IS IT ECONOMICALLY VIABLE FOR DEVELOPING COUNTRIES TO CUT DOWN CARBON DIOXIDE EMISSIONS?

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I. INTRODUCTION

In recent years, nations all over the world have become increasingly troubled by the buildup of "greenhouse" trace gases in the atmosphere. It is feared these gases—primarily carbon dioxide ("CO_2"), methane, nitrous oxides, and chlorofluorocarbons ("CFCs")—could trigger a significant warming of the earth's surface with potentially harmful, even devastating, consequences for humankind. Scenarios of changing patterns of rainfall, different temperature levels, increased frequency of natural disasters, and rising sea levels abound, but clear scientific evidence confirming such an enhanced greenhouse warming is still lacking.

What is certain is that greenhouse gases are accumulating rapidly and changing the chemical composition of the earth's atmosphere. While greenhouse gases are building up in the atmosphere, scientific evidence has not confirmed their actual climatic impact. For example, it is still not accurate to say that the global warming of 0.5 to 0.7°C observed during the past century is a proven result of the greenhouse effect. Globally averaged air temperature data indicate that five of the warmest years on record occurred during the 1980s, leading some scientists to claim that the impact of the greenhouse effect is being demonstrated. Others still question whether anyone can affirmatively answer the question: "Is this the year an enhanced greenhouse effect began to bite?" Recent events are illustrative of what could be expected if an enhanced greenhouse effect were underway.

Given this uncertainty, how should nations respond? One difficulty is that the benefits from activities that lead to the production of these gases (low cost power and transportation, manufacture of cement, refrigeration, waste disposal, etc.) are localized, immediate, and clear, but the costs are not. A second difficulty is that although the developed world is generating most of the greenhouse gases—of the two most prominent gases, only 25% of fossil fuel related CO_2 emissions and less than 10% of CFC emissions come from developing countries—most of the *increases* in emissions are now coming from the third world. In fact, the energy sector alone generates approximately one half of all CO_2 emissions, and the emerging demands for commercial energy in developing countries are very strong. Several interrelated factors drive this demand, including the growth of populations and per

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capita incomes, the migration to urban areas leading to fuel substitution from fuelwood to commercial energy, the increasing penetration of energy intensive technologies (fertilizers, vehicles, appliances, motors), and a relatively low level of efficient energy production and consumption.

On a global scale, the growth in energy consumption in developing countries over the past two decades has been more than seven times that of the Organization for Economic Cooperation and Development ("OECD") countries (5.3% per year compared with 0.7% per year). Growth in the electric power sector has been particularly dramatic. In over 90% of a recent sample of 51 developing countries, growth rates of installed capacity and generation per capita were more than double the real growth rate of Gross Domestic Product. In 57% of the countries, installed capacity and generation per capita were more than three times the real growth rate. The average growth rate of connections for World Bank projects for which data were available was 9% per year, or about two and a half times the average population growth rate.

Over the next few decades, it is projected that commercial energy consumption in the developing world will increase dramatically and will account for almost all of the increase in world energy consumption. To assume otherwise would be to condemn much of the developing world to very low levels of economic development. Assuming 4% growth per year over the next four decades (2 percentage points below a projected rate with full economic recovery in Latin America and Africa), developing country per capita energy consumption would still be less than one-quarter of the OECD countries. Nevertheless, total developing country commercial energy consumption will likely be greater than those of the OECD countries within 15 to 20 years and more than four times those of Eastern Europe and the (former) USSR combined.

Given this rapidly growing demand, a wide spectrum of policy options is available for countries to address CO_2 and other greenhouse gas emissions concerns. For purposes of this discussion the spectrum is divided into three parts:

(1) Those options where making investments or pursuing policy initiatives will yield unambiguous economic benefits that exceed costs without having to include the uncertain benefits from the accompanying reduction in greenhouse gases;

(2) Those options where, while either the costs or the benefits of the initiative are uncertain, the costs of the action are thought to be low relative to the potentially high costs which might be incurred by doing nothing. This is like *buying insurance*; and

(3) Other options being discussed where not enough is known at this time to warrant incurring the costs necessary to vigorously pursue them. The costs of buying insurance are thought to be too high at this time.

