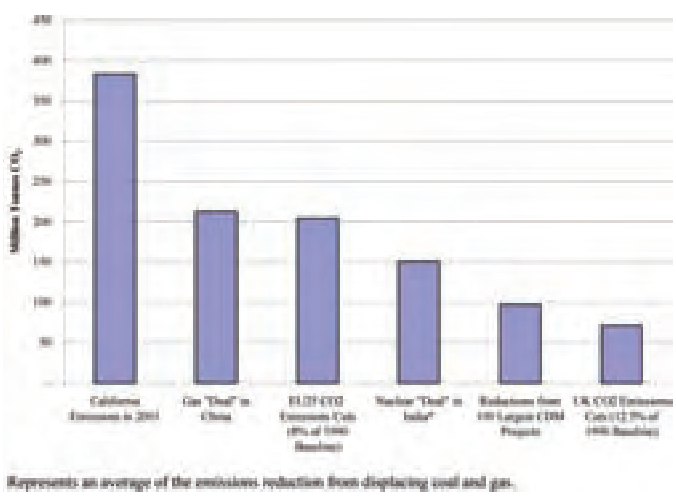
Successful implementation of these energy infrastructure investments requires attention to three general areas. Firstly, targeted developing countries need flexible, but credible policy, that can adapt to these energy infrastructure changes. Second, the right actors, including private entities adept at managing technical and political risk, need to be involved in these infrastructure deals.

Lastly, contextual changes in areas such as price formation and security concerns may be needed to accommodate newly established energy markets. Our institution, The Program on Energy and Sustainable Development, focuses on these issues in our other work and plans to examine them in the context of these deals.

The purpose of the analyses here is simply to provide a rough estimate of the magnitude of these deals' potential CO2 savings. Our models' implications underscore the need for further and more sophisticated analysis.



Appendix
Figure 1: Global CO2 Emissions by Region (2002 and 2020)



Appendix
Figure 2: CO2 Savings in Perspective
* Represents an average of the emissions reduction from displacing coal and gas.