THE WHITE HOUSE

Assistant to the President and
Director of Intergovernmental Affairs

Roger —

Jon Hartle spoke to the President at an event I was at last week about this. He asked Jon to send him a memo.

Mark

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policy

Developing **countries** & Global **climate change**

Electric Power Options in Korea

KOREA ENERGY ECONOMICS INSTITUTE

BATTELLE, ADVANCED INTERNATIONAL STUDIES UNIT

PEW CENTER ON Global CLIMATE CHANGE

ACTIONS BY DEVELOPING COUNTRIES TO CONTROL GREENHOUSE GAS EMISSIONS

Short-Term Technical Support
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CONTENTS

Country Case Study Annexes

EXECUTIVE SUMMARY

ES.1 INTRODUCTION

The ultimate objective of the 1992 United Nations Framework Convention on Climate Change (UNFCCC) is to stabilize atmospheric concentrations of greenhouse gases (GHGs) at levels that protect the global climate. The UNFCCC's nonbinding goal of a return to 1990 emission levels applies only to industrialized countries. In 1997, industrialized countries committed themselves to specific reductions. Atmospheric concentrations of GHGs, however, cannot be stabilized without efforts by developing countries, whose emissions are growing faster than industrialized countries under most "business-as-usual" projections.

Negotiations to determine how to achieve the goals of the UNFCCC have been marked by deep divisions between industrialized and developing countries. In particular, some industrialized country policymakers perceive that developing countries have done little, if anything, to date that controls their GHG emissions. Moreover, goes the argument, unless developing countries make binding commitments, they will do little or nothing voluntarily to reduce emissions. For their part, policymakers in several key developing countries assert that accepting controls on their GHG emissions is tantamount to constraining their national development. These respective concerns have inhibited progress in implementing the UNFCCC by both blocs.

Although both the perception of developing country inaction and the fear that emission reduction will block national development have continued to affect the most recent negotiating session in Buenos Aires, neither are accurate. As evidence, this report documents a wide range of actions developing countries have already taken that are reducing GHG emissions below the levels they otherwise would have been. Moreover, the actions documented in this report, although they may have involved investment or the imposition of politically painful reforms, have not been at the expense of development. To the contrary, they have often been undertaken to stimulate their economies.

Given that most greenhouse gas emissions are associated with burning fossil fuels, the examples in this report focus on CO2 savings from reduced energy production and use. Much of the report focuses on the GHG-controlling actions of six key countries (China, India, Indonesia, Mexico, Brazil, and Korea). These countries are important because of their relatively high global GHG ranking (see Exhibit ES-1), their leadership among non-Annex 1 countries on opinions regarding the role of developing countries in the UNFCCC, and because evidence of voluntary actions to control their growing GHG emissions would send a strong positive signal to industrialized countries.

Exhibit ES-1
1995 CO_2 Emissions from the U.S. and Case Study Countries

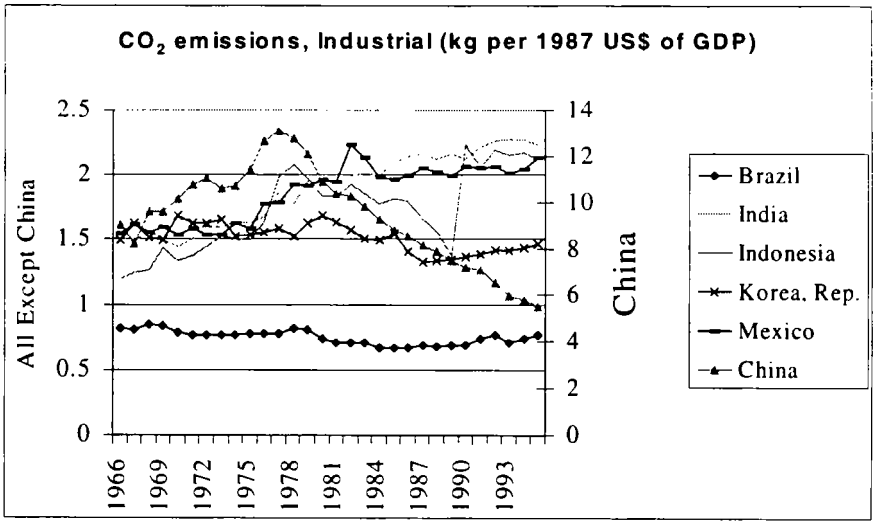
Country	Global Rank	CO_2 emissions from fuel combustion (million tons)
United States	1	5,228
China	2	3,006.9
India	6	803.0
Korea	12	353.1
Mexico	14	327.6
Brazil	16	287.5
Indonesia	21	227.0

ES.2 INTERNATIONAL TRENDS

The context in which developing countries are taking GHG-controlling actions is that of increasing absolute GHG emissions. There are, however, several other ways to compare countries' relative status and progress with respect to GHG emissions. One useful measure is carbon intensity (carbon emissions per $GDP). By this measure, the six countries represent the diversity in trends across the developing world over the past two decades (See Exhibit ES-2)

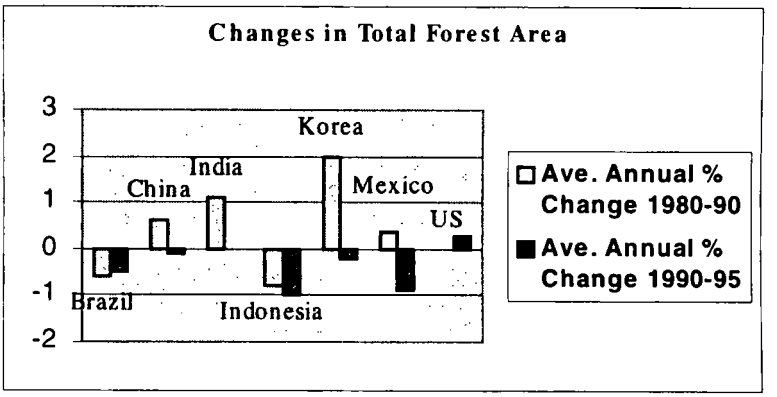
Historically, as countries transition from agrarian to industrial economies, most experience growing energy intensity as shown, for example, by the trend line in ES-2 for India. In some countries, the oil shocks of the 1970s stimulated improvements in carbon intensity as shown by the trend lines for the U.S. and Korea. The carbon emissions trend line for China suggests that it has been able to de-couple economic growth and carbon emissions, even though it remains heavily reliant on coal. Developing countries whose carbon intensities are still increasing may be able to deploy more efficient and low carbon technologies to meet their growing demand for energy services. If so, they will be able to begin reducing their carbon intensity before they reach the historic carbon intensity highs experienced by the U.S. and China. A country's overall carbon intensity trends, in turn, are a function of trends in carbon intensity across its major sectors.

Exhibit ES-2
Overall Trends -- GHG Intensity by Country



In addition to carbon intensity trends, the status of a country's forest area is important from the standpoint of net emissions since forests act as a carbon sink. Again, forest cover trends from the six countries highlighted in this report demonstrate the wide range among developing countries. (See Exhibit ES-3)

Exhibit ES-3
Sector Specific Initiatives -- Forests

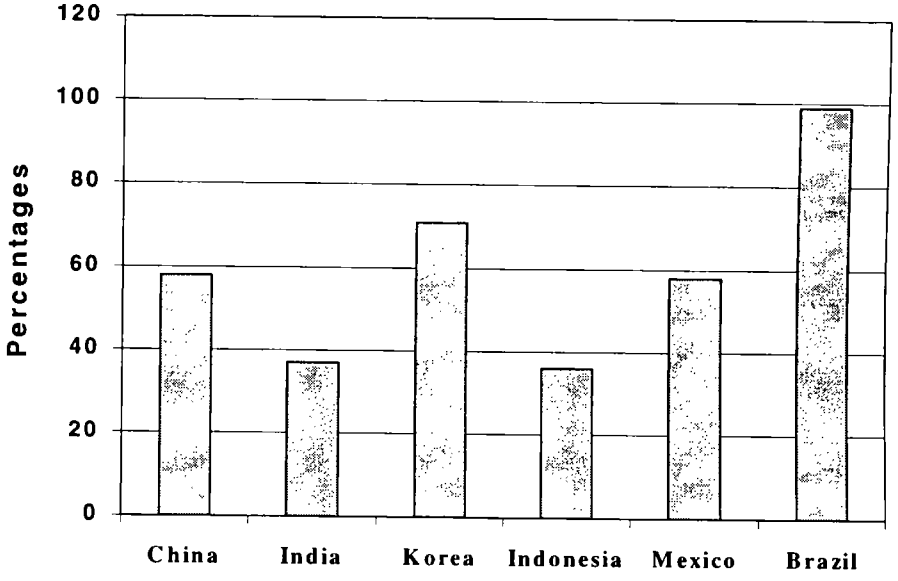


ES.3 REDUCING ENERGY SUBSIDIES

Since energy subsidies encourage inefficient usage patterns, carbon emissions in countries that subsidize energy are higher than they otherwise would be. Energy use can be subsidized in many ways, both direct and indirect, including grants and tax breaks to producers and distributors. Governments may subsidize prices for energy goods and services directly, through public enterprises, or indirectly, through regulation. In 1990 many developing countries were subsidizing various fuels, especially those used by households.

Since 1990, subsidies have been substantially reduced. Measured as the difference between border and domestic prices, fossil fuel subsidies dropped dramatically from about $119 billion in 1990-91 to $58 billion in 1995-96 across 20 developing and former Soviet Bloc countries (which account for 77% of the world's energy consumption among non-industrialized countries). (See Exhibit ES-4 for subsidy reductions in several of these countries.) Subsidies have dropped even more since 1996. In many cases, the resulting increase in energy prices to consumers created hardships and political strife. Although the U.S. government subsidizes fossil fuels largely through means other than price controls (producer subsidies rather than consumer subsidies), fossil fuel subsidies in the U.S. were of the same order of magnitude as in developing countries in 1995.

Exhibit ES-4
Percentage Reduction in Coal, Natural Gas, and Oil Subsidies in Case Study Countries between 1990-91 and 1995-96



Energy prices to consumers reflect the actual costs of production plus the price effects of subsidies and taxes. For example, developing countries tend to tax gasoline heavily relative to the U.S. As of early 1998, the average consumer price for gasoline (including taxes) in developing countries was at least half again as much as in the U.S. Part of the difference is due to higher gas taxes in developing countries.

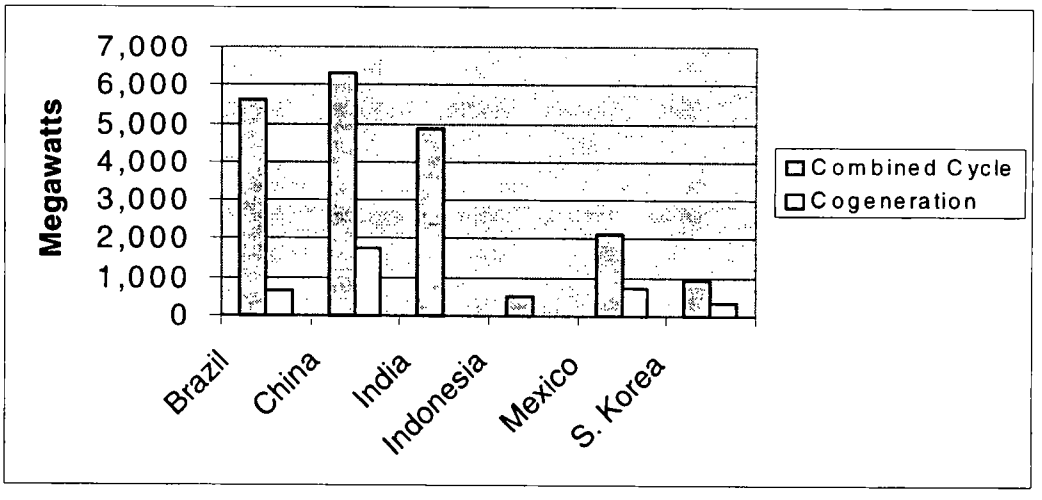
Some developing countries are also using energy price signals in other ways to reduce waste. For example, industrial firms in China pay more per unit of energy when their use exceeds established quotas.

ES.4 REDUCING GHG EMISSIONS FROM ENERGY PRODUCTION AND USE

Electricity Production

The GHG-intensity of a country's electricity sector is a function of the efficiency of its generation and delivery system and the GHG-intensity of its generation mix. Historically, the efficiency of the electricity system in developing countries has been poor relative to comparable measures in industrialized countries. In the 1990s, however, significant improvements have been made in several countries, stimulated in part by foreign investment in new equipment and refurbishing existing equipment. India's National Thermal Power Corporation is implementing extensive renovation of its units. Energy losses from transmitting electricity from plant to customer dropped in Argentina in the wake of privatization. The use of high efficiency generation technologies (combined cycle and cogeneration) is also growing in several countries including China, Brazil, and India. (See Exhibit ES-5).

Exhibit ES-5
Current Power Project Using High Efficiency Technologies



The other major determinant of electricity-related GHG emissions is the generation mix. Historically, the average overall GHG-intensity of the generation mix among low and middle income countries has been lower than that of the U.S. Individual countries, of course, vary widely. India is highly dependent on coal for power generation but India is taking major steps in an effort to reduce its dependence. It has established a cabinet level ministry of renewable energy, a national renewable energy financing agency, and a comprehensive set of policy measures that have, among other results, stimulated a domestic wind power industry.

In the future, more and more power plants in developing countries will be built by independent developers who will sell their power to the local utility or in a competitive market. Many of these developers prefer natural gas as a fuel, which has a lower carbon content per kWh than coal or oil. Developing countries are making major investments to establish facilities for importing and transporting gas that will allow them to reduce their dependence on oil for power generation.

Transportation

GHG emissions from transportation are particularly hard to control because there are so many emission sources. Still, developing countries have used motor vehicle efficiency labeling and policy incentives to reduce driving. They have also made investments to use low and no carbon energy sources in transportation, as well as to improve efficiency. Brazil's alcohol fuel program is the largest alternative motor fuels program in the world. Begun in 1975 as an import substitution program, today the country boasts some 4.5 million ethanol-powered vehicles. Brazil's alcohol is produced from sugarcane using a low-input process that has resulted in a 15% reduction in CO2 emissions compared to the use of gasoline. Brazil has also reduced diesel fuel consumption by 14% through a commercial transport conservation program.

Buildings and Industry

Buildings and industry typically account for 20%-40% of energy use in developing countries. During the 1990s, developing countries initiated a wide range of activities to improve energy efficiency in buildings and industry, lowering the demand for energy and thus GHG emissions from what they otherwise would have been. (See Exhibit ES-6) Among the six focus countries, Brazil and Korea have the most comprehensive package of programs. In Thailand, all existing buildings must demonstrate compliance with energy conservation codes or risk electricity bill surcharges. In 1997, energy efficiency programs in Mexico saved an estimated 2,316 GWh, about 2% of total consumption. Several other countries have established Energy Efficiency Centers that offer information, demonstration projects, and training. Energy savings by Brazil's electricity conservation organization, PROCEL, amounted to 3,600 GWh in 1996 while China's national energy intensity has declined substantially due to its energy efficiency policies.

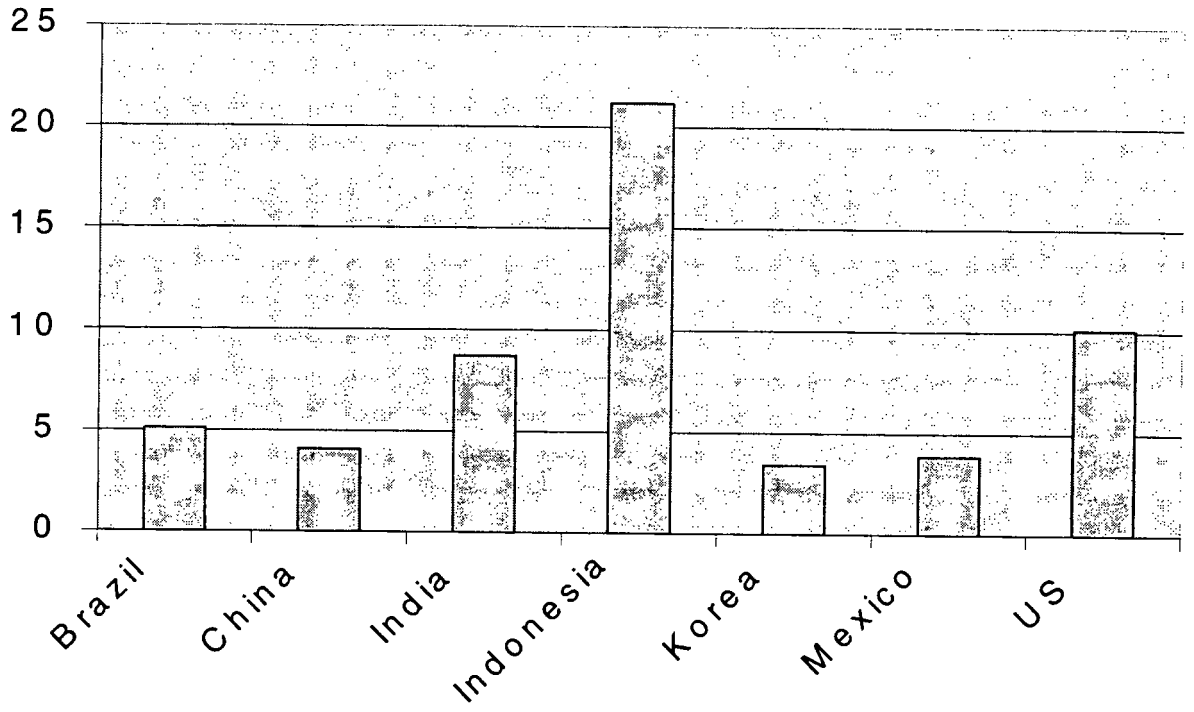
Exhibit ES-6
Overview of Energy-Saving Activities in Buildings and Industry in Selected Countries

Key Countries/ Regions	Codes and Standards		Financial Incentives			Technical Services and Promotion (Market Transformation)		
	Building Codes	Appliance Standards	Free Technical Services	Rebates/ Credits	Utility DSM	Information & Promotion	ESCO Development	Labeling
Argentina						✔	✔	
Brazil	✔	✔		✔	✔	✔	✔	✔
Chile	✔					✔	✔	
Mexico		✔		✔	✔		✔	✔
China	✔	✔		✔			✔	
India				✔		✔		
Indonesia	✔				✔	✔		
Korea	✔	✔	✔	✔		✔		✔
Philippines	✔	✔	✔	✔	✔	✔		✔
Thailand	✔	✔	✔	✔	✔	✔	✔	✔

ES.5 PROTECTING CARBON SINKS

To mitigate overall trends that are reducing the value of forests as carbon sinks, developing countries are taking actions to protect and better manage their forests. Granting legal protection to forests is one approach. (See Exhibit ES- 7) In addition, several countries such as China have implemented major initiatives in afforestation and reforestation. India is promoting better local management of forest areas and deploying improved efficiency wood-burning cook stoves.