II. OPTIONS WHERE BENEFITS OF TAKING ACTION CLEARLY EXCEED COSTS

The most obvious set of actions available to developing countries relate to promoting the efficient use of resources. It is well known that many developing countries suffer from poor pricing, other development related policies, weak institutions, and a general lack of incentives to stimulate managers to pursue efficiency. There is a tremendous potential for reducing resource wastage and reducing accompanying CO_2 and other greenhouse gas emissions. This is both a macroeconomic and a sector specific problem. On the macroeconomic side, national income accounting systems in both developed and developing countries do not adequately reflect the economic costs of environmental change. This is a partial reason for the lack of concern for environmental issues in developing country economic planning. With regard to sector issues, prime candidates to slow CO_2 growth through efficiency related investment or policy initiatives include the areas of energy, industry, and transportation.

A. Energy Sector

Development depends upon the effective substitution of various forms of energy for human labor no matter what path of development a country chooses. Whether this energy is used to move water, make cement, heat or cool a house, move a truck, propel an industry, or cook food, it is effort expended to make the human condition more bearable. Developing countries, almost by definition, consume little energy other than that generated by human labor. Even Brazil has only about one-tenth the per capita energy consumption of the United States or many European countries. The electric power consumption of the whole of sub-Saharan Africa is less than that of New York City. So for those countries, the future hinges on expanding energy use in the whole range of economic and social activities.

But expanding energy use requires a commodity in very scarce supply in the third world—capital—and large amounts of it. The annual investment bill for all developing countries could be about $100 billion per year for electric power supply alone. China, India, and Brazil account for nearly half that amount, and this figure does not even include the large additional investments needed to consume this energy (e.g., motors, appliances, air conditioning, light bulbs) and make that consumption more efficient. Moreover, the requirements for investments in oil, gas, and coal are at least of similar scale. Not surprisingly developing countries increasingly place a high priority on promoting more efficient use of new and existing resources. The energy sector is by far the largest single contributor (accounting for roughly half) of CO_2 and total greenhouse gas emissions, making measures that improve efficiency—where the gains exceed the costs—a high priority.

Payback periods on energy efficiency investments in developing countries tend to be much shorter and rates of return higher than for investments designed only to increase energy supplies. Moreover, the reduction of energy inputs per unit of useful output almost always has a positive effect on the release of greenhouse gases, and the economic benefits are clear. In many developing countries, efficiency gains in the order of 20% could be achieved with relatively minor investments in upgrading existing capital stock. Energy-efficient new investment often can obtain further substantial gains.

The current existence of large inefficiencies proves implementing efficient investment programs is by no means a simple task. Developing countries must step up efforts to end the tremendous wastage. The major means will come through better pricing, more efficient consumption and supply, and cleaner alternative fuels and technologies.

- *Pricing.* In much of the developing world, energy prices, other than for some petroleum products, do not cover economic costs. Energy consumers—many of whom are producers of other goods—do not face prices that encourage them to use energy efficiently and to select the right form of energy for their needs. In particular, the underpricing of electricity leads to its inefficient production and use. Major industrial countries charge about 8 cents per kilowatt hour, double that of many developing countries. The cost-plus pricing of protected or monopoly energy consuming industries leaves no incentive for reducing costs.

- *Energy use.* Many developing countries could increase energy consumption efficiency through the use, for example, of better motor speed controls and more efficient motors, refrigerators, air conditioners, water heaters, lighting in commercial buildings, window coverings, wood burning cookstoves, and charcoal kilns. If the energy requirements of everything from industrial boilers to stoves to light bulbs could be lowered, it would significantly slow the growth in overall energy demand. Pure economic grounds alone justify such increased efficiency in energy consumption.

But to date, countries all over the world have found it difficult to make much progress on this score, and developing countries, in particular, have run into major obstacles. A myriad of reasons hamper progress: imperfections in the market, such as protected industries and subsidized energy pricing; inadequate consumer information on costs and alternatives; social mores on how things should be done; and a lack of available technologies. Nevertheless, new and evolving energy end-use efficiency technologies are promising, and there is a need to continuously re-evaluate the economic, technical, and social feasibility of their implementation. Other possible avenues include new initiatives on appliance labeling, information programs, and building codes.