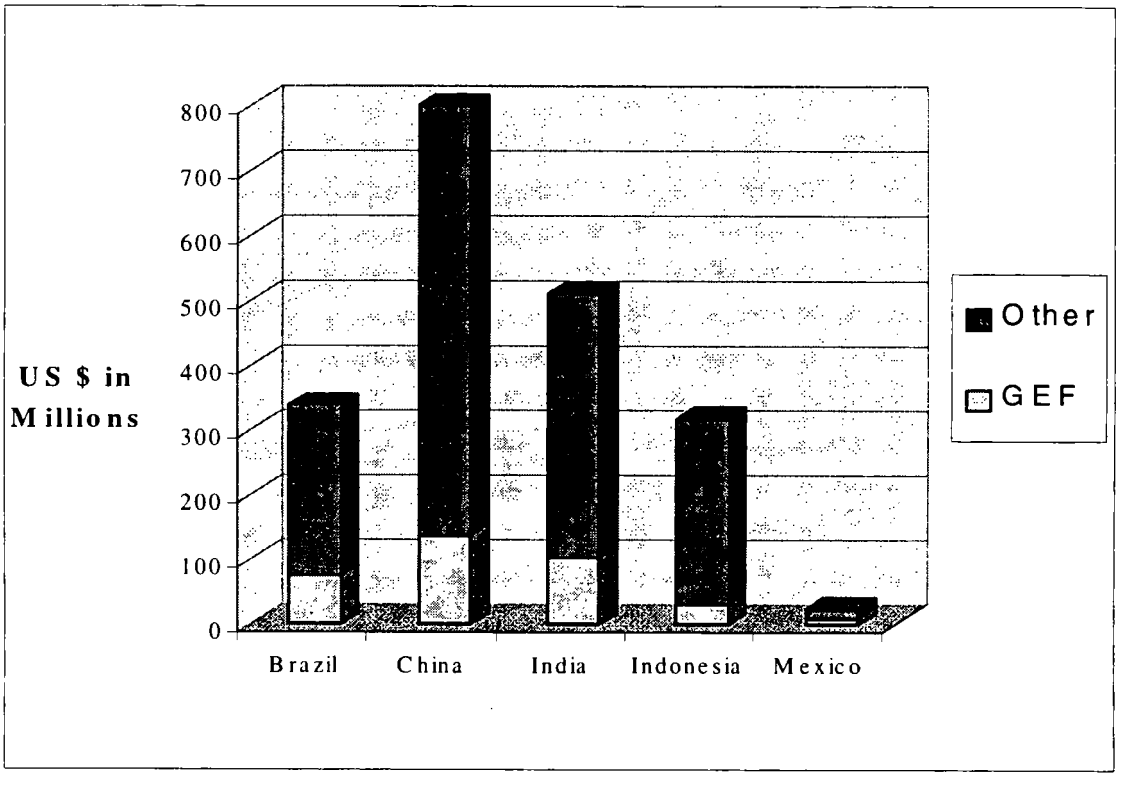
Exhibit ES-7
Percent of Total Forest Area Under Protection



ES.6 ACTIONS DIRECTLY SUPPORTING THE UNFCCC

This final category of actions includes national communications, GHG reduction action plans, and participation in international initiatives such as country studies, joint implementation, Global Environment Facility (GEF) climate projects, and preparation for the Clean Development Mechanism (CDM). Most developing countries are at least in the process of formulating national plans to control GHG emissions. Many have participated in GEF projects, including making a portion of the investment. (See Exhibit ES-8)

Exhibit ES-8
Funding for GEF Climate Change Projects
Selected Countries Through May 1998 (US$ Millions)



ES.7 CONCLUSIONS

As in the U.S. and among other industrialized countries, most of the above actions have been taken for reasons other than explicit GHG reduction or protection of carbon sinks. The particular set of GHG reducing actions taken by each country reflects its individual economic characteristics and political priorities and constraints. Their reasons for taking actions are also diverse, including saving money, compliance with requirements of multilateral lenders, energy security, conservation of foreign exchange, and biodiversity conservation.

The six case study countries are diverse in their degree and types of GHG-reducing activity as well. The GHG-controlling actions by individual countries target the economic sectors responsible for the bulk of their own GHG emission sources (buildings and industry, transport, power) and carbon sinks (forestry). Overall, India and Indonesia appear to have taken fewer actions that control their GHG emissions than the other four.

Some types of action have been more common than others. For example, all six case study countries have significantly reduced fossil fuel subsidies and initiated programs to reduce energy use in buildings and industry. In addition, most have implemented broad reforms (including in their energy sector reform), although the effects of these actions on GHG emissions are mixed. The six countries have been less effective in reducing transportation fossil fuel and protecting carbon sinks. Finally, as non-Annex 1 countries, they have taken fewer actions in direct support of the UNFCCC or to otherwise control GHG emissions than actions that control GHG emissions as a side benefit.

GHG-reducing actions among developing countries are at various stages of implementation. Some actions constitute fully completed projects. At the other extreme, many countries, such as Indonesia, are building their institutional capacity to reduce GHG emissions in the future or have passed enabling legislation or policy directives. Often, international assistance agencies and private firms have provided some financial support, given that most developing countries, almost by definition, face a scarcity of domestic investment capital.

The information contained in this report is intended to promote the implementation of the UNFCCC in two ways. First, developing countries may be willing to be more flexible in their negotiating position if industrialized countries acknowledge the positive actions already taken. Second, industrialized countries may be more willing to implement emissions reductions if they that developing countries are doing their share.

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

The world's scientific community, as represented by the Intergovernmental Panel on Climate Change (IPCC), generally agrees that atmospheric concentrations of greenhouse gases (GHGs) must be stabilized if the risk of unacceptable climate change is to be avoided. Stabilization will require control of GHG emissions by the major GHG-emitting countries in both the industrialized and the developing worlds.

The ultimate objective of the 1992 United Nations Framework Convention on Climate Change (UNFCCC) is to stabilize atmospheric concentrations of greenhouse gases (GHGs) at levels that protect the global climate. The UNFCCC's nonbinding goal of a return to 1990 emission levels applies only to industrialized countries. In 1997, industrialized countries committed themselves to specific reductions. Atmospheric concentrations of GHGs, however, cannot be stabilized without efforts by developing countries, whose emissions are growing faster than industrialized countries under most "business-as-usual" projections.

As of early 1998, over 160 countries had agreed to reduce their GHG emissions through implementation of the Kyoto Protocol. The world's industrialized (Annex 1) countries have committed themselves to quantified GHG reductions. The United States, for example, agreed to a 7% reduction from its 1990 levels. Targets are to be reached over a five year period rather than by a single year. The first period is 2008-2012. Activities that absorb carbon, such as planting trees, will be offset against emissions targets. Six GHGs – carbon dioxide, methane, nitrous oxide, and three substitutes for ozone-depleting CFCs — are included.

For now, non-Annex 1 countries are not bound to make commensurate reductions because the vast majority of emissions to date are from the industrialized countries.[1] (Although the set of "non-Annex 1" countries includes a few that are not considered "developing," this report uses the terms synonymously for convenience.) Developing countries may voluntarily assume binding emissions targets, however, as a prerequisite for engaging in emissions trading. As of November, 1998, Argentina and Kazakhstan have announced their intention to assume such targets.

Disagreement has arisen over the extent to which various countries need to control their emissions and the timetable for doing so. In particular, industrialized countries do not wish to commit to severe limitations unless these also apply to the developing countries, whose emissions are growing much faster. Many people believe that, absent binding commitments,

developing countries will do little to control their GHG emissions. For their part, developing countries do not want to be held to the same standard as industrialized countries, which have much higher absolute and per capita emissions and are primarily responsible for current elevated levels of GHG concentrations. Moreover, they fear that adhering to emission restrictions will stifle their national development goals.

The debate has not been enlightened by much information about the extent to which developing countries have already acted to control GHG emissions in the absence of binding commitments. Such information has not been assembled, much less analyzed and widely disseminated. In the absence of such information, some observers have concluded that developing countries have done little, both in absolute terms and relative to the United States and other industrialized countries.

To remedy this gap in information, this report investigates the scope and nature of recent activities that control GHG emissions initiated by developing countries, particularly in those with large and rapidly growing emissions. These activities include those that limit emissions from GHG sources, those that protect carbon sinks, and those specifically identified as GHG reduction measures. In addition, certain national economic reforms may impact GHG emissions levels favorably. Many of the initiatives are consistent with the policies and measures recommended in the UNFCCC for use by Annex I Parties in implementing their National Action Plans (See Exhibit 1-1).

Exhibit 1-1
Typical Recommendations from the UNFCCC

Policies and measures to mitigate climate change through reduction in GHG emissions and enhancement of GHG sinks were originally mentioned in the FCCC for Annex 1 countries and then elaborated upon in the Kyoto Protocol. Examples include:

- enhancement of energy efficiency in relevant sectors of the national economy
- protection and enhancement of sinks and reservoirs of greenhouse gases not controlled by the Montreal Protocol, through promotion of sustainable forest management practices, afforestation, and reforestation
- promotion of sustainable forms of agriculture
- research, promotion, development, and increased use of new and renewable forms of energy, carbon dioxide sequestration technologies, and innovative environment-friendly technologies
- progressive reduction or phasing out of market imperfections, fiscal incentives, tax and duty exemptions, and subsidies that run counter to the objective of the Convention and the application of market instruments

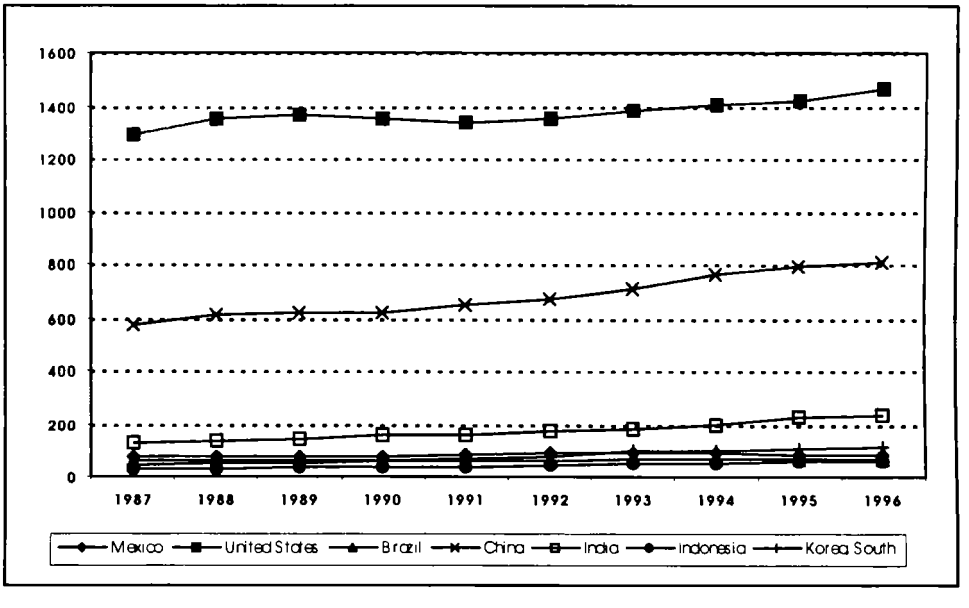
Exhibit 1-1
Typical Recommendations from the UNFCCC (Continued)

- encouragement of reforms aimed at promoting policies and measures which limit or reduce emissions of greenhouse gases not controlled by the Montreal Protocol
- limitation and/or reduction of emissions in the transport sector of greenhouse gases not controlled by the Montreal Protocol
- limitation and/or reduction of methane emissions through recovery and use in waste management, as well as in the production, transport and distribution of energy

1.2 TRENDS IN GHG EMISSIONS

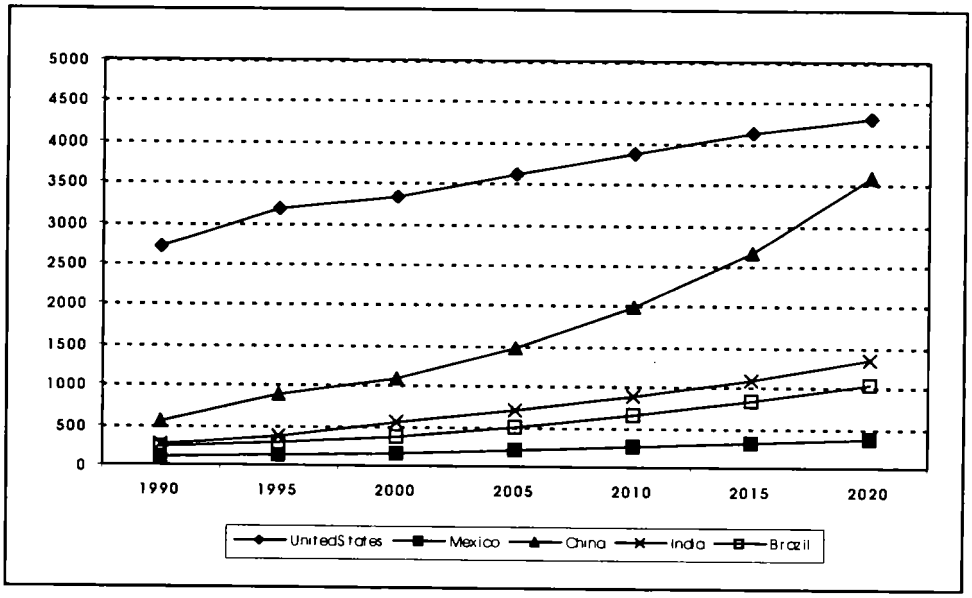
A country's status with respect to GHG emissions can be assessed in several ways, including absolute GHG emissions, GHG intensity (per unit GDP), and GNP per capita. Developing countries have generally had low absolute GHG emissions relative to the United States. (see Exhibit 1-2). According to business as usual projections, however, emissions from the developing world will increase faster than those of the industrialized world and surpass them by about 2020 (See Exhibit 1-3). (The crossing point, however, could be delayed depending on how the Asian financial crisis affects economic growth rates.)

Exhibit 1-2
World Carbon Dioxide Emissions from the Consumption and Flaring of Fossil Fuels, 1987-1996 ***(Million Metric Tons of Carbon)***



Source: World Bank Development Indicators, 1998.

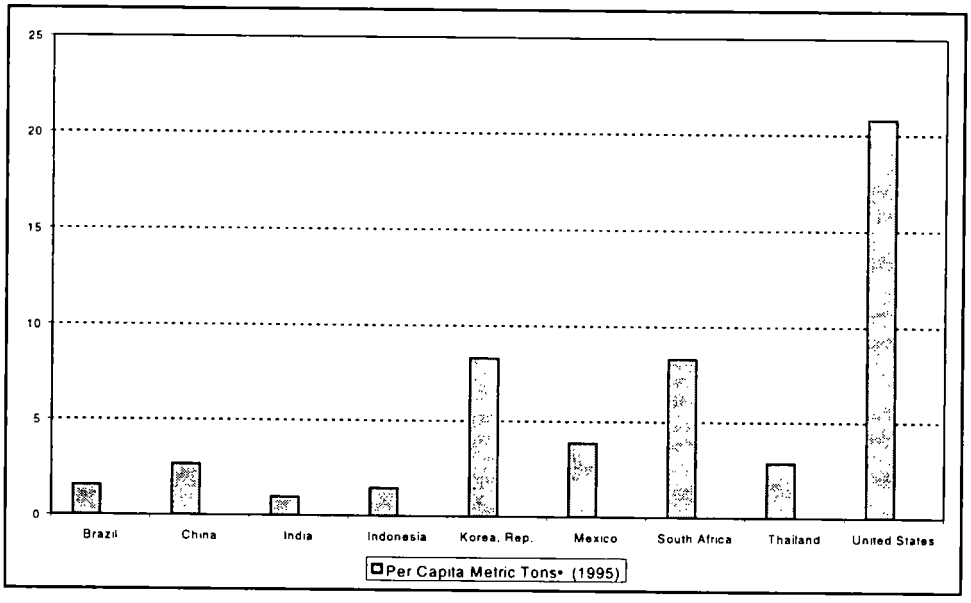
Exhibit 1-3
Projected Carbon Dioxide Emissions for Selected Countries



Source: U.S. Department of Energy, Energy Information Administration, 1997 International Energy Outlook, Washington, D.C.

Emissions per capita is often used as a measure of global equity under the concept that every individual (regardless of country) has a right to emit an equivalent level of emissions. Under this measure, Korea ranks first and India last among the six case study countries. (See Exhibit 1-4)

Exhibit 1-4: Metric Tons of Carbon per Capita for Selected Countries



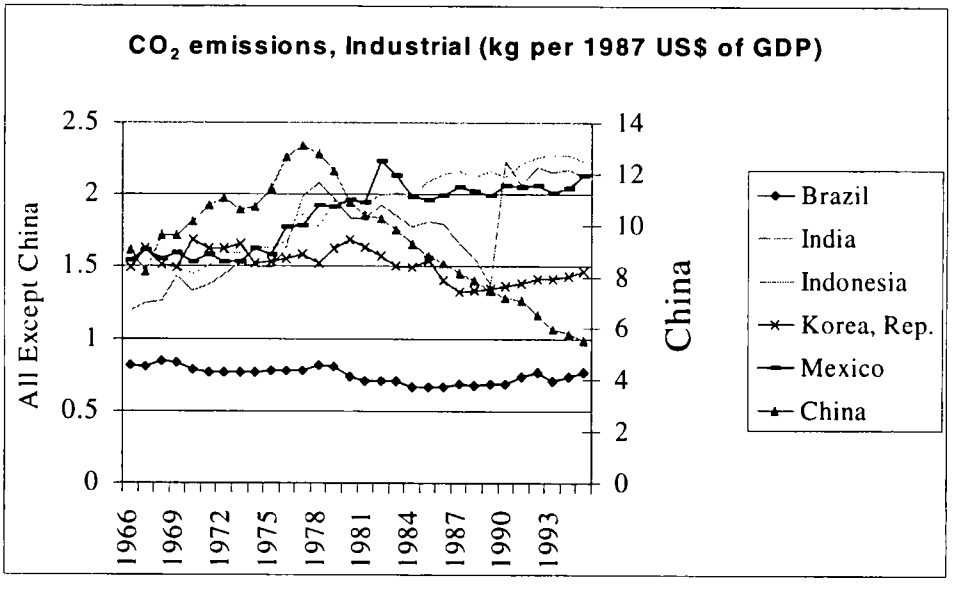
In addition to GHG intensity , carbon intensity (tons of carbon per GDP), and energy intensity (Btus per GDP) are useful indicators of a country's progress in controlling its GHG emissions. (However, see Exhibit 1-5). Among the six case study countries, Brazil has the least carbon intensive economy; China is the most carbon intensive. A downward trend in carbon intensity means that a country is becoming more efficient in producing economic output, substituting other sources of energy for fossil fuels, or changing the structure of its economy. (See Exhibit 1-6).

Exhibit 1-5
Limitations of GHG Benchmarks

Although carbon and energy intensities are useful indicators to evaluate how well different countries are doing to control their contribution to climate change, neither are completely accurate proxies for the progress a country has made toward mitigating the risk of climate change. For one thing, GDP does not reflect the status of the natural capital of a country, such as soils and forests, both of which are carbon sinks. There have been recent efforts to develop indicators that account for natural capital.

Another problem is that GDP is usually based on market exchange rates and so does not reflect differences in the cost of living in various countries. When GDP statistics are adjusted to reflect purchasing power parity, the GDP of developing countries appears to be much greater and disparities in energy use/GDP between the U.S. and developing countries disappear. By this measure, developing countries are as efficient as their counterparts in the industrialized world. (For this report, GDP is based on market exchange rates.)

Exhibit 1-6



Countries at different development stages exhibit different energy intensities. Many industrialized countries have experienced an increase and then a decline in their energy intensity as they first moved from an agrarian to an industrial and then to a more service oriented economy. (Oil-importing countries reduced their reliance on fossil fuels as a response to the oil crises of the 1970s.) By adopting efficient and low carbon energy producing and consuming technologies, developing countries may be able to experience a carbon intensity peak that is lower than that experienced in the US.

Over the coming decades, the developing countries' rate of GHG emissions growth is generally projected to exceed that of the United States. For most countries, however, it will be many years before they catch up in terms of GHG emissions/capita. From a development perspective, most industrialized countries have gone through a period of increasing energy use per GDP and then a period of decreasing energy use per GDP, although most peaked at lower levels than did the U.S. If developing countries follow this pattern, their past and future efforts to control emissions may mean they will also peak at a lower GHG/GDP level than did the U.S.