• *Energy supply.* Here, too, the record is disappointing. Reviews of the performance of developing country power utilities over a 20-year period reflect a general trend of increasing inefficiency. Losses in the delivery of electricity are commonly greater than 20%—sometimes approaching 40-50%. While some loss represents theft and inadequacies in metering and billing, technical losses in networks are clearly too high. Furthermore, in many countries, the thermal efficiency of electricity generation tends to be low, especially when such generation is based on old coal technology. Losses in petroleum refining (excluding the energy requirements of the refining process) are as high as 5%; whereas, they could be as low as 0.5% in a well-run refinery. Such losses typically represent leakage and the flaring of refinery gases. Even charcoal kilns often have efficiencies as low as 10%, despite the fact that they can easily be designed to operate three times more efficiently.

Fortunately, the costs of reducing these high energy losses tend to be low relative to the large benefits gained. A dollar spent improving efficiency in the power sector, for example, might provide as much incremental supply capacity as three to ten times as much money spent on new capacity. Such improvements involve a strategy that (a) shifts investment resources at the margin from increasing capacity to improving efficiency; (b) strengthens the internal organization of energy supply enterprises to promote efficient operations; (c) reforms legislative and regulatory arrangements to ensure that all energy-related enterprises have increased incentives for efficient operations and investment; and (d) increases competition among energy suppliers, partly through encouraging the private provision of risk capital and private sector participation in energy supply.

• *Alternative fuels and technologies.* One of the most promising cleaner alternative fuels is natural gas. Its CO_2 emissions are much lower than those of other fossil fuels. The combustion of coal and oil yields 1.8 to 1.9 times and 1.4 to 1.5 times as much CO_2 as does natural gas, respectively. Natural gas has been discovered in over 50 developing countries, and proven reserves are now larger than those of oil. At the same time, its development has become increasingly attractive on economic grounds, thanks to the new low capital cost, short lead time, and high energy efficiency turbine technology. Yet, natural gas is not being exploited anywhere near its potential due to complex issues relating to legislation, regulation, ownership, institutional structure, fiscal regimes, financing, and information flows. Compounding matters is the fact that few developing countries have much experience with natural gas, and the experience of the developed countries tends to be inappropriate. In most industrialized nations, the natural gas market developed slowly, largely in response to industrial and residential demands. In many developing countries, though, the industrial and residential markets are too small, and most of the demand will be for power generation.

Another alternative may be hydropower where there is still substantial development potential. The key advantages of this technology are twofold: (1) the operating costs are low, and (2) hydropower stations are less complex to operate than other types of electric power stations. Moreover, in recent years the outlook for hydropower use has improved. With the advent of high voltage direct current transmission lines, many sites once considered too remote from load centers are now becoming economically viable. The establishment of suitable legislative or regulatory frameworks in some countries has also made privately owned mini-hydro schemes more attractive. In addition, a number of countries have now substantially upgraded their hydro policies and practices in order to avoid or mitigate local environmental and resettlement problems. Further attention in this area is likely.

A third prominent alternative relates to other renewable energy sources (e.g., biomass [plant materials and animal waste], solar and wind) since these usually do not contribute significantly to the net CO_2 emission. Their use is economically justified in selected developing country applications because they provide one of the few viable alternatives for populations in isolated and remote areas, although currently they can only meet a fraction of total demand. A number of studies on these renewables have attempted to identify niches for their use. Studies in India, Ghana, Indonesia, and Cote D'Ivoire show that cogeneration with bagasse from sugar mills and wood wastes from saw mills and/or plyboard mills can supplement electric power supply. Photovoltaics for health services, water pumping in remote areas, solar water heaters in the commercial sector, and small hydropower stations in selected rural locations also offer frequent solutions. Other applications are still relatively costly compared with conventional alternatives, although new research and development initiatives promise to bring the costs down.

B. Industrial Sector

Most of the greenhouse gases released by industry are the result of energy use rather than specific industrial processes. Thus, most of the measures suggested for improving the efficiency of consumption in the energy sector also apply here with the added bonus that energy-intensive industries tend to be more sensitive to price signals than small domestic consumers. The actual degree of sensitivity depends partly on the competitive structure of the industry. Those companies that are highly protected or lack competition will be able to pass price increases and costly inefficiencies on to consumers.

A few industries, however, do release substantial CO_2 as part of the production process, and in most cases, efficiency measures could reduce the problem. For example, in the cement industry, the energy requirements of a number of developing countries are some 35% to 50% greater than those of equivalent cement plants in developed countries. These requirements are even larger for the more prevalent small-scale cement-making operations.