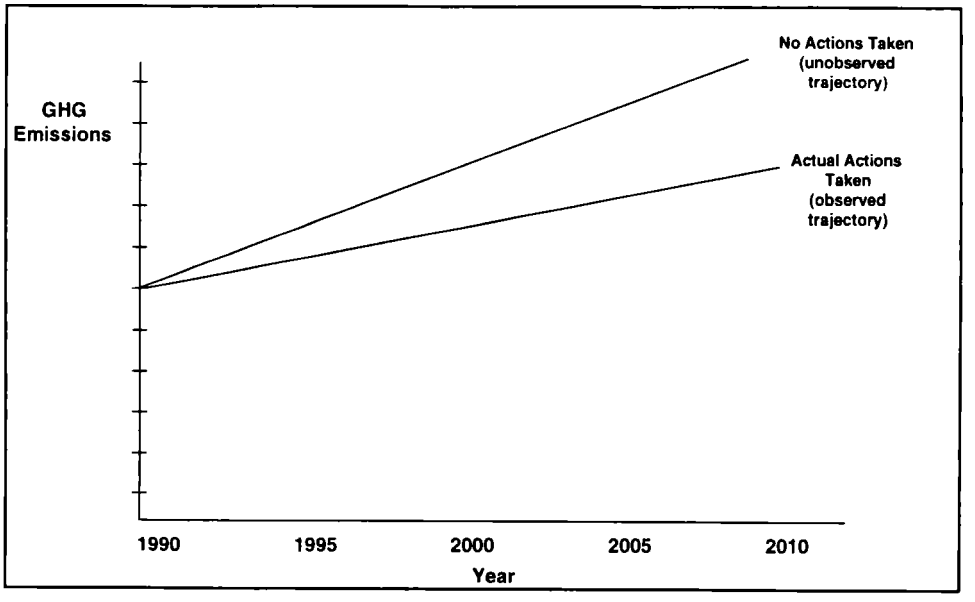
1.3 APPROACH AND ORGANIZATION

This report is the first in a planned series of three studies. This first study assesses the actions that developing countries have taken since about 1990. The next study will develop estimates of the impact some subset of these actions have had and will have on GHG emissions. The third study will explore alternatives and make recommendations for initiatives to be implemented over the next ten years.

The overall approach used to prepare this report is to focus on actions that affect emissions in key countries and sectors. Since developing countries currently produce far lower levels of GHG emissions than industrialized countries, but have higher rates of GHG growth, the report focuses not on absolute emissions reductions but with the degree of success these countries are having in controlling their growth in emissions.

The actions described in this report have been included not only because they are thought to have lowered the rate of GHG emissions growth for the period 1990 to the present but also because they are expected to continue to do so over the next two decades. Many of the actions described in this report have not yet had their greatest effect. The effects of GHG-reducing policies and measures will grow in the years ahead as the overall investment in energy-producing and using capital stock grows. In some cases, a country has passed laws or established an institutional infrastructure whose effects on energy production and consumption decisions and thus GHG emissions will be felt over a period of decades. (See Exhibit 1-7.)

Exhibit 1-7
Schematic Showing Potential Effect of Actions on GHG Emission Trajectories



The present study does not seek to quantify the effect that these actions will have on GHG emissions. That will be the subject of a future study. As part of the methodology for this future study, it will be necessary to establish a "counterfactual" (unobserved) business-as-usual trajectory of emissions from 1990 onward, that is, a projection of emissions that would have occurred if the various emissions-controlling actions had not been taken.

Sources of information include international organizations such as the World Bank, bilateral agencies, developing country government ministries (some of which provide information on the Internet), private organizations, and others. In some cases, government agencies were contacted directly.

Although information has been drawn from throughout the developing world, special attention has been paid to the six developing countries that have large GHG emissions and whose participation in controlling emissions is considered critical to the success of global efforts to stabilize atmospheric GHG concentrations. These countries are China, India, Mexico, Brazil, Indonesia, and South Korea. They represent a range of income levels and geographic conditions. For comparison, data from the U.S. are sometimes included in the discussion.

The report has two major components: a general discussion of GHG-affecting actions, with emphasis on the experience of those countries with significant emissions; and a series of six country case study appendices. The general discussion is organized according to a taxonomy of actions taken by both the public and the private sectors that would be expected to affect GHG

sources or sinks. The main body of the report consists of four chapters. The remainder of this chapter presents baseline conditions and trends. Chapter 2 examines broad economic policies that affect GHG emissions. Chapter 3 discusses actions that developing countries have taken that affect major GHG sources and sinks. Chapter 4 discusses the initiatives that developing countries have taken that explicitly reduce GHG emissions or otherwise support implementation of the FCCC. Each of the six case study annexes follows the same general taxonomy as the main body of the report.

CHAPTER 2
BROAD ECONOMIC REFORMS AFFECTING GHG EMISSIONS

During the 1980s many developing countries had significant economic problems, such as high inflation, severe indebtedness, or lack of competitiveness in the world economy. Since then, several have instituted broad economic reforms in response to these and other economic problems.

Reforms were made to open the economy, decrease inefficiency and waste, and improve stability. On a national level, these reforms have made economies move outward-oriented, liberalized trade regimes, reduced the role of the state in economic affairs, supported privatization of major sectors, removed impediments to the international flow of capital and formation of domestic capital markets, and deregulated and reformed domestic labor markets. Reform packages have included commodity price deregulation, inflation controls, currency devaluation, trade liberalization, and privatization of state industries.

Despite their hoped-for long term benefits, many of these reforms were politically painful in the short run because they resulted in job losses and higher prices for basic commodities and services. Several countries that experienced economic crises during the 1990s -- Mexico, Indonesia, Thailand, Korea -- had to implement fiscal reforms as part of financial assistance packages from the International Monetary Fund (IMF). Although the following discussion focuses on how reforms affect GHG emissions, the crises themselves have also affected emissions. (See Exhibit 2-1)

Exhibit 2-1 Effects of Financial Crises on GHG Emissions

Most recently exemplified by events in East Asia, financial crises potentially affect the energy sector directly through shifts in supply and demand. There, energy demand has fallen, resulting in at least a short term surplus of energy supply capacity. Energy projects and contracts are being rescheduled. Also, currency devaluations have made imported energy as well as imported energy-producing and consuming equipment more expensive. At the same time, countries seeking foreign exchange may boost energy exports at the expense of domestic consumption. Finally, GHG emissions may be affected as energy suppliers and users seek to minimize costs, balancing those associated with maintenance and upgrading of processes that improve their efficiency with resulting cost savings. Deforestation for lumber exports may also increase.

2.1 HOW ECONOMIC REFORMS AFFECT GHG EMISSIONS

When economic reforms are designed, their environmental implications (including climate change) are not generally considered, even though these may be considerable. Economic reforms can have many differing implications for GHG sources and sinks. First, where reforms have been successful, economic growth has accelerated. Reforms in Latin America have increased annual growth rates by about 2% since 1990. Although the two do not necessarily march in lockstep, increased economic growth usually means increased GHG emissions.

Second, reforms often include relaxation of government controls on energy prices. The resulting price corrections generally lead to reduced energy consumption and therefore lower GHG emissions, especially if relaxed control is accompanied by complementary policy and institutional reforms.

Such reforms stimulate in-flows of foreign capital. A substantial portion of this capital is directed to manufacturing energy and infrastructure sectors, which are responsible for a high proportion of GHG emissions. Third, during the 1990s, several developing countries became significantly more integrated in terms of capital flows. (See Exhibit 2-2.)

Exhibit 2-2
Countries Undergoing Economic Integration[1]

Moving from low to medium level of integration	Moving from medium to high level of integration
Panama, Jamaica, Peru, China, Swaziland, South Africa	Thailand, Turkey, Brazil, Argentina, Indonesia, Mexico, Hungary, Ghana, Chile, Pakistan, Philippines

[1] *Private Capital Flows to Developing Countries: The Road to Financial Integration.* A World Bank Policy Research Report. The World Bank, Washington, DC, 1997.

Fourth, in striving for greater economic integration, many developing countries liberalized their trade policies during the 1990s. Prior to that time, these countries had imposed domestic content requirements, quotas, or other non-tariff trade barriers, which inhibited trade in a wide range of goods and services, including those that are more climate-friendly than domestically produced counterparts. Differentiations had been made between domestic and imported goods to protect domestic industries, and restrictions were imposed on imported fuels.

The 1990s saw substantial movement toward liberalized trade and export-oriented trade policies. Between 1985 and 1991, for example, virtually all Latin American countries initiated large scale programs to open up their trade regimes. Average tariffs in the region dropped from 41.6% to 13.7%. Regional trading initiatives that were negotiated include APEC, ASEAN, NAFTA, and Mercosur.

The effects of trade liberalization on GHG sources and sinks are various. The net effects for any individual country are determined by the increase in trade, the shift in economic activities, and any change in the way traded goods are produced. Treaties encouraging trade liberalization clearly influence the flow of private capital and thereby affect companies' investment decisions. Increasingly, these treaties are also influencing domestic regulations and standards. Many countries now look to international standards for energy efficiency in traded goods and industrial processes. APEC members adopt international standards for measuring energy efficiency of equipment and appliances traded among themselves.

APEC members adopt international standards for measuring energy efficiency of equipment and appliances traded among themselves.

Finally, many developing countries initiated inflation controls and introduced currency exchange and interest rate policies that impact both overall economic growth and the relative attractiveness of climate-friendly investments. Inflation control encourages private investment, especially when returns are denominated in the local currency. From 1990 to 1996, median inflation among Latin American countries declined from 30% to 11%. Among the many effects that inflation control has throughout the economy is to increase the incentive for both households and businesses to make energy-savings investments. With inflation under control, projected energy cost savings are worth more.

Currency devaluation was undertaken by many developing countries during the 1990s. For energy-importing countries, this reform had the effect of increasing the domestic price of energy. Many countries also liberalized interest rates, which tended to have a negative effect on GHG emissions. Higher interest rates increased the up-front costs of investing in new equipment and thus made investments in energy end use equipment less attractive. Seventeen Latin American countries have liberalized interest rates during the 1990s.

In summary, the GHG effects of economic reforms can be profound. National economic policy reforms have a potential impact on GHG sources and sinks any time they change the relative returns earned by alternative investments (e.g., acquisition or holding of natural resource assets, industrial production, or natural resource extraction), the mix of production inputs in a given sector, the share of resources allocated among different sectors, or the return on investment in climate-friendly technologies.

Quantifying these effects, however, or even determining the direction of the net change in GHG emissions, may require macroeconomic modeling.[1] The assessment of effects on GHG emissions

[1] "An Overview of the Environmental Impacts of Macroeconomic and Sectoral Policies." Mohan Munasinghe. *Environmental Impacts of Macroeconomic and Sectoral Policies.* Edited by Mohan Munasinghe. International Society for Ecological Economics, The World Bank, and The United Nations Environment Programme, Washington DC 1996.

is complicated by two factors. First, the sequence in which reforms occur can determine whether a positive or a negative effect is observed at any point in time. If a country that is considering both trade liberalization and elimination of energy subsidies decides to implement trade liberalization first, perhaps because of powerful vested interests, the resulting increase in foreign investment could lead to expansion of energy-intensive industries and greater GHG emissions. If energy subsidies are implemented first, GHG emissions will most likely decrease.

Second, the interrelationship among economic sectors means that beneficial GHG effects in one sector can either be magnified or offset by GHG effects in another sector. For example, an increase in the stumpage price charged to timber companies for logging national forests might reduce deforestation from logging, but it might also cause a contraction of the whole forest industry sector, such that resources are shifted to the agricultural sector, causing expansion of this sector and further deforestation.

Because macroeconomic modeling is beyond the scope of this study, the following discussion focuses only on some of the more direct GHG implications of economic reforms: reducing energy subsidies, restructuring energy sectors, and reforming tax policy.

2.2 REDUCING ENERGY SUBSIDIES

2.2.1 Government Role in Energy Pricing

Although energy prices are affected by world markets, national government policy also plays a role. Energy is subsidized in many ways, both direct and indirect, including grants and tax breaks to producers and distributors. Governments may set prices for energy goods and services directly, through public enterprises, or indirectly, through regulation. In many developing countries, the energy supply chain is owned and managed in whole or in part by the government. When it controls prices, it does so most often on behalf of residential, rural, and low-income customers. Countries with extensive energy resources may impose export restrictions, thus keeping domestic prices artificially low.

Where energy demand exceeds supply, the government may give priority to certain classes of customers. This affects the prices paid by other customers, who must compete for a diminished supply of energy. For example, some states in India give priority to farmers for electricity, which leaves such a shortage that some industrial customers must generate their own power.

Removing energy subsidies generally causes a decrease in energy use; the amount of change varies among sectors and countries and over time. When price increases appear to be permanent and when efficient technologies are affordable and readily available, the response to the increase

is stronger. Energy savings of 30%-60% can sometimes be achieved for a long enough period to make replacement of capital equipment a very attractive option.[2]

Of course energy use and production patterns are greatly affected by the responsiveness of households and businesses to changes in energy prices. For example, industrial energy use is more likely to decrease if elimination of subsidies is accompanied by reforms that privatize state-owned industries or otherwise make them sensitive to price changes. On the other hand, eliminating energy subsidies reduces energy use and GHG emissions only to the extent that users do not substitute other GHG-emitting sources of energy. For example, poor consumers may use more fuelwood for cooking and heating if subsidies for fossil fuels are ended.

2.2.2 Trends in Energy Subsidies

In 1990 many developing countries were subsidizing various fuels, especially those used by households. Subsidies have been substantially reduced since that time. In a study of 20 countries that account for 77% of the developing world's energy consumption, fossil fuel subsidies (defined as the difference between border and domestic prices) fell from about $119 billion in 1990-91 to $58 billion in 1995-96. (See Exhibit 2-3)

Estimates of fossil fuel subsidies in the U.S. range from $2 billion (based on direct government costs in 1992) to $21 billion (based on value of subsidies to recipients in 1989).[3] If the mid-point of this range is used to make a rough comparison, subsidies in the U.S. are similar to those in the countries listed in Exhibit 2-3, in terms of percentage of GDP.

[2] *World Bank Development Report,* 1992.

[3] *Federal Energy Subsidies: Energy, Environmental, and Fiscal Impacts.* Douglas Koplow. Alliance to Save Energy, Washington, DC, 1993, and *Federal Energy Subsidies: Direct and Indirect Interventions in Energy Markets.* Energy Information Administration, US Department of Energy, Washington, DC, 1992.

Exhibit 2-3
Coal, Natural Gas, and Oil Subsidies in 20 Countries[4]

Country or Region	1990-91 Subsidy Rates (%)	1995-96 Subsidy Rates (%)	1990-91 Total Subsidies (1995 $US millions)	1995-96 Total Subsidies ($US millions)
Russia	45	31	28,797	9,427
Eastern Europe*	42	23	13,120	5,838
China	42	20	24,545	10,297
India	25	19	4,250	2,663
South Korea	<1	<1	42	12
Indonesia	29	21	2,071	1,333
Mexico	32	16	5,403	2,271
Other oil producers**	NA	NA	23,593	15,668
Argentina	12	3	659	150
Brazil	26	0	2,193	11
South Africa	12	4	981	367
Total	**NA**	**NA**	**106,179**	**48,495**

* Bulgaria, Czech Republic, Hungary, Poland, Romania

**Egypt, Iran, Nigeria, Saudi Arabia, Venezuela

In China, subsidies for coal declined from 37% in 1991 to 29% in 1995; total fossil fuel subsidies fell from $25 billion in 1990-91 to $10 billion in 1995-96. The average retail energy price is now at or above the cost of supply. Coal and oil prices are determined by market forces.

Fossil fuel subsidies in 14 developing countries declined 45% between 1990 and 1996. China reduced fossil fuel subsidies by more than 50% between 1990 and 1996.

[4] *Expanding the Measure of Wealth: Indicators of Environmentally Sustainable Development.* Environmentally Sustainable Development Studies and Monographs Series No. 17 World Bank, Washington, DC, 1997.

In India, all petroleum products except kerosene are at or above world prices. Coal prices for all grades have been raised sufficiently to cover at least operating costs, and prices for higher grades have been deregulated entirely.

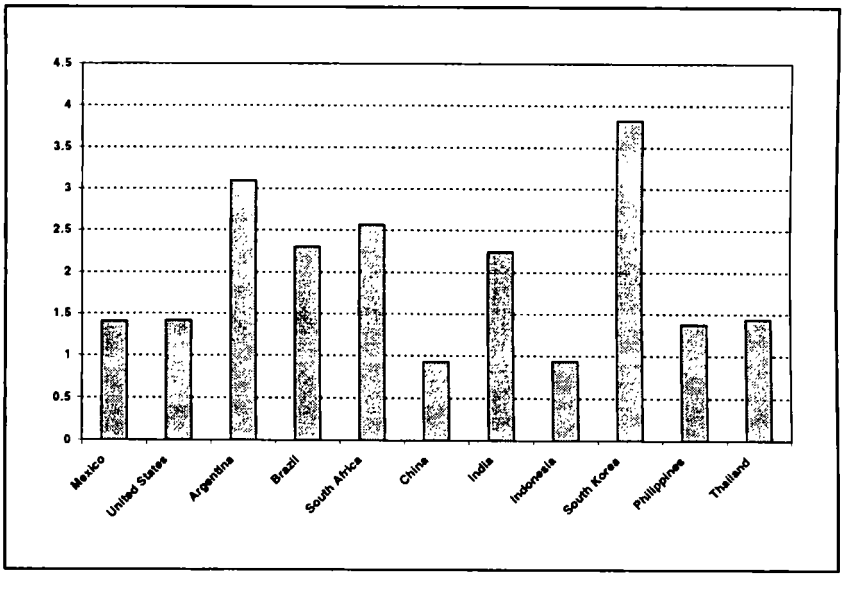
Most developing countries now price gasoline higher than the does the U.S. (See Exhibit 2-4) Among the six countries targeted in this report, Korea has the highest gasoline prices, followed by Brazil (See Exhibit 2-5).

Due to high inflation, real energy prices fell slightly in the 1980s in all Latin American countries except Argentina. Once inflation began to be brought under control in the 1990s, real fuel prices began to rise.

Exhibit 2-4
Mean Consumer Gas Price at the Pump
(in US$ per liter)

	Gasoline	Diesel
United States	$ 0.37	$ 0.31
Developing Country Average	$ 0.56	$ 0.38
Poorest Country Average	$ 0.57	$ 0.40

Exhibit 2-5
1998 Prices of Premium Unleaded Gasoline in Selected Countries Including Taxes



2.3 RESTRUCTURING ENERGY SECTORS

The average consumer price for gasoline in developing countries is now over $2.00/gallon.

In 1990 the power sectors of developing countries were dominated by publicly owned and managed utilities that could not meet rapidly growing demand, and that were unreliable. The utilities frequently lacked the capital to invest in new capacity and/or to maintain the infrastructure that was already in place.

Changes in the ownership, management, and structure of the energy industry can have profound effects on GHG emissions. The reforms change the incentives for using particular types of fuel and power generating technologies, for reducing energy losses in the transmission and distribution of power, and for managing customers' end use demand.

The full process of reform takes several years. Although only a few countries have completed it, many took significant steps during the 1990s. Data on changes in power system efficiency, use of low-carbon fuels, and tariff reforms are not yet available for many of the countries that have initiated reforms.

Energy sector reforms in developing countries affect GHG emissions in several ways. Beneficial effects on GHG emissions have resulted from:

- enhanced incentives to improve efficiency in generating, transmitting, and distributing power;
- enhanced incentives to fully recover the costs of serving households and businesses;
- increased use of natural gas for power generation; and
- strengthened environmental regulation.

2.3.1 Improvements in Power System and End Use Efficiency

Commercialization and private power development have brought an infusion of capital that has allowed developing countries to upgrade existing facilities and to construct new more efficient facilities. Energy losses in transmission and distribution systems have been reduced. Distribution losses in Argentina dropped from 21% in 1992 to 12% in 1995.[5]

[5] "Regulatory Lessons from Argentina's Power Concessions." 1996. Estache, Antonio and Martin Rodriguez-Pardina. Private Sector Note No. 92. World Bank, Washington, DC.

As part of their power sector reforms, several countries have also established utility regulatory structures that promote energy efficiency. In 1995, the Philippines Department of Energy issued a mandate for all utilities to create plans for demand side management (DSM). The Energy Regulatory Board, which oversees electric utilities, is drafting regulations that will allow utilities to recover the costs of programs in their plans. The State of Orissa in India has approved an $80 million DSM program as part of the restructuring of its utility. To ensure that energy efficiency continues to be promoted in a privatized electricity industry, the Government of Brazil has created a fund from taxes on electricity sales with over $100 million available annually to leverage energy efficiency investments.

In the wake of privatization, distribution energy losses were reduced in Argentina from 21% in 1992 to 12% in 1995.

2.3.2 Improvements in Electricity Price Signals

Developing countries' electricity price subsidies in the early 1990s are estimated to have totaled about $54 billion, for an average of 3.6% of GNP for these countries. Since then, electricity prices have risen significantly in real terms. By 1996 electricity prices in many countries were approaching the levels of the U.S. (see Exhibit 2-6). In India, where the price is still very low, legislation has been proposed to establish regulatory authority over the power sector and to recover at least 50% of the cost of electricity production through tariffs.

To ensure that energy efficiency continues to be promoted in a privatized electricity industry, the Government of Brazil has created a fund from taxes on electricity sales with over $100 million annually to leverage energy efficiency investments

Although reductions in fossil fuel subsidies have been partly responsible for rising electricity prices, there have been other contributing factors as well, including a reduced willingness to use government funds to offset public power company losses and the transfer of ownership to the private sector. During the period that electricity tariffs have been brought more closely into line with costs, revenue collection has also been improved in many countries. India has adopted the policy that tariffs must recover at least 50% of the cost of service from even rural low income customer classes.

Privatization of state owned industries that are large energy users has also occurred. Prior to being privatized, many of these industries had not been accustomed to having to pay their energy bills and so were insensitive to how much energy they used. After privatization, these industries became subject to the same rules as other industries. (There is empirical evidence, however, that

publicly owned enterprises are price sensitive to some degree, even if they are not as responsive to prices as private enterprises.[6])

Exhibit 2-6

Country	Household Electricity Prices in US$/KWh (1996)
South Korea	0.103
Mexico	0.054 (1997)
Brazil	0.146
India	0.028 (1995)
South Africa	0.045
Thailand	0.086
United States	0.084

Source: International Energy Agency. Energy Prices and Taxes.

2.3.3 Opening Up Energy Markets

India plans to recover at least 50% of the cost of electricity production through tariffs.

Some countries have privatized fuel production and certain industrial sectors as part of a general economic liberalization. Privatization of fuel production has stimulated investment in extraction and transport facilities. One result has been the expansion of the range of fuels available for power generation and other purposes. In some countries, privatization of natural gas development has increased the share of that fuel during the 1990s.

A key reform is private management and ownership of the power sector. In Latin America, utilities account for 43% of the value of all privatizations that have taken place.

Several countries have established initiatives for purchasing independently produced power generated from renewable sources. The wholesale bulk power market for renewable power producers in Thailand is the Small Power Producer (SPP) program. By the end of 1995, the Electric Generating Authority of Thailand (EGAT) had received 84 SPP proposals totaling 4,435 MW. Based on this higher than expected response to the SPP program, EGAT decided to allow EGAT to purchase up to 3,200 MW from SPP developers during the period 1996-2001, subject to dispatching requirements and transmission constraints. The SPP program includes bagasse

[6] "Estimating the Price Responsiveness of Chinese State-Owned Enterprises: Implications for Environmental Policy." Koshy Mathai. New Ideas in Pollution Regulation, World Bank, Washington, DC, 1997.

regulation of conventional air pollutants and the increase in associated compliance costs have made climate-friendly generation options more competitive.

Prior to regulatory reforms of the electricity industry in Thailand, the electricity industry regulated itself with respect to environmental performance. Under the new industry structure, there is independent regulation, which has been shown to be more stringent than the self-regulation practiced in other Asian countries. In some countries, when bids submitted by competing power developers are reviewed, credit is given for clean fuels.[7] [8]

In Argentina, environmental issues have been taken into account in the laws and decrees implementing the electricity sector's deregulation. Air and water emissions are explicitly addressed in the law governing power sector privatization. Although GHG emissions are not currently regulated, controls should be relatively easy to introduce, if and when they are necessary, because the environmental regulatory structure is already in place.

2.4 REFORMING TAX POLICY

Tax policies can directly influence investment and consumption decisions that have GHG implications. Energy tax policies vary widely from country to country. Taxes may be imposed at the point of fuel extraction (in the form of royalty payments), on imports of fuel or energy technologies, on fuel transport, on wholesale power generation, or on retail fuel or electricity sales. Taxes on upstream production and transport of fuels show up as higher prices at the retail level.

The tax structure in developing countries has often been narrowly based, sometimes incorporating features that motivate investment and consumption decisions that are detrimental from a societal perspective. In Latin America tax reform has most commonly sought to promote neutrality (so that the tax structure does not distort investment and consumption decisions), simplification, and greater revenues. To moderate the distorting effects of taxation on production and saving decisions, more than 21 countries have attempted to change consumption patterns by adopting tax and value-added systems. Taxes on foreign trade have been reduced.

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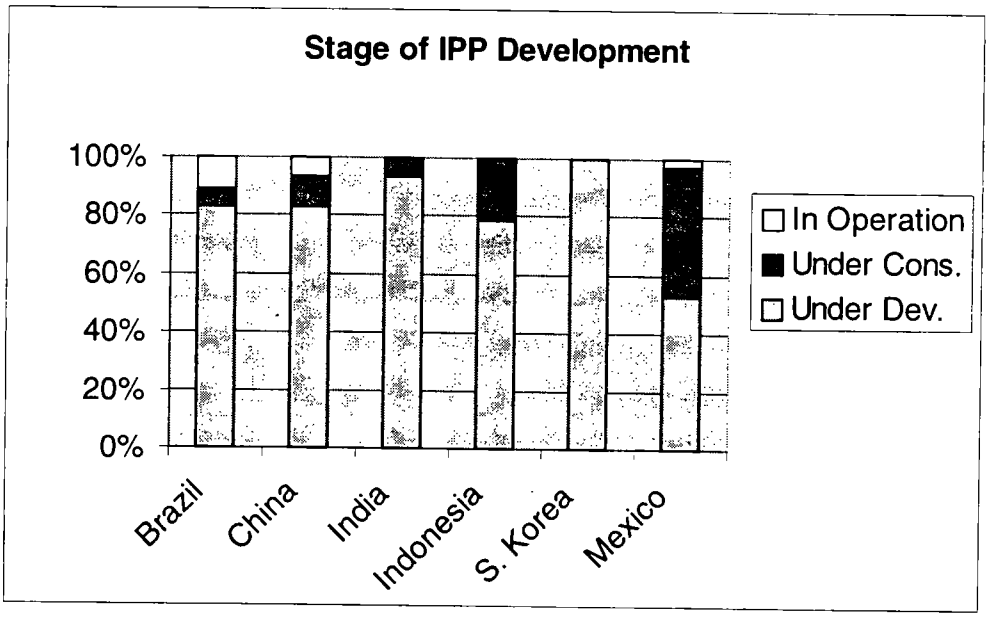
[7] "Power Sector Reform in Thailand: Will the Recent Structural Reforms Result in Better Environmental Management?" Romeo Pacudan, Asian Institute of Technology.

[8] *Private Sector Participation in Power Generation and Its Consequences on Environmental Quality.* Economic and Social Commission for Asia and the Pacific Programme for Asian Cooperation on Energy and the Environment, United Nations, New York, 1995.

and rice husks as well as cogeneration, which all have lower GHG emissions than conventional generation. Exhibit 2-7 shows the status of independent power projects in selected countries.

Exhibit 2-7



In Argentina, the effort to increase private participation in the power sector has fostered the development of an innovative experiment to establish an electricity concession market for unserved areas, using renewable energy sources when possible. Under the Electricity Supply Program for the Rural Dispersed Population, which the Argentinean government has initiated in cooperation with participating provincial regulatory authorities, priority is given to photovoltaic panels, small windmills, hydroelectric micro-turbines, and diesel-driven generators. The total estimated investment of US $314 will be shared, with 45% paid by users and 25% coming from provincial subsidies and 30% from national subsidies. Preliminary analyses suggest that renewable technologies will often be competitive with diesel generators.

2.3.4 Strengthened Environmental Regulation

While privatizing their energy sectors, many developing countries also strengthened regulatory oversight. More stringent

Argentina is providing incentives for privatized electricity distribution companies to use renewable energy sources in rural areas.

Some countries have used tax policy to encourage investment in development of GHG-friendly energy options. Measures include tax exemptions or credits for specific technologies or types of investments, and accelerated depreciation.

These various innovations and adjustments to tax policy often represent a dramatic change from previous practice. In 1994, China increased taxes on gasoline by 17% and on diesel oil by 13%. Consumption of these two fuels dropped from 38 million tons in 1994 to 27 million tons in 1995. (In China, local governments determine taxes on resource extraction activities.) To discourage waste of electricity by residential customers in the Philippines, a tax was imposed on a graduated scale for consumption exceeding 650 kWh/month. In Brazil, import taxes on renewable energy equipment were reduced during the 1990s, and in 1997 the 18% state value-added tax was eliminated altogether for certain types of renewable energy equipment.

CHAPTER 3
SECTOR-SPECIFIC ACTIONS AFFECTING GHG EMISSIONS

The net contribution that a country makes to GHG emissions is a combination of its emissions from various sectors and the carbon that becomes stored in plants. The rate of emissions growth might be mitigated by actions to improve the efficiency in which energy is supplied and consumed, increase reliance on renewable energy sources, and protect land areas that serve as carbon sinks. As with broad economic policy reforms documented in the previous chapter, the sector-specific actions summarized below have been taken for reasons other than GHG control — reducing reliance on imported fuels, improving local environmental quality, saving money, protecting biodiversity, etc.

This chapter is organized according to key GHG sectors: buildings and industry, transportation, power production, and carbon sinks (forests). Their relative contribution of each sector varies by country. For example, the transport sector plays the largest role only in Brazil. Buildings and industry contribute over 50% of total emissions in China, Korea, and Indonesia. India is the only country of the six in which the power sector is responsible for the largest share of emissions. (See Exhibit 3-1) Emissions resulting from loss of biomass are not included in Exhibit 3-1 since these data were not available to directly compare to those from burning fossil fuels.

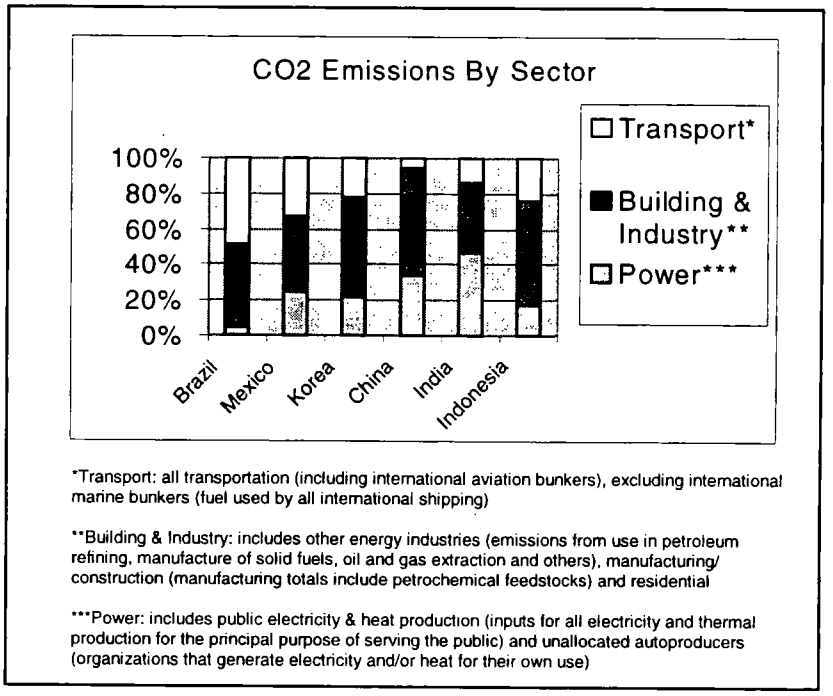
3.1 REDUCING FOSSIL FUEL ENERGY USE IN BUILDINGS AND INDUSTRY

Buildings and industry constitute a large and growing source of carbon emissions from developing countries. Emissions result from direct fuel combustion, such as for cooking and industrial processes, as well as from fossil fuels burned to generate electricity for lighting, air conditioning, refrigeration, water heating, etc.

Some buildings or industries emit greenhouse gases directly, through cogeneration or as a consequence of certain industrial processes such as the burning of fuel oil in pulp and paper mills, but the vast majority of greenhouse gases associated with buildings and industry are emitted as a result of their electricity needs. This is particularly true for buildings.

This chapter will focus primarily on electrical end-use efficiency activities that developing countries have undertaken to reduce their GHG emissions. During the 1990s developing countries have initiated a wide range of activities to improve energy efficiency in the building and industry sectors.

Exhibit 3-1
CO_2 Emissions By Sector (Million Tonnes of CO_2)



Source: 1998 World Development Indicators, World Bank, (format CD-ROM)

Many energy efficiency activities affecting buildings and industry are tied to specific technologies. These include building controls; heating, ventilation and air conditioning equipment (HVAC); building envelope, such as windows and insulation; industrial process controls; motors and adjustable speed drives; and lighting. A 1997 USAID report estimated the size of the developing country market just for efficient models of these technologies at $9.5 billion.[1]

Approaches to promoting efficiency in buildings and industry differ according to each country's economic, political, and social characteristics. In general, as in most industrialized countries, the types of activities fall into three main categories:

- **Codes and Standards.** A number of developing countries have adopted national building codes, as well as efficiency standards for major energy-using appliances such as motors, refrigerators, furnaces, and air conditioning.

[1] *The Energy Efficiency Market in Developing Countries: Trends and Policy Implications,* USAID/Office of Energy, Environment, and Technology, November 1997, p. 19.

- **Market-Based Programs.** Market incentives include tax credits for energy efficiency retrofits, efficient appliance rebates, formation of energy service companies, and advertising.

- **Services and Incentives.** Programs include public information campaigns, development of innovative financing mechanisms for energy efficiency improvements, and appliance labeling programs, as well as traditional commercial and industrial sector demand-side management (DSM) programs.

Among ten large GHG emitting countries in Asia and Latin America, eight had implemented efficiency codes and standards, market-based efficiency activities, and provided other energy efficiency services and incentives.

Many developing countries have initiated at least some programs in all three categories. Exhibit 3-2 gives an overview of some of the types of activities undertaken by key GHG-emitting countries in Asia and Latin America. The programs are not necessarily equivalent; for example, Indonesia's building efficiency code is voluntary, while the Philippines and Thailand made building codes mandatory in 1994 and 1995, respectively.[2]

Exhibit 3-2
Energy-Saving Activities in Buildings and Industry Selected Countries

Key Countries/ Regions	Codes and Standards		Financial Incentives			Technical Services and Promotion (Market Transformation)		
	Building Codes	Appliance Standards	Free Technical Services	Rebates/ Credits	Utility DSM	Information & Promotion	ESCO Development	Labeling
Argentina						✔	✔	
Brazil	✔	✔		✔	✔	✔	✔	✔
Chile	✔					✔	✔	
Mexico		✔		✔	✔		✔	✔
China	✔	✔		✔			✔	
India				✔		✔		
Indonesia	✔				✔	✔		
Korea	✔	✔	✔	✔		✔		✔
Philippines	✔	✔	✔	✔	✔	✔		✔
Thailand	✔	✔	✔	✔	✔	✔	✔	✔

[2] Ted Flanigan and Peter Rumsey, *A Compendium of Asian Energy Efficiency Success Stories*, The Results Center and International Institute for Energy Conservation, March 1996, p. 34.

3.1.1 Building Codes and Appliance Efficiency Standards

The adoption of codes and standards is one of the most effective means of reducing energy use in buildings and industry throughout the developing world. Voluntary codes and standards can act as a market "pull" strategy, whereby companies whose products meet or exceed the standards can use their compliance as a competitive tool. This then motivates other manufacturers to meet the standards as well, so that they can continue to compete.

Mandatory standards are more of a "push" strategy, forcing all manufacturers to comply. Many countries have initially implemented voluntary standards and followed up with mandatory ones.

Codes and standards are not enough, in and of themselves, to ensure reduced energy consumption in buildings and industry. Once they have adopted codes and standards, developing countries may still face many barriers to their enforcement. Often building engineers and designers are unfamiliar with efficient equipment and design techniques and need training. In addition, codes and standards generally apply to new construction and appliances rather than to existing equipment, with the consequence that codes and standards are most effective in countries experiencing high rates of growth in new buildings and industry.

Building Codes

ASEAN.[3] Southeast Asia has been one of the most successful regions in implementing new commercial building codes. Singapore was the first country in the region to institute a building code, in 1979. Singapore has a strong incentive, in general, to implement energy conservation strategies, because it relies on 100% imported energy. Following the adoption of codes in Singapore, USAID provided assistance to help other countries in the region initiate and enforce their own building codes. This effort began in 1982 and is ongoing today.

The codes differ slightly depending on the specific conditions in each country, but in general they focus on building envelope, lighting, and cooling equipment. Some countries have relied on prescriptive codes, which specify the exact technologies and types of equipment to be used in building construction. Other countries have performance-based codes, where a building must meet certain standards of overall thermal transmittance value (OTTV), which is verified by computer simulations before construction and by actual measurements afterward. (See Exhibit 3-3)

[3] All information contained in this section is taken from Flanigan and Rumsey, *A Compendium of Asian Energy Efficiency Success Stories*, pp. 28-34.

Exhibit 3-3
ASEAN Building Codes

Country	Year	Applicability	Provisions	Compliance
Indonesia	1990	New buildings with air conditioning	Building shell, lighting, A/C equipment	Voluntary -- low private sector compliance
Malaysia	1989	New buildings	Building shell, lighting, A/C equipment	Voluntary -- high private sector compliance
Philippines	1994	New buildings with energy use greater than 10 W per square meter	Building shell, lighting, A/C boilers and hot water systems	Mandatory -- poor enforcement
Singapore	1980	New and existing buildings A/C greater than 30 kW	Building shell, lighting, controls and ventilation	Mandatory -- tax incentives for compliance, penalties for noncompliance
Thailand	1995	New and existing buildings w/ greater than 100 kW demand	Building shell, lighting, A/C (sizing, ventilation, efficiency)	Mandatory -- surcharges for noncompliance

Source: Flanigan and Rumsey, 1996.

No measurement or evaluation of the success of the ASEAN building codes has yet been conducted. When the original codes were designed, potential energy savings were estimated at between 19 and 24%.

Mexico. Mexico began developing a national commercial building energy standard in 1992. The Mexican National Commission for Energy Conservation (CONAE) is managing the effort. The warm Mexican climate means that the building standard is dominated by building envelope specifications such as insulation and windows. A first draft of the standard was released for public comment in mid-1995. CONAE worked to ensure awareness by holding public workshops and organizing advisory meetings with building designers and engineers. In response to comments gathered in these fora, CONAE is still in the process of revising the standard, which will become law one year after it is finalized.

While CONAE continues to receive comments on the standard and to revise it accordingly, plans are being developed for information dissemination, training, and standard enforcement. Options under consideration include certification of building engineers by CONAE, who will then enforce the standard.[4]

[4] Joe Huang, et al. "A Commercial Building Energy Standard for Mexico," *ACEEE Summer Study*, August 1998, p. 5.153.

Appliance Efficiency Standards

Mexico. The Mexican National Commission for Energy Conservation (CONAE) has implemented a number of appliance standards since 1995. These include room air conditioner, water pump, clothes washer, central air conditioner, and refrigerator/freezer standards. Most standards were modeled after those used in the US. In 1992 an oversight and standardization body was created, made up of government agencies, academics, and manufacturers, to approve the appliance efficiency standards published in the Mexican Federal Registry.[5] The most important accomplishment of these standards has been to eliminate the most inefficient models from the marketplace. In addition, CONAE has established a relationship with a number of appliance manufacturers, which helps to promote cooperation and understanding of various pressures on both sides. Exhibit 3-4 gives approximate first year savings for the various appliance efficiency standards adopted.