The differences stem partly from different production methods—developed nations prefer the dry over the wet method—and partly from different quality standards, management practices, operation procedures, and maintenance routines.

C. Transportation Sector

This sector contributes greenhouse gases mostly through the burning of motor fuels. There are few off-the-shelf technologies, though, that significantly ameliorate emissions. In the long term, it is possible that cleaner fuels and their associated production and distribution systems will be developed further. At today's prices and production levels, however, these fuels are generally more costly than existing oil-based ones. Even so, economically enticing initiatives will have a beneficial impact in reducing greenhouse gas emissions. Foremost among these initiatives are improvements in the efficiency of transport enterprises or agencies and the pricing of transport services. Simply stated, inefficient operation and inefficient usage of transport lead to the use of outdated technology and excess fuel consumption. Poorly maintained roads and under-inflated tires also lead to excessive fuel consumption. All these factors result in unnecessary emissions of greenhouse gases as well as uneconomic operation.

Improving the efficiency of urban transport is particularly important. The failure to adequately transfer the costs of scarce urban street space to vehicle users through congestion charges, vehicle registration fees and parking fees has resulted in large and quantifiable economic costs, even without including externalities such as local air pollution or the release of greenhouse gases. Measures taken to improve the operation of urban transport systems, such as improved signalling and traffic controls or displacement of the automobile by buses, can significantly reduce the consumption of energy required for the functioning of the urban area. Addressing urban traffic congestion through pricing, investment, and regulatory measures has a high economic rate of return as well as potentially large positive environmental impacts.

III. OPTIONS TO BUY INSURANCE OR INCUR HIGH COSTS FOR UNCERTAIN BENEFITS

The second and third parts of the policy choice spectrum primarily relate to industrial countries. They include leading the way in phasing out CFCs, funding increased amounts of research on both preventive and adaptive measures associated with global warming, freezing CO_2 emissions, reforesting large areas, and increasing nuclear energy.

IV. WHY IS DEVELOPING COUNTRY ENERGY EFFICIENCY PERFORMANCE SO POOR?

Recent work which contrasted developing with developed country performance in the energy sector has identified three critical factors which correlate with differences in the efficiency of energy production and end-use. These differences relate to the fact that

(1) Developing country governments tend to be more involved in micro-managing their monopoly energy enterprises; whereas, developed countries tend to have a more formal arms length transparent relationship existing within a formal rule framework;

(2) Developing countries tend to price energy, particularly electricity, below the costs of production and distribution while developed countries tend to at least recover full costs; and

(3) Relatively few large monopoly or highly protected state enterprises dominate many developing countries' industrial and large commercial sectors, but developed countries tend to have less protected, more competitive industrial and commercial sectors.

Given these differences, the *highest priority* for a developing country's focus is improvement in the energy supply and end-use efficiency of these institutional, regulatory, energy pricing and competitive market areas. Experience has shown that if one does not address these institutional and incentive structure issues first, then many of the more specific institutional, sector, technical fix, or program initiatives will not be sustainable through time.

However, even as better institutional and regulatory frameworks are coming into place, energy prices begin to reflect real costs and competitive markets are beginning to function. But experience in both developed and developing countries has shown that other market imperfections can still provide significant barriers to the efficiency of energy production and end-use. These barriers include:

(1) A lack of government commitment at high levels encouraging energy efficiency, an absence of clear goals and no timetable to achieve those goals;

(2) Inconsistent national policies, codes, and regulations and/or an absence of comprehensive codes and standards which effect energy efficiency; and

(3) Information gaps on energy losses, loss reduction techniques, joint venture opportunities, and technology and process options, etc.

Since consumers are least responsive to the costs and benefits of energy use, barriers to the introduction of energy-efficient technologies are probably strongest in the household sector. This condition stems from inadequate energy metering in large sections of the residential sector and a split in investment decisions among tenants, owners, and contractors. In addition, household energy users usually do not have easy access to, nor do they try to obtain, necessary technical information and capital. Private transport also suffers from many of the same barriers as the household sector, and the fuel economy of a passenger car usually is not the most important criterion in purchase decisions. In contrast, market barriers tend to be less apparent in the commercial sector and are lowest in the industrial sector because these sectors operate in a competitive environment where awareness of costs and benefits is important. In developed countries with competitive markets, the industrial sector, especially energy-intensive industries, have substantially improved their energy efficiency in the past, particularly when economic growth has encouraged rapid stock turnover and the introduction of newer, more efficient technologies.