Exhibit 3-4
First-Year Energy Savings from Implementation of Appliance Standards in Mexico

Mexico has imposed efficiency standards for five major electric appliances.

Appliance	Date Standard Applied	Savings (%)	Savings (GWh/year)
Room Air Conditioner	1/1/95	20%	323.0
Water pump	4/19/95	18	6.0
Clothes Washer	5/11/97	10	7.9
Central Air Conditioner	8/2/98	3	18.5
Refrigerator/Freezer	8/1/97	41	579.0

Source: CONAE.

Philippines. In the Philippines energy master plan, the Department of Energy's Fuel and Appliance Testing Laboratory (FATL) is charged with developing performance testing procedures, labels, and standards for a number of appliances. The FATL, however, suffers from lack of market information about specific appliances, especially motors, which hampers its ability to develop and implement standards. The Philippines DOE is currently working on collecting data about motors in use in the Philippines today in order to begin to estimate the savings potential. At the same time, FATL is developing motor testing standards.[6]

[5] Dr. Rafael Friedmann, "Activities and Lessons Learned Saving Electricity in Mexican Households," *ACEEE Summer Study,* August 1998, p. 5.122-5.123.

[6] Stephen Wiel, et al., "Implementing Energy Standards for Motors and Buildings in the Philippines," *ACEEE Summer Study,* August 1998, p. 5.339-4.344.

Through agreement with fluorescent tube manufacturers to modify production types, EGAT created savings of 242 MW of peak demand and 1,063 GWh of energy between October 1994 and October 1997.

Thailand. Between September 1993 and September 1995, the Demand-Side Management Office (DSMO) of the Electric Generating Authority of Thailand (EGAT) undertook to negotiate with the main manufacturers of fluorescent tube lighting in Thailand to replace production of 40W and 20W tubes with 36W and 18W models. Through negotiations and financial incentives, EGAT was able to secure commitment from the manufacturers to produce the more efficient lamps, and phase out production of the higher wattages entirely by 1995.[7] This voluntary agreement amounts to an efficiency standard for fluorescent lighting in Thailand.

In addition, EGAT's DSM programs are being supported by the establishment of a Thai Industrial Standards Institute (TISI), to provide testing of the energy efficiency of refrigerators and air conditioners.

Brazil. Brazil's agency for energy efficiency promotion, PROCEL, has implemented energy efficiency standards for boilers, refrigerators, small air conditioners, buildings and electric motors.

Ghana. The government of Ghana is developing minimum standards for room air-conditioners, refrigerators, and lighting systems. A comprehensive market analysis will be undertaken first, to provide information on the manufacturers and the types of appliances that are being sold and used. The information will be used to set an appropriate minimum standard for those appliances.[8]

3.1.2 Market-Based Energy Efficiency Programs

In general, the private sector in developing countries has not yet participated as much as the government in the energy efficiency activity occurring in buildings and industry. In some countries such as Brazil, where there is a long history of government-sponsored energy efficiency programs, private sector activity is more likely. Many developing country governments have been looking for ways to encourage private activities. This section discusses some private sector energy efficiency activities, some of which are government designed or sponsored.

[7] DSMO, EGAT. *Together in Conservation. DSM Experience and Perspective.* November 1997, p. 16.

[8] Seth Baruch and Mark Hopkins, "Combining National and Municipal Initiative to Address International Energy Efficiency: Examples from Ukraine, Ghana and India," *ACEEE Summer Study*, August 1998, p. 5.7.

Brazil

Lighting. In Brazil, where there is a long history of energy efficiency activities, the private sector has initiated a number of energy saving programs. For example, the Brazilian lighting industry organization (ABILUX) has developed lighting efficiency projects which total approximately US$20-30 million in investment. Their programs are expected to generate 200 GWh annually in energy savings, as well as 1 million tons of CO_2 reductions, over the life of the programs.[9] Technical feasibility would allow 60% energy savings on lighting in commercial and public buildings.

China

ESCO Pilot Project. The Chinese government is currently sponsoring a pilot program to establish three energy service companies in the Beijing area, to help introduce the concepts of performance contracting to industries in the region. The energy service companies are receiving technical assistance through donor funding and the Beijing Energy Efficiency Center (BECon).

South Africa

Green Buildings for Africa (GBA). GBA is a market-based voluntary program modeled after the US Energy Star and Green Lights partnerships. This recently designed program is managed by the Buildings Technologies Division of South Africa's largest research institute. One of its first activities will be a showcase program, where 10 showcase partners agree to perform energy efficient upgrades to at least one building. The GBA team is currently working on development of logos, marketing strategies, and training plans.[10]

Mexico

The 100 Public and Private Buildings Programs. These programs, begun in May 1996 and managed by CONAE (Mexico's National Commission for Energy Conservation), began by showcasing energy efficiency upgrades in pilot buildings. CONAE computer models estimate potential energy and cost savings, based on modification of installed equipment. In addition, CONAE checks billing data and occasionally conducts site visits to specific buildings. Currently, 47 audits have been conducted in public buildings, with eight undergoing upgrades.[11]

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[9] Hagler Bailly, "Trip Report Brazil Energy Efficiency Financing Program." *USAID Office of Energy, Environment, and Technology*, February 1998.

[10] Dale R. Stanton-Hoyle, "Opportunities for Market-Based Programs Worldwide that Reduce Greenhouse Gas Emissions: Initial Observations from Missions to the Philippines, South Africa and Mexico," *ACEEE Summer Study*, August 1998, p. 5.310.

[11] Dale R. Stanton-Hoyle, "Opportunities for Market-Based Programs Worldwide that Reduce Greenhouse Gas Emissions: Initial Observations from Missions to the Philippines, South Africa and Mexico," *ACEEE Summer*

3.1.3 Services and Incentives

The types of programs that fall into this category are very broad. Traditional utility-sponsored demand-side management programs, which offer rebates and other incentives for the adoption of energy saving technologies, are just one example. In many countries, those types of programs have been widely used, modeled after DSM programs in the United States in the 1980s.

DSM Programs

Indonesia. Since 1992 the Directorate General of Electricity and Energy Development and Indonesia's national electric utility (PLN) have been designing and implementing DSM pilot projects in the commercial and industrial sectors. Two main areas of focus are the installation of a Utility Communication System (UCS) and high efficiency lighting.

The UCS is to be the primary means of administering commercial and industrial DSM programs, and includes the following functions: automatic meter reading; load research; theft detection; direct load control; real-time pricing; curtailment alert; generator request; outage detection; and remote service connect and disconnect. All of these capabilities will allow the utility and the customer to monitor energy use more effectively. A key to designing future successful DSM programs is full knowledge of energy use.

In addition, Indonesia has focused on lighting as a primary technology for energy savings in the short term. PLN's commercial and industrial DSM program includes an incentive for the purchase and installation of two different high efficiency lighting technologies: electronic ballasts and T-8-type fluorescent tube lamps. These replace magnetic ballasts and standard lamps. Compact fluorescent lights replacing incandescent bulbs also qualify for the program.

Brazil. Brazil has been among the more aggressive countries targeting energy savings in buildings and industry, especially through PROCEL, the energy efficiency organization within the Brazilian electricity holding company. During the 1990s, a number of energy efficiency and demand-side management programs have been undertaken. Lighting and appliance efficiency programs were described above. In total, all of PROCEL's efficiency projects have been credited with saving 3,600 GWh of energy in 1996.[12]

Mexico. In 1994 FIDE began a pilot project to increase the efficiency of electric motors. As part of this project, 20 local audits of industrial facilities' motor use were conducted. Electric energy savings in the participating plants were estimated to be as much as 15 percent, or approximately

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Study, August 1998, pp. 5.312 and 5.313.

[12] Howard Geller, "Brazil Fourth Quarterly Report." *Prepared for USAID, Office of Energy, Environment, and Technology*, May 1997.

9.4 GWh per year, with demand reduction of 1.2 MW.[13] In coordination with this project, FIDE and CFE (the federal electric utility) designed a five-year information campaign, which provides customer incentives to be financed through a forthcoming energy efficiency loan of approximately $30 million from the Inter-American Development Bank. This motor efficiency project has gained respect from the Mexican technical community because of its rigorous analytical approach to motor system efficiency.

Ilumex program savings amount to 114 GWh per year, 54 MW of peak demand, and 87,000 tons of CO_2.

The US $23 million Ilumex project, funded by Mexico's state-owned utility (CFE), the Global Environment Fund (GEF), Government of Norway, and the World Bank, was designed to increase penetration of the residential market by compact fluorescent lamps (CFLs). The project began in 1990 in the pilot cities of Guadalajara and Monterrey, the largest cities served by CFE. As of December 1997, 1.71 million CFLs have been sold and 315,000 households have participated, buying an average of 5.4 CFLs each. Ilumex program savings amount to 114 GWh per year, 54 MW of peak demand, and 87,000 tons of CO_2. Because of the success of this program, CFE will use remaining funds to expand Ilumex to 2.5 million CFLs. The Inter-American Development Bank has granted a US$23.4 million loan to FIDE for future lighting programs.[14]

In addition, US$46.8 million from FIDE and CFE, along with a $23.4 million loan from the Inter-American Development Bank, is helping provide incentives to industries in Mexico to invest in energy-efficient equipment. Technologies included in the program are motors, compressors, and lighting. Estimated energy savings over a five-year period are 2,722 GWh of consumption and 300 MW of demand.

Viet Nam. The Vietnamese Institute of Energy (EI) and Electricity of Viet Name (EVN) has been receiving planning assistance from the World Bank to help identify potential contributions of energy efficiency and DSM to help manage growth of electrical demand. Several DSM programs have been designed and will be implemented soon.

Programs designed for the industrial sector include:

- electrical efficiency review of large new projects;
- standards development for motors and lighting in industry;

[13] "World Energy Efficiency News," World Energy Efficiency Association, September 1997, p.2.

[14] Dr. Rafael Friedmann, "Activities and Lessons Learned Saving Electricity in Mexican Households," *ACEEE Summer Study*, August 1998, p. 5.122.

- load management for large facilities; and
- facility energy audits.

For new commercial buildings, Viet Nam will be developing building shell efficiency standards as well as equipment efficiency standards (including lighting). While these standards are being developed, it has been proposed that existing international standards be used.

Ukraine. A number of DSM project opportunities have been identified and are being implemented in Ukraine. The initial work to identify opportunities was funded by USAID Industrial programs under development include load management, process improvements, fluorescent lighting, and motor efficiency. All of these programs have multiple parts. For example, motor efficiency includes motor downsizing, high efficiency drive applications, installation of adjustable speed drives, and efficiency improvements in existing and new motors. Commercial measures include lighting and communal services pumping (including water, sewage, district heating, and water heating systems).

Poland. Poland has also identified a number of cost effective DSM projects to undertake. These include:

- Commercial lighting. This program includes compact fluorescent lamps, occupancy sensors, and T-8 lamps with electronic ballasts. These were designed to be used in retrofit applications.

- Industrial motors. Targeting three motor sizes, this program aims to encourage motor replacement, instead of rewinding, at the time of failure. In addition, a separate motor downsizing project is being implemented. The downsizing project has virtually zero capital cost except for installation, because it involves trading existing motors to achieve a better match between applications and motor capacity.

- Industrial lighting. This is a retrofit program designed to replace inefficient lighting with a combination of high pressure sodium, metal halide, and T-8 lamps and electronic ballasts.

- Industrial tariffs. This activity includes the design of rates specific to industrial customers, including time-of-use and interruptible/curtailable rates.

Morocco. Between 1989 and 1995 USAID funded the Morocco Energy Demand Management Project. The purpose of the project was to reduce energy consumption and alleviate Morocco's dependence on energy imports, while creating a market for energy management services which would guarantee the sustainability of energy management practices. Project activities included:

- Information dissemination to develop awareness of energy management in key industrial sectors and throughout Morocco. Such activities included the distribution of a newsletter

to over 1300 subscribers, the participation of project staff in media shows and news conferences, and the organization of symposia.

- Technical support for selected firms to conduct energy audits and assist in equipment replacement in industry.

- Training to build the necessary Moroccan expertise in conducting audits and implementing energy management practices. Such activities included in-country training through seminars on energy conservation held every three months, and US study tours geared to familiarize private sector companies and government officials with US companies and technologies and to foster business linkages.

- Policy analysis to conduct specific studies which will influence and support policy decisions on energy demand issues. This included a study on the potential for DSM and a study on the impact of excessive customs duties on energy-efficient equipment.

India. Beginning in 1995, the State Electricity Board of Andhra Pradesh (APSEB) undertook a project funded by USAID to introduce integrated resource planning (IRP) in the state. Although not specifically oriented to buildings and industry, the project has many implications for these sectors. The project seeks to assess the magnitude of DSM opportunities available to help diminish the need for additional installed capacity to meet demand shortfalls. The specific objectives of the project were to:

- Establish an institutional basis for IRP by 1) demonstrating the value of the resource acquisition plans that result from IRP so that the SEB can be guided in its future investment decisions; 2) building the knowledge and skills necessary to conduct IRP; and 3) gaining political and power sector commitment to pursue the recommended actions.

- Analyze a full range of options for meeting power requirements (including renewable generation, cogeneration, private power, and DSM), taking into account economic costs, power quality and reliability, and environmental consequences.

- Introduce a set of analytic tools and an IRP model for state-wide analysis of generation, transmission, distribution, and DSM resource investment options.

- Apply methods of analyzing the risk and uncertainty in the assumptions that bear upon various supply and demand management options.

Public Information Campaigns

Other important activities taking place in developing countries have been government-sponsored. Many programs are aimed primarily at increasing awareness of energy conservation. Public information campaigns are one example.

In Thailand, a pilot program has been developed to create energy efficiency curricula to be introduced at all school levels between kindergarten and high school. This program is being coordinated with the Ministry of Education and is nicknamed "green classrooms." The curriculum design and materials have been translated into English and are being used as a prototype by the World Bank for demonstration in other countries. Similar programs, designed on the Thai model, are being developed for China, Philippines, Indonesia, Viet Nam and Laos.

A Thai air conditioner labeling program, which incorporated an innovative financing scheme for interest-free loans to consumers through the credit cards of three major banks, resulted in savings of 196 GWh of energy by October 1997.

Appliance Labeling

Thailand also has a program under way to label appliances such as refrigerators and air conditioners with their efficiency ratings. Mandatory refrigerator labeling went into effect in September 1994, while air conditioners have been labeled since September 1995. In coordination with mandatory labeling, EGAT has spent over US$12.5 million on public information and on a program to encourage consumers to purchase efficient air conditioners. Interest-free loans were provided, with the loans to be paid back over 20 months through the credit cards of three major Thai banks.[15]

Energy Efficiency Centers

Another popular model for developing services and incentives programs in developing countries has been the establishment of energy efficiency centers. Such centers allow local and foreign experts to come together to share information and engage in dialogue on the subject of efficiency in buildings and industry, as well as other sectors. These centers have been particularly successful in Eastern Europe and the former Soviet Union, where energy efficiency levels are among the worst in the world. The centers have been instrumental in drafting basic energy-efficiency legislation in many countries, as well as providing a logical point for technology transfer from OECD countries.

Four centers have been particularly successful:[16]

- The Polish Foundation for Energy Efficiency (FEWE). Among the accomplishments of this center has been the drafting of a policy to allow utilities to profit from investing in

[15] DSMO, EGAT. *Together in Conservation. DSM Experience and Perspective.* November 1997, p. 19.

[16] William U. Chandler, et al., "Energy Efficiency Centers: Experiences in the Transition Economies," Pacific Northwest National Laboratory, Washington, DC, February 1996.

energy-efficiency equipment in their customers' facilities. In addition, FEWE facilitated Poland's signing of the Framework Convention on Climate Change.

- The Czech Center for Energy Efficiency (SEVEn). This agency has been involved in drafting Czech energy legislation, developing a program for air quality improvement, and supporting collaboration between national ministries and municipalities in energy and environment.

- The Russian Center for Energy Efficiency (CENEf). CENEf developed the first municipal standard for energy efficient building construction, which was adopted by the Moscow city government in August 1994.

- The Beijing Energy Efficiency Center (BECon). BECon has been successful in using integrated resource planning to replace planned investment in generating capacity with demand side management. This prompted China's Minister of Electric Power to propose that IRP become part of every Chinese utility's management practice.

All four of these centers have offered demonstration projects and training to help introduce efficient technologies in their countries. These demonstration projects are often complimented by public information and education programs, including television announcements, newsletters, videos, and other information dissemination techniques.

The government of India has undertaken other types of information dissemination activities such as the following:

- The Energy Management Centre (EMC) is in the process of preparing a manual on energy efficiency for pumping systems.

- The Ministry of Power is planning a technology mission in collaboration with other ministries involved in the development of an energy efficient pumping system for agriculture.

- The Confederation of Indian Industry (CII) is implementing a project to prepare the CPR for rapid displacement heat pulping process in the paper industry.

- A project studying energy consumption in the small and medium-scale industries of Kerala was sanctioned in 1998 by the Energy Conservation Society.

Targeted Industries and Technologies

China has aggressively targeted energy consumption in industry, spending over US$6 billion during the 1980s and saving 1,414 PJ of energy (approximately 20%).

China. China has focused on encouraging energy savings in specific types of industries. During the 1980s, China gave a great deal of attention to developing policies, procedures, regulations, and technical assistance, particularly in energy-intensive industries such as steel and cement. The government encouraged specific technical and process modifications to improve energy efficiency.

In particular, China has targeted medium and small-scale industrial boilers for efficiency improvements. In 1990, such boilers accounted for 35% of the country's coal use and 30% of GHG emissions. If boiler efficiency levels in China were brought up to the standard of boilers in industrialized countries, coal consumption could be reduced by approximately 20% per year.

Modeled on similar programs in OECD countries, the China Green Lights Program (CGLP) is managed by the State Economic and Trade Commission and supported by the Beijing Energy Efficiency Center (BECon). Early pilot projects in lighting showed that fluorescent lighting could reduce peak loads, while saving energy and carbon emissions. Through this program, China has also developed lighting standards and is working on codes for lighting design in residential and commercial buildings.

The China Green Lights Program aims to save 22 TWh of energy and 7.4 million tons of carbon emissions annually, by increasing the number of installed high-efficiency lights to 300 million units by the year 2000.

Indonesia. Indonesia has targeted industry as a major energy consumer and emitter of greenhouse gases. The government of Indonesia plans to introduce mandatory energy audits in some industries. This regulation is being drafted by the Ministry of Trade and Industry in collaboration with the Ministry of Mines and Energy.

In coordination with several environmental NGOs, Indonesia's Environmental Impact Management Agency (BAPEDAL) initiated an effort to promote clean production in 1994. In 1996, the Ministry of Trade and Industry joined the effort to introduce more efficient technologies and processes into industrial practice. The program focuses on minimizing energy waste, as well as other types of industrial waste. Emphasis is on small and medium industries.

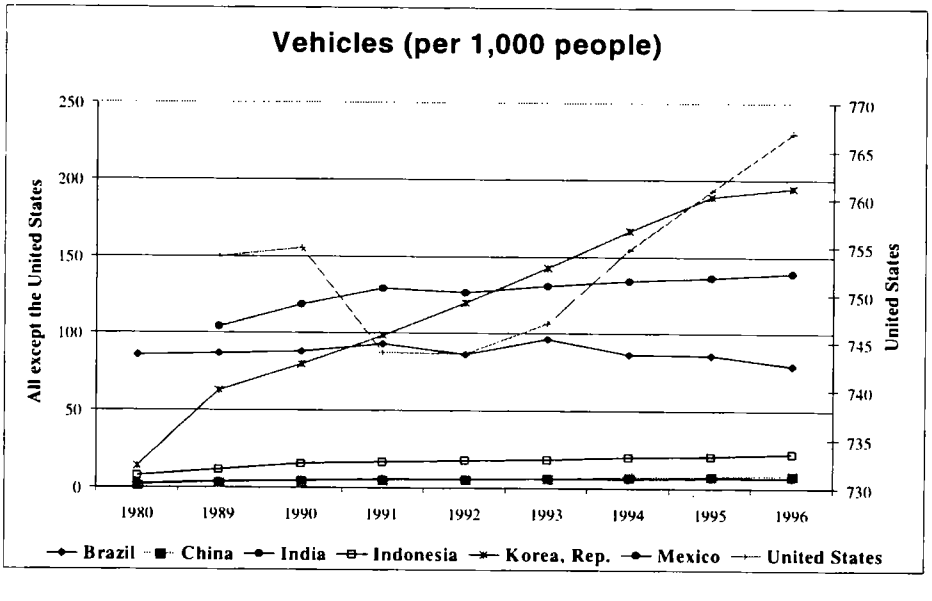
The Directorate General of Electricity and Energy Development has sponsored, with USAID, a pilot project to improve motor efficiency. Some estimates show that electric motors consume up to 75% of the electricity used in industry in Indonesia. This pilot project was designed to promote awareness of high-efficiency motors and encourage quality rewinding of existing motors, such that efficiency losses are not sustained.