Nevertheless, energy costs do not always represent a significant share of production costs, required rates of return for energy efficiency initiatives are usually very high, and industry is not necessarily aware of the exact effects of energy efficiency investments. In fact, a recent International Energy Agency study stated that while it is generally recognized that the industrial market for energy-efficient equipment in OECD countries is less subject to market barriers than other end-uses, a number of significant barriers include a separation of expenditures and benefits, limited capital, rapid payback requirements dictated by investment opportunities elsewhere, the impact of electric and gas tariffs, lack of interest in peripheral operating costs, and legal and administrative obstacles.

Additional ways to address these barriers in a developing country include (a) setting up or strengthening national or local dedicated energy efficiency institutions, (b) putting standards and codes in place, (c) implementing integrated energy resource planning, (d) targeting specific technology transfer and efficient fuel options to get things moving, (e) focusing more on energy efficiency in transport, and (f) encouraging the formation of private energy service companies. Of this menu of options, the creation of dedicated *energy efficiency institutions* deserves more discussion.

A review of World Bank experience has shown that developing country electric utilities resist taking responsibility for energy conservation initiatives because conservation conflicts with most utilities' objectives to increase sales and revenues. For this reason, some governments have located energy conservation activities separately from those of regulation and operation of electric power supply. The establishment or upgrading of national Dedicated Energy Efficiency Institutions can segregate conservation activities and

enable pursuit of relatively small scale energy conservation initiatives. This is true, especially when governments are encouraged to make high level and well-publicized commitments to them. High level national energy efficiency institutions could be set up to

(1) Serve as the institutional focal point for conservation, efficiency, and alternative fuel initiatives in the country;

(2) Assist with demonstration projects;

(3) Carry out energy audits;

(4) Disseminate information on technology options, financing, and successes and failures;

(5) Help draft codes and standards;

(6) Provide training, information and advice on loss reduction techniques;

(7) Where possible, encourage the establishment of private energy service companies which share in the profits from loss reduction or efficiency increase initiatives; and

(8) Receive, appraise, and bundle economically justified low capital requirement projects for potential bank or donor funding.

The institutions could also serve as the focal point in the country for identifying and lobbying against macroeconomic and sectoral barriers to achieving successful conservation and alternative fuel initiatives. Possible initiatives include import duties or restrictions on more efficient technologies, foreign exchange controls, and protected industries engaged in cost-plus pricing. These institutions can also draw on energy efficiency technical assistance from bilateral aid agencies and non-governmental organizations ("NGOs") and coordinate energy related efficiency or alternative fuels projects which qualify for World Bank funds.

As a *caveat,* one must note that the relative lack of emphasis on end-use efficiency in developing countries is not an oversight. Rather, in many instances it has been rationalized on the grounds that the developed countries focus on the demand side for most of the potential savings and innovative energy conservation work, while developing countries still have a larger high return potential for energy saving on the supply side. This distinction is particularly important since energy consumption in the OECD countries is predicted to grow at less than one percent per year. But in the developing countries, the average rate is expected to increase 5% to 6% per year, with rapidly growing countries, such as Thailand, having a rate more than double the average. Under the best of assumptions about end-use energy efficiency

gains, large increases in energy supplies and CO_2 emissions will be necessary to maintain even modest rates of developing country economic growth. Given the initial very low developing country energy consumption levels, the new sources of supply will be significant additions to the stock. Therefore, improving the efficiency of these large new energy supplies must have a higher priority than it has in the already energy supply efficient OECD countries.

V. CONCLUSION

With the exception of a few large consumers located in major industrial centers, end-use of commercial energy in developing countries is spread thinly over a vast number of consumers who consume very little on average. Management capabilities of energy utilities are limited, and in many countries there are significant shortages of skilled engineers and technicians who could address end-use energy problems. As a result, setting energy prices to reflect the real costs of supply, while simultaneously promoting competition in the marketplace, remain the fundamental first order bases for addressing end-use efficiency issues in the developing world.