3.2 REDUCING FOSSIL FUEL USE IN TRANSPORTATION

Motor vehicle ownership and use in the developing world is low compared to the United States and other industrialized nations. In many parts of the developing world, bicycles, rickshaws, and walking remain the most important forms of mobility. None of these produce greenhouse gases. In large African cities such as Kinshasa and Dar es Salaam, two-thirds of total trips are made on foot. In Delhi, India, 29 percent of trips are made on foot and 18 percent on bicycles (according to information available from the 1980s). By contrast, only about 5 percent of person trips are made on foot in the U.S.; 90 percent of trips are made by private vehicle.[17] In most of the developing world, vehicle ownership rates are less than one-tenth the rate of the U.S. (See Exhibit 3-5).

Although starting from a small base (14% of the world total in 1970 compared to 44% from the U.S.), motor vehicle ownership in the developing world is increasing rapidly. By 1993, non-OECD countries accounted for approximately 24 percent of the world motor vehicle fleet, up from 14 percent in 1970. In India the number of passenger vehicles grew more than fourfold, and in China car registrations grew more than tenfold between 1970 and 1992.

Exhibit 3-5
Motor Vehicles per 1,000 People
(1996)



Source: World Development Indicators, 1998.

[17] U.S. Department of Transportation, Federal Highway Administration, *1995 Nationwide Personal Transportation Survey Early Results Report* (Washington, DC: 1998), p. 17.

Non-motorized transportation even carries a considerable amount of the urban freight in many developing countries. Cycle rickshaws move 10 to 20 percent of the urban freight in some Asian cities. Non-motorized vehicles accounted for an estimated 36 percent of Bangladesh's freight ton-miles in 1995.[18] In the US the amount of freight moved by non-motorized modes is negligible. These differences are reflected in vehicle kilometers traveled per capita, which are much higher in the U.S. (10,000) than among the case study countries.

Much of the motorized traffic in developing countries is in the form of two- and three-wheeled vehicles. In many parts of Asia particularly, motorcycle ownership is increasing rapidly. Such vehicles are more affordable than cars and often serve as a stepping-stone to car ownership.[19] Two- and three-wheel motorized vehicles consume up to 50 percent of the gasoline used in Taiwan, 30 percent in Thailand, and 45 percent in India.[20]

Various forces are encouraging a vast increase in motor vehicle use worldwide. These forces include demographic factors (e.g., urbanization, increasing population), economic factors (e.g., higher incomes), and social factors (e.g., increased leisure time and status associated with vehicle ownership). The increase in vehicular traffic has brought an increase in traffic congestion and demands for new roads and infrastructure. Following the example of western countries, many governments in less developed countries have provided capital investments and subsidies to support motorization over the past 20 to 30 years.

More recently there has been increased recognition of the problems of urban traffic congestion and pollution caused by motor vehicles. In many cities of India, China, and Indonesia, peak period traffic speeds in city centers consistently declined throughout the 1980s due to increasing traffic congestion. Perhaps the most notorious example is Bangkok. Traffic congestion is particularly problematic in very dense cities like Bangkok and Shanghai, where additional road construction would require destroying existing buildings and/or displacing informal settlements.

Many nations have begun to reformulate their policies in order to favor more sustainable transportation options including mass transit and non-motorized modes. These strategies will eventually help to reduce the rate of growth in greenhouse gas emissions.
Although most of the transportation strategies that are reducing greenhouse gas emissions in developing countries are motivated not by a concern about climate change but by the need to address the more pressing problems of urban traffic congestion and air pollution, these strategies

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[18] U.S. Department of Transportation, Bureau of Transportation Statistics, *Transportation Statistics Annual Report 1996* (Washington, DC: 1966), p. 222.

[19] Faiz, Asif and Surhid Gautam, "Motorization, Urbanization, and Air Pollution." Discussion paper (The World Bank, Washington, DC 1994), p. 8.

[20] U.S. Department of Transportation, Bureau of Transportation Statistics. *Transportation Statistics Annual Report 1996* (Washington, DC: 1996), p. 220.

are nevertheless yielding reductions in emissions of carbon dioxide and other greenhouse gases. GHG emissions reductions are possible both through a reduction in the amount of energy used in transportation and through substitution of fuels with a lower life-cycle carbon content.

3.2.1 Reducing Energy Consumption

Reducing energy consumption in transportation is being accomplished through various means. In much of the developing world, strategies have focused on reducing motor vehicle travel demand or shifting demand to more energy-efficient modes. Since developing countries tend to rely on non-motorized forms of transportation and land uses have not been altered to the extent that motorized travel is necessary, their strategies have involved efforts to promote public transit, bicycling, or walking. Examples of such strategies include incentives like road pricing and fuel taxes, mandates or limitations on motor vehicle use, investments in transit and bicycle facilities, and land use planning.

Economic Disincentives to Motorized Travel

A number of developing countries have tried to reduce demand for personal motorized travel by introducing disincentives. One of the most effective disincentives is cost. Most developing nations have fuel taxes that are significantly higher than those in the U.S. Some countries have also introduced a variety of fees and tolls that make the use of passenger cars very expensive.

High Costs of Gasoline. Throughout the developing world, gasoline and diesel fuel prices are considerably higher than in the United States. As shown in Exhibit 3-6, gasoline in developing countries costs on average about $0.20 more per liter than it does in the U.S. Given the low average personal income in developing nations, high fuel costs are a very effective means of suppressing demand for transportation by private vehicle.

Exhibit 3-6
Comparative Fuel Costs
(in U.S. dollars/liter, 1997-1998)

Region	Gasoline	Diesel
United States	$0.37	$0.31
Developing Country Average	$0.56	$0.38
Poorest Country Average	$0.57	$0.40

Source: World Bank.

Singapore Vehicle Ownership Fees. To limit passenger car use, Singapore has imposed extraordinarily high fees on vehicle ownership and use. Duties on imported

Gasoline prices in the developing world are 50% higher than in the U.S.

automobiles (100% of Singapore's cars) and vehicle registration fees together equaled 195% of automobile import values in 1994. Singapore also imposes road taxes, with the tax varying according to a car's engine capacity.

Duties and taxes on Singapore's automobiles amount to nearly twice the value of the vehicles.

Singapore Tolls and Congestion Pricing. Singapore has instituted congestion pricing as a means to reduce vehicle travel, especially during peak hours. Under an area licensing program first adopted in 1975 and then expanded in 1984 and 1994, drivers must purchase stickers for display on windshields in order to access the central business district during specified hours. An electronic toll system was put into effect in 1996.

Restrictions on Vehicle Use

Some cities in developing countries have placed restrictions on motor vehicle use in an attempt to reduce traffic congestion. These efforts have met with limited success where people have purchased additional vehicles in order to get around the restrictions.

Mexico City's Prohibition on Older Model Vehicles and No Drive Days. To reduce gasoline consumption, traffic congestion, and emissions in Mexico City, taxis older than model year 1986 and microbuses older than 1984 are prohibited from circulating in the Federal District. Since 1989, *hoy no circula* (don't drive days) have also been in effect. This program prohibits the use of a vehicle during one day of the workweek, based on the last digit of the vehicle's license. In addition, during emergency air quality days, 40 percent of vehicles are prohibited from operating. The two programs are estimated to reduce the number of vehicles in circulation daily by 385,000 and are credited with reducing gasoline consumption by some 35,000 gallons daily.

Santiago's Vehicle Prohibitions. From March through December, 20% of cars without catalytic converters and 20% of buses without modern emissions control equipment are prohibited from operating in Santiago on any given weekday. These operating restrictions result in a 5 percent increase in bus occupancy during the period they are in effect. During air quality emergencies an additional 20 percent of vehicles are prohibited from operating. Buses more than 18 years old are prohibited from operating in downtown Santiago, and on busy roads bus routes are auctioned out to reduce oversupply in the otherwise unregulated transit industry. The auctioning has reduced the number of buses operating by about 4,000, saving some $24.4 million in fuel consumption and reducing emissions by about 10 percent. The number of passengers carried per day by each bus has increased from 375 to about 600. Since 1994, empty taxis have been prohibited from passing through twelve access points into downtown Santiago from 10 AM to 8PM. This has reduced traffic flow by about 30 percent.

Singapore's Restrictions on Vehicle Registrations. In 1990 a monthly quota system was imposed to limit the number of new vehicles in Singapore. In the first three years of the program,

the number of new vehicle registrations fell appreciably; however in 1993 registrations passed the 1990 level. Still, it is estimated that Singapore's 1990 fuel consumption would have been about 40 percent higher without various constraints on automobile use, including these vehicle restrictions and pricing measures.

Transit and Land Use Strategies

In compact urban areas, motor vehicle traffic quickly turns into traffic congestion as cars clog narrow streets and limited roadway systems. A number of developing countries are focusing transportation investments in transit and encouraging land use patterns to support transit use. Efforts to increase the efficiency of transit networks through dedicated busways and rail systems have the duel benefits of encouraging transit use and improving the energy efficiency of transit systems.

Curitiba's "Surface Subway." Curitiba, Brazil, has implemented one of the most efficient and cost-effective bus priority systems in the world. In 1974, before the start of the busway program, the city's express buses carried 54,000 passengers a day. By 1982, there were five bus-only roads in place and they carried 400,000 passengers a day. Currently, some 1,000,000 passengers per day ride on buses that travel at least partially on the bus-only roads. Because the city concentrated growth around transit routes, the city has managed to reduce car use despite the second highest per capita auto ownership in Brazil. Some 70 percent of commuters travel by bus and as a result gasoline consumption is 25 percent lower than that of eight comparable Brazilian cities. The system operates at cost and at service levels that are far superior to other large Brazilian cities.

As a result of land use and transit policies, public transit accounts for 70% of the average daily commuter trip in the City of Curitiba, Brazil.

Mexico City's Metro Expansion. The metro system in the Mexico City metropolitan area has been expanded by some 37 kilometers. The new subway lines have provided 300 million passenger trips annually, eliminating about 100,000 vehicles daily from circulation. The tenth line is now under construction; when completed it will replace an estimated 230 buses, 1,160 microbuses, and 18,000 private cars a day. The trolleybus fleet in the Federal District was completely modernized between 1991 and 1994 and twelve new trains were purchased for the light rail system. The frequency of train service during rush hours is now 3 minutes.

Buenos Aires' Privatization of Metro and Commuter Rail. Buenos Aires, Argentina, recently privatized its metro and commuter rail systems. Under public ownership service had deteriorated so much that ridership dropped by almost half between 1970 and 1992. Under new private management, ridership has rebounded. By 1996 ridership on the metro had increased by 38 percent and on the commuter rail system by 93 percent. Some of this increase is attributable to riders who once commuted by car.

Rio de Janeiro Rail System Rehabilitation. The rail system in Rio de Janeiro is being rehabilitated as part of a World Bank funded transport project. This project includes the construction of transfer points within stations for integration with other modes of transportation. It is expected to increase daily rail ridership from about 400,000 to about 1 million.

Integration of Rio de Janeiro's rail system with other modes of transportation is expected to increase daily ridership by 600,000.

Santafe de Bogota Busway. Santafe de Bogota, Colombia, has implemented a busway on 16 kilometers of Caracas Avenue. The busway increased the number of passengers moved in each direction during peak hours from 19,000 to 30,000 (more passengers than are carried by most of the world's other busways and light rail lines) and at same time increased bus speeds from 12 to 20 kilometers an hour and general traffic speeds from 13 to 24 kilometers an hour. The World Bank is currently funding an extension of the busway and to implement traffic management measures on streets transverse to the busway.

Public Transit Expansion in China. In China, the world's most populous country, the public transit vehicle fleet and the service routes grew 2.5 and 2.8 times respectively in the period 1978-1993. China also has 65km of operational metro and another 37 kilometers under development. The Beijing metro carries 1.5 million passengers daily, 15% of all transit riders in the city. There are currently 29 projects in the planning stages in 20 cities throughout China.

Delhi Land Use Plan. Growth in Delhi, India, for more than 35 years has been guided by the Delhi Master Plan. This plan provides for more than 35 mixed use centers which provide residential, shopping, commercial, and recreational facilities. The result of this plan is that Delhi has a high population density and mixed land uses resulting in a substantial number of short trips, many of which are nonmotorized.

Sao Paulo Integrated Transport, Land Use, Air Quality Plan. Sao Paulo, Brazil, is developing an integrated urban transport, land use, and air quality strategy for the metropolitan region. The plan will guide future transport investment in the region so as to minimize air pollution and traffic congestion. Once implemented the plan is expected to harmonize project implementation with policy objectives. 100 KM of high ridership bus routes have received priority through the use of reserved bus lanes and exclusive bus routes. The establishment of these priority and exclusive lanes has shortened bus trips by up to 30 percent, thereby reducing emissions and fuel consumption. The Sao Paolo metro is one of the most modern and heavily used urban rail systems in the world. The State of Sao Paolo is working on a plan to expand the metro system and integrate it with the commuter rail system as well as increase the number of bus lanes. The integration of train, metro, and bus services has taken a large number of cars off the road. Two planned expansions of the commuter rail and metro systems would also eliminate approximately 122 million bus trips.

Belo Horisonte Reserved Bus Lanes. In Belo Horizonte, Brazil, a reserved bus lane has been implemented on one main road. A new transport project financed by the World Bank will include an extension of the urban rail system and other transit measures (busways, bus lanes, and shelters for bus passengers) which are expected to alleviate traffic congestion, currently growing by 20 percent a year.

Abijan Bus Lanes. In Abidjan, Cote d'Ivoire, there exists a system of exclusive bus lanes on which a high speed bus network operates. It has cut bus trip lengths in half and thereby decreased fuel consumption.

Bicycle Promotion Strategies

Bicycles are an inexpensive, non-polluting form of travel. A number of countries have implemented programs to promote bicycle use through the construction and installation of bicycle lanes and pathways and other incentives.

Lima has committed $4.1 million to construct a bikeway linking low income areas with urban centers.

Lima Bicycle Pilot Project. In Peru bicycles are being promoted as an alternative to public transportation, which is often erratic or too expensive for many lower income people. In the capital city of Lima, the national and local governments joined with the World Bank in 1992 to establish a pilot program with the goal of increasing bicycle use from 2 percent to 10 percent of all trips. The project is estimated to cost $4.1 million, mostly for the construction of bikeways that link Lima's low-income areas with the urban center. Construction has been undertaken on 51 kilometers of dedicated bicycle lanes and 35 kilometers of bike paths. The project also established a credit facility to provide $100 loans, repayable over a 12-month period, for the purchase of a bicycle by those who live near the bicycle network and who have annual incomes under $1,800.

Accra Bicycle Paths. In Accra, Ghana, the World Bank is sponsoring the construction of dedicated cycle paths to connect neighborhoods with commercial districts. The purpose is to encourage bicycling as a viable alternative to motorized vehicle use.

Fuel Efficiency Measures

Another means to reducing energy consumption in transportation, which has received less attention in developing countries, is to increase vehicle fuel economy. This can be accomplished through improvements in in-use vehicle technologies, in driver behavior, or in travel conditions (e.g., by improving traffic flow and reducing stop-and-go traffic). Efforts to increase vehicle fuel economy and vehicle purchase decisions have taken hold in a few developing countries.

Motor Vehicle Fuel Economy Labeling. Korea and Brazil have adopted fuel efficiency labeling for motor vehicles. Armed with relevant information, consumers will be more likely to select a vehicle that is more fuel efficient since it will lower their gasoline costs.

Korea and Brazil have adopted fuel efficiency labeling for motor vehicles.

3.2.2 Alternative Fuel Strategies

Switching to alternative fuels is another strategy being implemented in developing countries, primarily as a pollution abatement solution. The amount of carbon emitted per unit of energy consumed during combustion varies for each type of fuel. Motor vehicles that use fuels with low life-cycle carbon contents produce fewer carbon dioxide emissions.

Carbon emissions are also produced during upstream activities, such as fuel production, fuel distribution, feedstock transport, methane leaks, and production and assembly of vehicles. The GHG benefit of an alternative fuel depends on the full life-cycle carbon emissions associated with its use. In theory, fuels from biomass (e.g., ethanol and methanol from wood, ethanol from corn) and renewable resources (e.g., solar, hydroelectric) are the best from a GHG perspective. Other alternative fuels may or may not reduce greenhouse gases.

A number of programs have been implemented in developing countries to encourage use of alternative transportation fuels.

Argentina's tax exemption for CNG. The government of Argentina since 1985 has exempted compressed natural gas (CNG) from taxation. Since then some 400,000 vehicles have been retrofitted to burn CNG. Some 270,000 of these vehicles are in the Buenos Aires region. Over 80% of the taxis and a high percent of other fleet vehicles are CNG powered.

Columbia's fuel switching program. In the Bogota, the Santafe de Bogota Environmental Agency and the Ecopetrol, the national oil company, have begun a fuel switching program for buses and taxis.

Mexico's LPG fueling facilities. PEMEX, the state owned oil company [is it still state owned?], supports an effort to promote the use of liquid propane gas (LPG) powered vehicles by providing 10 fueling facilities in the Mexico City region. Some 28,300 vehicles in Mexico City have been converted to LPG.

Brazil's ethanol vehicle program. The Proalcohol program in Brazil is the largest alternative fuels program in the world. Begun in 1975 as a import substitution program, today the country boasts some 4.5 million ethanol powered vehicles.

The Proalcohol program in Brazil is the largest alternative fuels program in the world, with U.S. million ethanol-powered vehicles on the road.

Sao Paulo's CNG buses. The City of Sao Paulo requires private bus companies operating in the city to acquire CNG fueled buses. To comply with the requirement bus companies have ordered about 500 CNG powered buses, which will result in reduced CHG emissions.

Rio de Janeiro's CHG program. In Rio de Janeiro, CNG has been used an alternative fuel. The Municipality of Rio de Janeiro promotes the use of CNG by requiring gas stations in certain parts of the city to sell CNG. About 2,000 taxis and 200 buses have been converted to CNG operation.

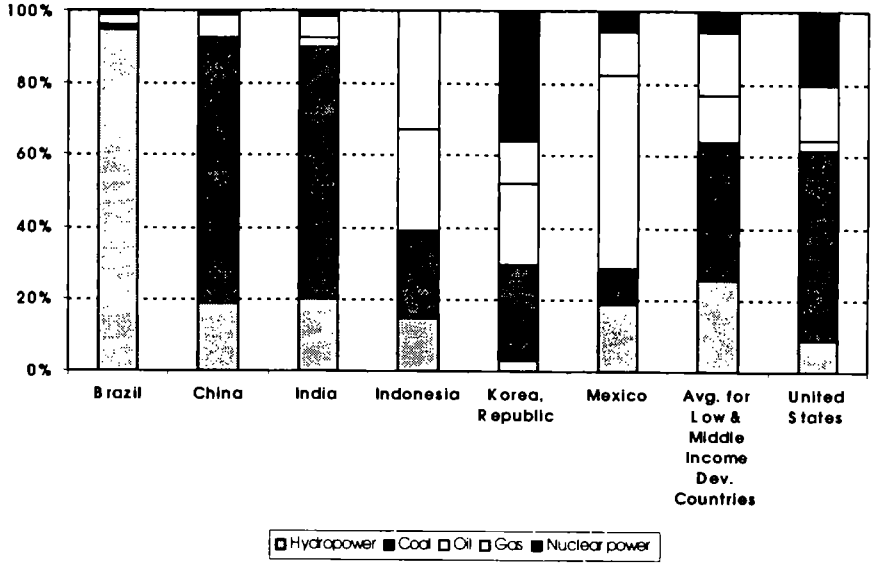
The City of Sao Paulo is currently replacing all diesel-powered buses with buses fueled by natural gas.

3.3 REDUCING GHG EMISSIONS IN POWER PRODUCTION

The electricity sector is a major and growing source of worldwide GHG emissions. The total amount of greenhouse gases contributed by a country's power sector depends on how electricity-intensive its economy is, the efficiency of the energy generation and delivery system, and the GHG-intensity of its generating capacity.

The GHG-intensity of a country's electric generating system is partly a function of its natural endowments (fossil fuels, running water, and other resources) and partly a function of government policies. Many developing countries have historically relied heavily on hydropower for electricity generation, whereas others have relied more on indigenous coal resources (See Exhibit 3-7). Hydropower produces no GHG emissions directly. The inundation of land areas for reservoirs does cause decomposition of vegetation which in turn releases methane, a serious GHG, but this is a minor source of greenhouse gases compared to fossil fuels. As feasible sites for hydroelectric power are exhausted, these countries are often turning to domestic or imported fossil fuels to expand power capacity.

Exhibit 3-7
Electricity Production by Fuel Type (1996)



Government macroeconomic and security policies have also impacted the choice of fuels for the power sector, and thus the sector's carbon intensity. For instance, Indonesia has elected to burn its coal in power plants and export its oil, a less carbon intensive fuel, in order to generate foreign currency.

In addition, some countries are more electricity-intensive than others. In some countries, many communities in rural areas are not electrified. Moreover, the structure of a country's economy may be weighted more or less heavily toward sectors that are major users of electricity (e.g., aluminum smelting).

Finally, some utilities are more efficient than others in terms of how much fuel needs to be burned to deliver a kilowatt hour to the customer. The efficiency of various power plants that burn fossil fuels ranges from 15% to 50%.

Electricity consumption is growing more rapidly in the developing world than among industrialized countries. Because so much of the electric generating capacity needed by the developing world has not yet been built, an opportunity exists today to make decisions that will have a major impact on GHG emissions for decades to come. The efficiency and carbon intensity of the fuels and technologies employed by new generating capacity will play a very large part in determining developing countries' overall GHG emissions.

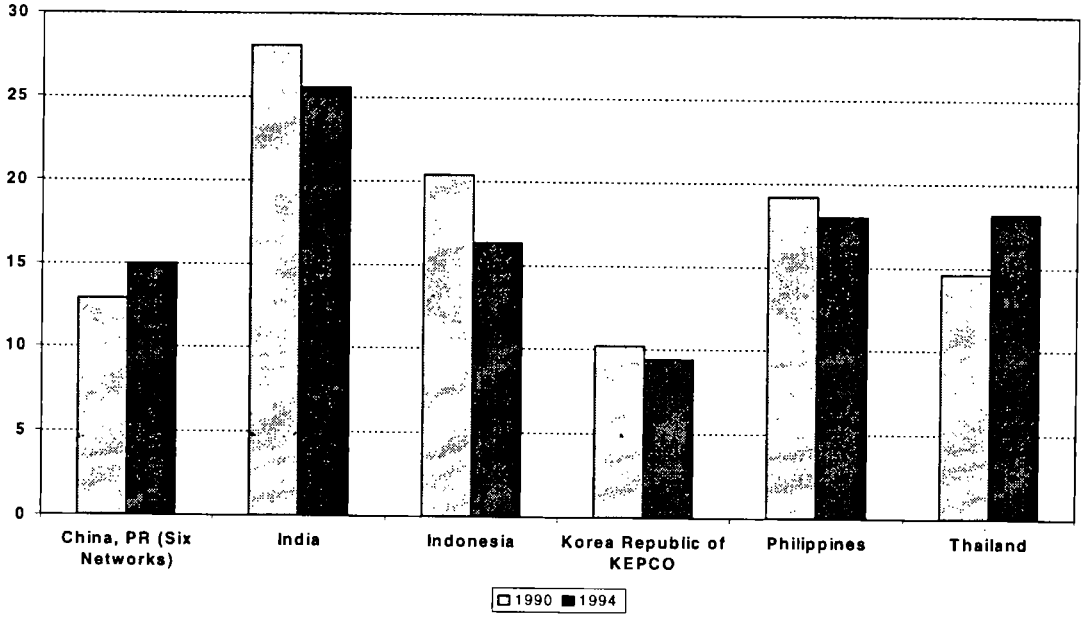
Geothermal, solar and wind power generation has increased to 282 billion kWh in 1996, an increase of 750% from 1987.

When natural gas or renewable energy generation is built in lieu of coal or oil generation, there is a decrease in the CO_2 emissions produced per unit of electricity generated. Electricity from natural gas and renewable energy sources has grown faster than overall electricity growth. Geothermal, solar, and wind power generation increased 750% between 1987 and 1996, to 282 billion kWh. The developing nations, particularly China and India, have significantly increased their use of coal in the 1990s.

3.3.1 Efficiency Improvements

New investments in generating capacity and in transmission and distribution systems have improved "supply side" efficiency and reduced energy losses associated with getting power to customers. Efficiency improvements are being made both through the modernization and rehabilitation of existing facilities and through the introduction of new efficient equipment and improved processes. Some utilities have reduced energy losses in transmission and distribution during the 1990s (see Exhibit 3-8).

Exhibit 3-8
Transmission and Distribution System Energy Losses (%) 1990-1994



Source: Asian Development Bank, Utility Statistics

Many of the developing countries are engaged in modernization programs because this is one of the most cost-effective ways to improve system efficiency. The Philippine National Power Corporation (NPC) has plans to improve the heat rates at existing power plants and expects to save the equivalent of 13.4 million barrels of oil by year 2025. The NPC reports that overall system losses are currently just 6.6%.

India's National Thermal Power Corporation (NTPC) has reduced carbon emissions in its coal-fired capacity through plant efficiency improvements and coal beneficiation. In the first phase of the renovation and modernization (R&M) program, which ran from 1984 through 1989, over 163 thermal units were ungraded. These actions resulted in an increase of over 10 billion kWh of electricity for customer use, or an increase in overall efficiency of roughly 3%. A similar program in 1990-95 resulted in an additional increase in usable electricity of about 7.8 billion kWh. Altogether India's R & M program in the past decade has resulted in efficiency improvements of approximately 5%.

Transmission losses in Indonesia were reduced from 24.6% in 1983 to 16.3% in 1994.

Indonesia's national utility (PLN) has aggressively addressed system losses in the power sector. Auxiliary losses range from 3.5 to 4.5%, a relatively modest value. PLN has also succeeded in reducing its transmission and distribution losses from 24.6% in 1983 to 16.3% in 1994.[21] For the same year, 1994, Korea had T&D losses of only 5.4% and China had losses of 8.7%.

New power plants typically are more efficient than existing plants. As more are built and put into operation throughout the world, there will be a decrease in the average amount of CO_2 per unit of electricity generated. Modern coal-fired power plants achieve efficiencies of 45%.[22] Using typical coal characteristics, such a power plant would emit about 0.75 Kg CO_2 per kilowatt hour of electricity produced. This is a reduction in CO_2 emissions of 1/3 from older plants that operate at 30% efficiency. As an example of the impact, a 1000 MW coal-fired plant operating at 38% efficiency and 60% capacity factor can be expected to emit 1.17 million tons less CO_2 than an older plant which operates at an average efficiency of 30%.

Although historically the power sectors of many developing countries have been relatively inefficient, these countries and their planning agencies have been forced by rapidly increasing demand for power and by financial and environmental concerns to adopt cost effective (hence efficient and relatively low CO_2 emitting) technologies. Much of the equipment is purchased

[21] *Electric Utilities Data Book.* 1997. Asian Development Bank.

[22] Huttl, Adolf J. 1998. "New Developments in Power Plant Technology: A Major Contribution to WorldWide Power Supply." *World Energy Council Journal*, July, pp. 53-58.

from OECD countries. For example, an estimated 70-80% of India's power equipment is imported from the U.S.[23] However, India itself has a formidable and growing high tech manufacturing industry serving the power sector. Although the power sector is rapidly expanding and CO_2 emissions are increasing, the implementation of efficient generating equipment will have a significant positive impact on the overall CO_2 emission rate per unit of electricity generated.

Even compared to modern coal-fired plants, CO_2 savings from efficient gas-fired plants in India are approximately 1.8 million tons per year.

The most impressive efficiency improvements in power plant design are associated with the combined cycle gas turbine plants. Efficiencies of current production systems exceed 58% and are expected to exceed 60% within two years.[24] The Enron combined cycle gas turbine plant which is under construction at Dahbol in India will produce significantly lower CO_2 emissions than a comparably sized coal-fired plant. The higher thermal efficiency, combined with the fact that the carbon emissions from natural gas are roughly 60% those from coal on a per unit energy basis, will result in much lower carbon emissions per unit of electricity produced. Initially the Enron plant will operate on fuel oil, but ultimately the plant will be fueled with LNG. Assuming that the 740 MW gas fueled plant operates at 55% efficiency and 60% capacity factor, it will avoid 2.8 million tons of CO_2 per year compared to an average existing coal-fired plant operating at 30% efficiency. Even compared to a modern coal-fired plant operating at 40% efficiency, the savings would still be significant — approximately 1.8 million tons per year.

Power system efficiency is also being improved in other ways. In India, for instance, the government is promoting the concept of locating very large power projects at the mine pitheads.[25] This eliminates the need to transport the coal from the mine to the plant, and effectively replaces the relatively inefficient rail transport process with a more efficient transport of electricity over high tension DC lines. Similarly, China plans to built power plants in Western Mongolia and transmit the power to Beijing.[26]

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[23] "U.S. Energy Information Administration Country Analysis Briefs - India." Energy Information Administration. Department of Energy.<http:// www.eia.gov/emeu/cabs/india.html>.

[24] Huttl, Adolf J., op. cit.

[25] "U.S. Energy Information Administration Country Analysis Briefs - India," op. cit.

[26] *Electric Utilities Data Book*, op. cit.

Another technique that India is using to improve efficiency, and therefore reduce GHG emissions, is to install coal washeries at the mine pitheads. Not only does coal beneficiation reduce the amount of particulates in the flue gases and increase the overall plant efficiency, but it reduces the coal transportation requirements thus reducing the amount of CO_2 emissions associated with transporting the coal to the power plants.

The choice of fuel can also impact the carbon emissions. The gross average heat content of Indian coal has increased by 17% from 17.0 million to 19.9 million BTU per ton from 1992 to 1996.[27] The higher average heat content can be attributed to a larger percentage of energy coming from bituminous rather than lignite grade coal. Analyses of over 5000 samples of U.S. coals[28] indicated that the carbon emission factor (carbon emitted per unit of heat content) for lignite was generally higher than that for subbituminous and bituminous coals. A production-weighted average carbon emission factor for lignite was estimated to be about 5% higher than that for bituminous rank coal.

India's R&M program over the past decade has resulted in efficiency improvements of approximately 5%.

3.3.2 Low and No Carbon Power Sources

Even with efficiency improvements, GHG emissions from electricity generation will continue to grow unless the sources of power are "decarbonized" by deploying renewable power sources. Greater use of natural gas, especially if burned in highly efficient turbines, will also help bring GHG emissions levels down below the levels that are produced by coal and oil-fired generation.

Renewable Energy

Renewable power sources, both connected to the grid and for off-grid applications, are helping to meet the need for expanded electric generation in many countries, without adding to GHG emissions. EIA/DOE[29] reports that the present consumption of renewable energy throughout the world is about 30 quads per year, which represents 8% of the total energy use. According to baseline projections, renewable energy's share of the global energy mix will remain roughly

[27] *International Energy Annual 1996.* Energy Information Administration, Department of Energy, DOE/EIA-0219(96), February, 1998.

[28] *Emissions of Greenhouse Gases in the United States 1987-1992.* Energy Information Administration, Department of Energy, DOE/EIA-0573. November, 1994.

[29] *International Energy Outlook 1998: With Projections through 2020.* 1998. Energy Information Administration, Department of Energy, DOEEIA-048(98). April.

constant over the next two decades. To promote greater use of renewable energy, developing countries are offering special financing provisions, tax incentives, assured access to the grid for renewable power developers, dedicated procurement initiatives, and other measures.

A total of 26,000 MW of new hydroelectric generating power will be commissioned in China between 1995 and 2000.

The largest increase in renewable energy use will be in the hydro sector where both refurbishment and new construction will occur. A number of large dam projects have been completed or are currently in the pipeline in developing countries in Asia, particularly in China. For instance, China in the past several years has commissioned the 2,000 MW Lijiaxia Hydropower Station and the 1,200 MW Gheyan plant. On the Hongshui River a 1,200 MW Tianshengquiao facility is slated for completion at the end of 1998 and nine other plants are planned. Work is also progressing on the world's largest hydroelectric facility, the 18,200 MW Three Gorges Dam project on the Yellow River.[30]

By the end of 1995, the use of renewable energy in China approached 300 million tons of coal equivalent annually. At the end of 1994 hydroelectric facilities represented 24.8% of the installed electrical generating capacity and produced about 19% of the electricity.[31] Installed mini-hydrocapacity in China has reached 16,200 MW. Approximately 25,000 MW of new generating capacity will be commissioned between 1995 and 2000 to maintain the fraction of installed capacity at the 25% level. However, over the long run the amount of electricity produced by renewable energy sources are expected to drop from the 19% level to a 14% share by 2020.[32]

In the Philippines, the NPC is implementing several projects designed to maximize the potential of cost effective geothermal power production. Plans have been developed to increase the installed capacity from 1414 MW to 2134 MW over the next decade.[33] In addition, a new high voltage Leyte-Luzon interconnection will be installed to allow excess electricity from an under-utilized geothermal plant at Tongonan in Leyte to be utilized in Luzon.[34] Although the amount of economically developable geothermal power is limited in the Philippines, the government is utilizing as much as possible.

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[30] Ibid.

[31] *Electrical Utilities Data Book*, op. cit.

[32] *International Energy Outlook 1998: With Projections through 2020,* op. cit.

[33] *Philippine Energy Plan: 1996-2025.* 1996. Republic of the Philippines, Department of Energy.

[34] Ibid.

The amount of GHG emissions will be affected both positively and negatively by counteracting trends in the projected energy use in the Philippines. The total amount of renewable resources used in the power sector (hydroelectric, geothermal, wood and wood/municipal wastes, bagasse, rice and coconut residues, animal manure, and black liquor) is expected to increase 380% over the next 30 years. On the other hand, the mix of renewables will fall from 39% to 24% because of the large expected increase in the use of oil and coal, most of it imported.

The 1,414 MW of geothermal capacity in the Philippines constitutes a greater share of total electricity generated by geothermal resources than in any other country.

In India, renewably-based power generation grew rapidly during the 1990s and the national Government strengthened its institutional capacity to stimulate the deployment of renewables. It raised renewable energy development to Cabinet ministry status and created the Renewable Energy Development Agency, which has responsibility for promoting the development of renewable energy systems. The ministry has been instrumental in pushing through favorable policies including tax incentives for renewable power and enabling renewable power developers to use the transmission system to sell power to other regions and to "bank" excess power in the system for later sale. National and state agencies have promoted a range of grid-connected renewable generation including wind farms and bagasse-based cogeneration. The government has also approved a solar thermal power project.

Over 200 MW of sugar cogeneration capacity are under construction in India.

At the end of 1997, India had over 870 MW of installed wind capacity, much of it in the southern part of the country. This ranked India fourth in installed wind capacity behind only Germany, the U.S., and Denmark.[35] A large part of the reason for the rapid increase in wind systems in India was the 100% tax depreciation allowance provided by the Ministry of Non-Conventional Energy Sources. The depreciation allowance has been reduced by 18% in 1997 and this is expected to slow the rate of installation. The wind farms, which were expected to operate at load factors of 25-30% have, instead performed at a disappointing 7%.[36] The Government recognizes that tax incentives must be revamped to encourage better output.

China too is rich in potential wind power, and its government is embarked in an active wind power development program. While only 160 MW of installed capacity existed by the end of

[35] "Presentations on Wind Energy." Danish Wind Turbine Manufacturers Association. <http://www.windpower.dk/present/index.htm>.

[36] *International Energy Outlook 1998: With Projections through 2020,* op. cit.

1997, the national government's power development plan calls for about 1,000 MW by the year 2000 and 3000 MW by 2010.

In addition to grid-connected power, renewables reduce carbon emissions when used for off-grid electricity generation. About two billion people throughout the developing world remain unconnected to the grid. For many, the only choice for lighting has been candles, kerosene lamps. Other electricity uses (such as radios, TVS, water pumps) have been served by local diesel generators or batteries charged by diesel generators.

Several types of renewable energy systems are being deployed to provide rural electricity services. One of the most widespread are solar home systems, small photovoltaic modules attached to a battery, lights, and a plug for a radio or small TV. The World Bank is supporting a $120 million solar home program in Indonesia. The project will supply electricity for 200,000 homes. The government of Australia is funding a project to provide electricity to 35,000 houses in Indonesia's eastern islands.[37] In Kenya, more rural households have received electricity services from privately-supplied PV systems than from grid extension. In 1996 26% of the 22.4 MW of photovoltaic cell and module exports from the U.S. went to developing nations in Asia, Africa, and Latin America.

Other renewables are also used in off-grid applications. By the end of 1993 there were almost 2 million small wind power units totaling 14.4 MW had been installed in China. Installed mini-hydro capacity has reached 16,200 MW in China.

Natural Gas

Activities that are promoting increased use of natural gas include construction of ports and off-loading facilities for LNG, reduction of flaring and methane losses during transport, pipeline developments, and capture of coal bed and landfill methane.

Not only will the natural gas offset CO_2 emissions from alternatives such as imported oil or coal, but the new plants will employ an efficient combined cycle design. Over a 20 year life, the natural gas power plants could produce approximately 55 million fewer tons of CO_2 emissions than a typical coal-fired plant.

Greater use of natural gas for power will also reduce carbon emissions from natural gas venting and flaring. This technique proved to be a convenient way to dispose of small quantities of natural gas associated with the pumping of oil or other normal processing operations where there was no easy way to collect and transport the gas for commercial use. As natural gas has become a more valued commodity and technology has improved, the oil and gas industry has reduced the amount of natural gas flaring. Globally the fraction of gross production of natural gas that has

[37] *International Energy Outlook 1998: With Projections through 2020,* op. cit.

been flared was reduced from about 4.2% in 1991 to 4.0% in 1995 (this excludes the abnormal situation in Kuwait during the Gulf War). Globally the oil and gas industry has reduced the amount of CO_2 emissions by 2.4 million tonnes from 1991 to 1995.

The potential increase in gas generation is particularly large in East Asia. The Philippines has 2.7 trillion cubic feet (Tcf) of proven natural gas reserves on the Malampaya and Camago gas fields located offshore of Palawan Island.[38] Development of the gas fields and construction of a 320 mile offshore pipeline and onshore terminal will allow the gas to be used to fuel new gas turbine power plants totaling 2,700 MW of electrical power. This project will increase the market share of natural gas in power generation to 15% by 2004. During this period of time the gas-fired plants will also expend almost 2/3 of the total gas reserve in the Camago-Malampaya region.

China plans to double its natural gas production to 1.1 trillion cubic feet by 2005 and is engaged in an aggressive exploration program.[39]

India's national oil companies have committed $24.5 billion over a three year period beginning in 1997 to the development of advanced technologies and new resources such as coalbed methane and gas hydrates.[40] Use of these gases in the future will reduce the amount of CO_2 emissions relative to the use of either oil or coal. India is developing its nominal natural gas supplies and is making plans to expand gas pipeline. India is also developing its LNG infrastructure to support increased use of natural gas, much of which will be in the power sector. In all, there are plans to import 50 million tons of LNG per year.[41]

The Republic of Korea has installed over 6,046 MW of high efficiency combined cycle natural gas turbines which provided 12.1% of the electricity in 1994. Thailand produced 46% of its electricity using natural gas in 1994. Over 31% of Indonesia's electricity was produced using natural gas in 1994.

In Latin America, use of gas for power generation is also increasing. In 1993, Mexico established a policy to increase the share of natural gas in the Mexican fuel market. Accordingly, 70% of thermoelectric plants using fuel oil and located in sensitive areas will convert to natural gas and the government opened up the gas sector for private development. Brazil is also seeking

[38] *Philippine Energy Plan: 1996-2025,* op. cit.

[39] *International Energy Outlook 1998: With Projections through 2020,* op. cit.

[40] "US Energy Information Administration Country Analysis Briefs - India," op. cit.

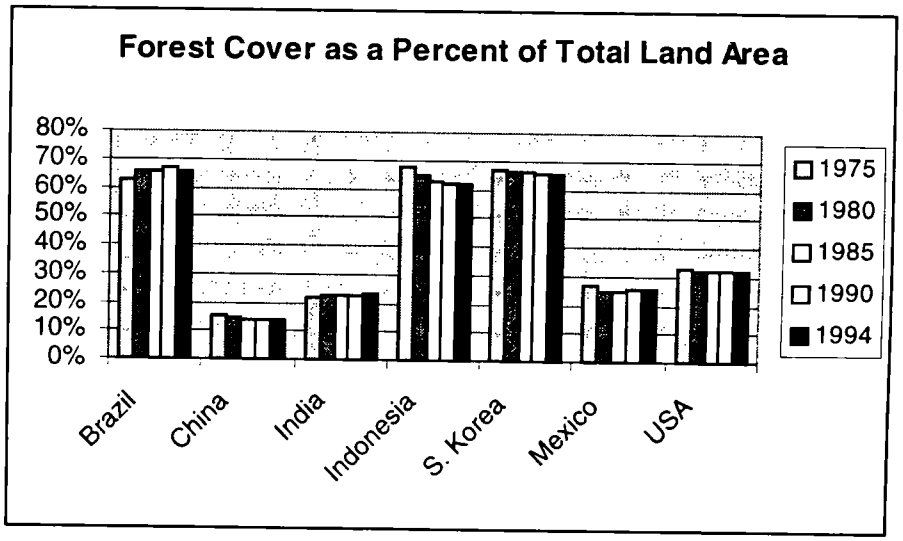
[41] Ibid.

to increase the use of natural gas in power generation through its participation in a gas pipeline project and promotion of independent power development.

3.4 PROTECTING CARBON SINKS

A country's net GHG emissions are affected by the status of its land areas where carbon is sequestered through the growth of plants. Of these areas, known as carbon sinks, forests are the most significant because of the amount of carbon they sequester. Forests are tremendously important in the global cycling of carbon, sequestering carbon at a rate of 20 to 100 times more per acre than pastures and croplands. Sequestering atmospheric carbon by planting trees and preserving forest areas is a viable way to combat carbon buildup. It has been estimated that 100-200 million hectares of new forest can sequester 1,000 million tons of carbon.[42] Exhibit 3-9 shows the amount of total land area accounted for by forests in various countries over a 15 year period.

Exhibit 3-9
Percentage of Total Land Area in Forest (1995)



Source: World Development Indicators, 1998. The World Bank, Washington, D.C.

Tropical deforestation has long been recognized as a significant resource loss on many fronts including biodiversity, watershed quality, and erosion. Adding to these is the recognition that

[42] Woodall, George, *The role of Forests in Climate Change*, In Managing the World's Forests: Looking for a Balance Between Conservation and Development, Hunt Publishing Company, Iowa, 1992.

deforestation is a major contributor to global warming. IPCC estimates that tropical deforestation and degradation may account for 23% of the CO_2 emissions derived from human activity.

Trees contain carbon and as they are cut down, this carbon is released. Continued deforestation not only removes sources for the sequestration of carbon but adds carbon to the atmosphere.

Economic pressures to clear forests for wood product markets and agricultural use are strong in many areas of the developing world. However, recognition of important nonwood benefits of forests, including carbon sequestration, biodiversity, recreation, ecotourism, protection of watersheds and soils, has been increasing throughout many areas of the world. This has caused a growing awareness of the need for reform initiatives and for the development of institutional capacity related to forest use and management. This section discusses the types of reforms and initiatives taken by developing countries, describes how these reforms contribute to the reduction of global GHG emissions, and identifies countries and regions where these reforms have begun to take hold.

The current scope of the Kyoto Protocal addresses carbon sinks and matters related to land-use change and forestrey as a general principle of sustainable development and a component of industrialized country assistance programs to developing countries. In practice reforestation and forest conservation programs such as the Rio Bravo carbon sequestration pilot project in Belize have been used as carbon offsets classified under Activities Implemented Jointly (AIJ). It is likely that carbon sinks will also be an integral component of the clean development mechanisms (CDM) once implementation begins. Finally, under the Kyoto Protocal carbon sinks are used as an accounting figure in the national inventories of GHG emissions.

3.4.1 Policy Reforms

Deforestation is the result of social, economic, cultural, and political factors including rural poverty, population growth, slash and burn farming, commercial agriculture, cattle ranching, fuelwood collection, land tenure and logging. The variety of problems confronting developing countries heighten these conditions as policy-makers attempt to balance issues including poverty, food security, economic development, and institutional reform and capacity building, with the management of natural resources. Control of GHG emissions must be viewed within the context of each specific region or country. Land use and forestry issues in particular often transect the political, social, economic, and cultural fabric of a country.

Throughout the world there are significant political trends that affect land use and forests. These trends include economic decentralization, privatization, greater participation by diverse interest groups, and greater involvement of local communities and indigenous forest-dependent people. In both developed and developing countries, the movement toward more localized control and management of forests is likely to continue. Responsibility is gradually moving from central agencies to provincial and district levels, where knowledge of the local conditions is

concentrated and where responsiveness to the needs of local communities and resource interests is greatest. Generally viewed as a positive trend toward local empowerment, decentralization in the management of forests can increase the forests' susceptibility to being 'captured' by powerful, private economic interests that are not motivated by long-run concerns. Similarly, efforts by local forest managers to protect and conserve forests could face increased resistance in areas where economic pressures for food, energy, and other subsistence needs are strong and dependence on forests is significant.

Privatization of lands and of forestry operations is also a significant trend in many countries. This trend affects management incentives and the extent to which nontimber benefits are likely to be taken into account. For example, in Latin America the granting of forest concessions has become a growing source of conflict between governments and communities searching for revenue streams and conservation groups and indigenous peoples.

However, the exploitation of forests for raw materials trade and international logging practices is not the main contributor to deforestation in developing countries. International timber trade makes up only 7 percent of all industrial roundwood in the marketplace with nearly 90 percent of global trade coming from the boreal forests in the Northern industrial countries. In the South roundwood is used primarily for fuelwood and charcoal production, according to the Food and Agriculture Organization (FAO), 80 percent of roundwood extraction in developing countries goes to fuelwood. Domestic consumption of fuelwood timber in developing countries is likely to increase as population and incomes grow with some developing countries becoming net importers of timber.

At a time of increasing economic globalization, developing countries must find ways to stimulate economic growth and investment, satisfy growing consumer demands, manage conflicts and competition for resources, and participate meaningfully in regional and global institutions, such as those aimed at controlling GHG emissions. With assistance from NGO's, world and regional development banks and institutions, and the support of national and international institutions, many developing countries are participating and promoting activities, initiating reforms, and evolving institutions that can begin to reverse trends in deforestation, encourage conservation, and improve land management practices.

Strategies that can influence CO_2 emissions and the sequestering of carbon in terrestrial ecosystems generally fall into three areas: conservation of existing forests; increasing the area and productivity of forests; and developing wood products and markets that can substitute for existing fossil fuel use and energy-intensive products.[43] This section discusses the first two

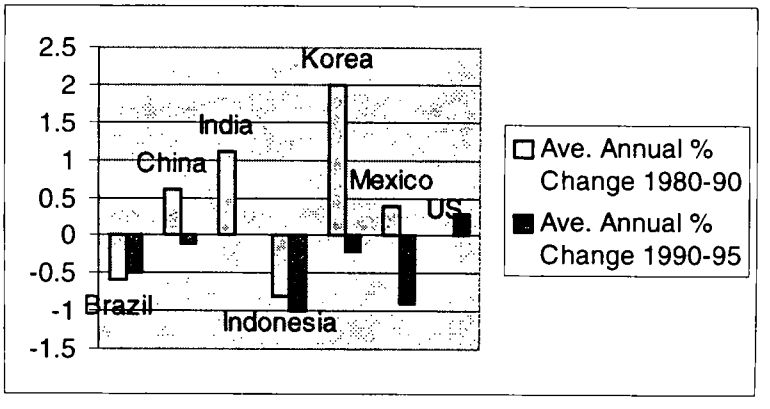
[43] In much of the world there is significant potential for replacing fossil fuels, and thus reducing fossil fuel emissions, through greater use of woody bioenergy sources such as those from forest residues, and through planting of forest crops grown primarily for fuel use, such as fast-growing poplars and eucalyptus. This strategy is mentioned here because of its overall importance in mitigating GHG emissions. However, it is linked more with the processing of forest products and their marketing than with forest management per se.

strategies, drawing upon examples from developing countries. The third strategy may become significant in the future but few examples exists to date.

3.4.2 Maintaining Existing Carbon Stocks

As a whole the world's forests are losing ground to development and deforestation. Their quality and productivity is also falling in many areas, especially in the tropical forests of developing countries. The tropical regions of the world lost 200,000 hectares/year during that period, an annual rate of loss of approximately 0.7%. Exhibit 3-10 shows the change in forest cover among the six case study countries and the U.S. The effects of policy and management changes made since 1995 to stem the rate of deforestation are not yet apparent in the current statistics from the Food and Agricultural Organization (FAO) and the World Bank, published in 1997 and 1998 respectively.

Exhibit 3-10
Changes in Total Forest Area



Source: FAO

Reducing rates of deforestation is a major first step required in the effort to reduce global GHG emissions from forest lands. We have classified the activities initiated to protect the existing carbon stocks into two broad categories: the use of a "protected status" for a specific region and empowering local stakeholders to more efficiently manage their resource through land tenure and property rights. Exhibit 3-11 outlines some of the initiatives undertaken by the six selected countries to minimize deforestation.

Exhibit 3-11
Initiatives to Combat Deforestation

Country	Description of Activity or Program
Brazil	Regulations require that pulp industries obtain their raw materials from plantations and not natural forest. National plans to triple the protected forest lands include 10% of the Amazon rainforests. Government has stopped offering land deeds for new settlements of more than 100 ha in the Amazon. Two year ban on mahogany logging practices in the Amazon cut the amount of the mahogany to be logged from 150,000 meters to 65,000 meters.
China	China is implementing a plan to include over 10% of China's forests in protected reserves by 2000
India	Movement toward decentralization of forest management through Joint Forest Management Programs.
Indonesia	Harvesting and logging restrictions prohibits harvesting trees under 50 cm in diameter. However, the restrictions also state that only 25% of a tree greater than 25 cm and less than 50 cm must remain standing.
Korea	Forest planning, including reforestation, silviculture, and harvesting practices, is required by law. Korea has provided 3% loans, subsidies, and other financial incentives to private owners implementing a wide range of reforestation and conservation measures.
Mexico	The Natural Protected Areas Program has implemented 27 pilot projects providing financing and management training to support protected areas.

Protected Areas

Placing lands under a protected status through conservation and preservation programs can help prevent further deforestation in developing countries. The World Conservation Monitoring Center and the FAO estimate that as of 1996 there were 200

The developing world has set aside an estimated 486 million hectares for conservation and protection.

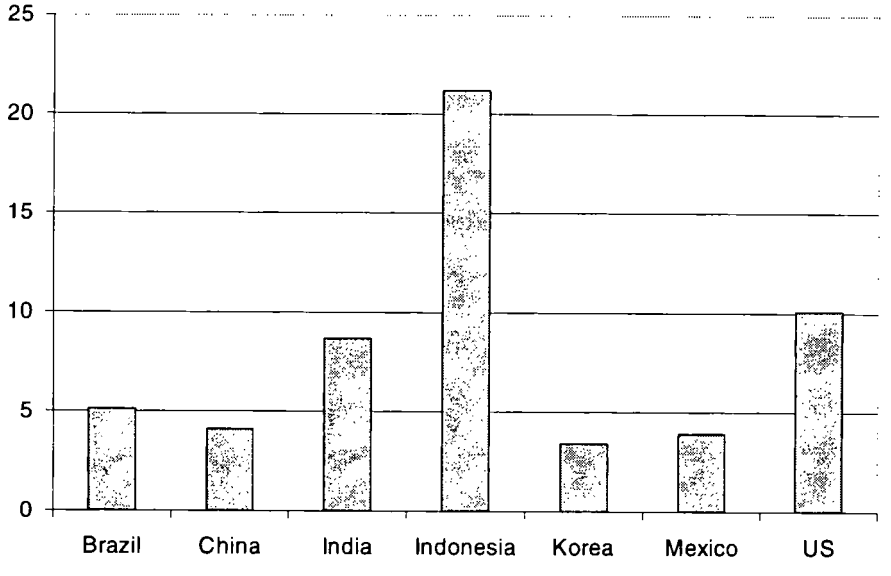
million of forest in developing countries were under protection.[44] Of this area, nearly half (48%) is in Latin America, and 29% and 23% are in Africa and Asia, respectively.

Increased public awareness, implementation of conservation policies, and heightened efforts from international NGO's has resulted in expansion of protected areas in many developing countries and the improved training of reserve managers. The IUCN defines protected areas as

An area of land dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.

Protected areas are then further defined by six categories: strict nature reserve, wilderness area, national park, natural monument, habitat/species management area, protected landscape and protected resource area. Exhibit 3-12 demonstrates the percent of forest lands in protective status for selected countries and the U.S.

Exhibit 3-12
Percent of Total Forests Protected



Source: FAO

An example of a protected area is the Noel Kempff Mercado, a national park of Bolivia being used as a carbon sequestration project. The Government of Bolivia and project partners are

[44] World Conservation Monitoring Center, Global Forest Information Service, www.wcmc.org.uk/forest/

committed to protecting large tracts of the Amazonian rainforest from logging and conversion to agricultural purposes. The 30-year Noel Kempff Climate Action Project[45]

For example, the Government of Bolivia and project partners are committed to protecting large tracts of the Amazonian rainforest from logging and conversion to agricultural purposes. The 30 year Noel Kempff Climate Action Project[46] increases the protection afforded to 631,900 ha within the Noel Kempff Mercado National Park, which has been subject to increased pressure from forest concessions and immigration. Project funding supports park guards, air patrols, and other protection activities, including monitoring and verification efforts to quantify the carbon benefits of the project.

The Rio Bravo Conservation and Forest Management Project in Belize comprises 97,000 hectares of mixed sub-tropical forest and provides an estimated reduction of 1.3 million mtC each year. The carbon sequestration project is broken into two components. Component A includes direct carbon sequestration through conservation efforts. The protected area will sequester an estimated at 768,480 mtC over 40 years. Component B sequesters an estimated 600,000 mtC from improved timber operations and ecosystem management.

In Costa Rica, tropical forest lands considered to be under imminent threat of deforestation through logging or expansion of agriculture were purchased through the Esquinas Carbon Offset Land Conservation Initiative (ECOLAND) project. These lands will be kept under permanent protection and sequester an estimated 1,200,000 tons of carbon.

Bolivia and Paraguay have created reserves to protect large tracts of rainforest threatened by expanding logging and agricultural interests.

In Paraguay, the Mbaracayu forest conservation project protects 58,000 ha of natural tropical rainforest, one of South America's last remaining major tracts of undisturbed dense tropical forest. Adjacent lands in Brazil are nearly 100 percent deforested, and the specific land area in question is threatened by expanding commercial logging activities from a Paraguayan forest products company. The reserve will be managed for recreational purposes, ecotourism, and scientific research. Local indigenous tribes will continue to have access to the reserve for traditional hunting activities.

[45] In addition to the Government of Bolivia, partners on the Noel Kempff Climate Action Project include, Fundación Amigos de la Naturaleza, The Nature Conservancy, American Electric Power, PacifiCorp, and BP America.

[46] In addition to the Government of Bolivia, partners on the Noel Kempff Climate Action Project include, Fundación Amigos de la Naturaleza, The Nature Conservancy, American Electric Power, PacifiCorp, and BP America.

Property Rights and Land Tenure

One of the contributing factors to deforestation is that local residents lack legal tenure over the land they occupy. With little incentive to invest in long-term protection and development of the forest, many communities subsist through slash-and-burn farming, illegal logging, and gathering of various forest resources. Initiatives and policies that empower communities to take control of their resources for the long-term encourage sustainable forest management. Both indigenous and non-indigenous marginalized peoples have, for centuries, retreated further into the forests in search of resources for their economic prosperity and survival. Likewise, farmers are unlikely to protect the forests unless they have an economic incentive to do so and continue to exploit the forest resources to which they have access.

Projects that give local communities explicit rights over forest management have been initiated in India, Nepal, the Philippines, Thailand, and Indonesia. In India, 20,000 villages have formed forest protection groups, which effectively control access to 3-5% of India's forests.

Community-based forest management is increasingly recognized as an essential component to sustainable development and protection against deforestation. In Mexico, the land has been traditionally held as community property in one of two forms, *communidades* where individuals have some rights to communally owned land or *ejidos,* where the state is the legal owner of the land. The government often granted land rights to foreign owned concessionaires. Many people living on the land worked for the foreign concessionaires with little regard to the management of the land. The Forest Law of 1986 recognized the rights of the *ejidos* and *communidades* to use the forests as they wanted and prohibited the government from extending management concessions to foreign interests. The resulting interest in sustainable forest management and silviculture demonstrates the importance of land tenure. Mexico recently revised its forest laws again to allow for individual privatization of communally owned properties.

3.4.3 Increasing Carbon Storage

Forestry can also have a significant effect on GHG emissions through reforestation, afforestation, and improved forest management. Although deforestation is most likely to continue in many developing countries, there is increasing acceptance of the importance of reforesting cleared lands and planting trees on previously unforested lands. Exhibit 3-13 lists some of the activities being implemented by the selected countries.

Exhibit 3-13

Country	Description of Activity or Program
Brazil	As a response to forest products incentive programs initiated in 1965, the area of planted forest in Brazil has increased from 470,000 ha to 5 million ha. The carbon fixation by fast growing forest plantations between 1990-94 was estimated to be 108.8 million tons C/year. Floram Reforestation Project designed as a carbon sequestration project spanning 20 million hectares in the Brazilian Rainforest for an estimated 154 million tons C/year. The project is not complete.
China	Initiated the largest afforestation program in the world, planting an average of 3.25 million ha/year between 1984-1988. China has increased standing forest biomass to almost 14% in recent years and is striving to reach 15.5% by 2000.
India	Nationwide afforestation plan has been in place since 1980 and cover 1.5 to 2 million hectares annually. Locally run social forestry programs distribute seedlings to farmers and households and plant woodlots on village lands to provide better management of forests and fuelwoods.
Indonesia	The "One Million Trees Program" encourages tree planting in urban and populated regions.
Korea	The Korean government provides substantial subsidies (often 90% to 100%) to afforestation and reforestation projects.
Mexico	The National Reforestation Program is focused on strategic restoration of forests and mixed plantations. One of the Program's objectives is to produce 340,000,000 trees. The Program for the Development of Commercial Tree Plantations intends to plant 875,000 ha in the next 25 years.

Afforestation and Reforestation Programs

Afforestation and reforestation programs have increased in many developing countries in response to efforts to support Activities Implemented Jointly (AIJ) under the guidelines of the FCCC. These include:

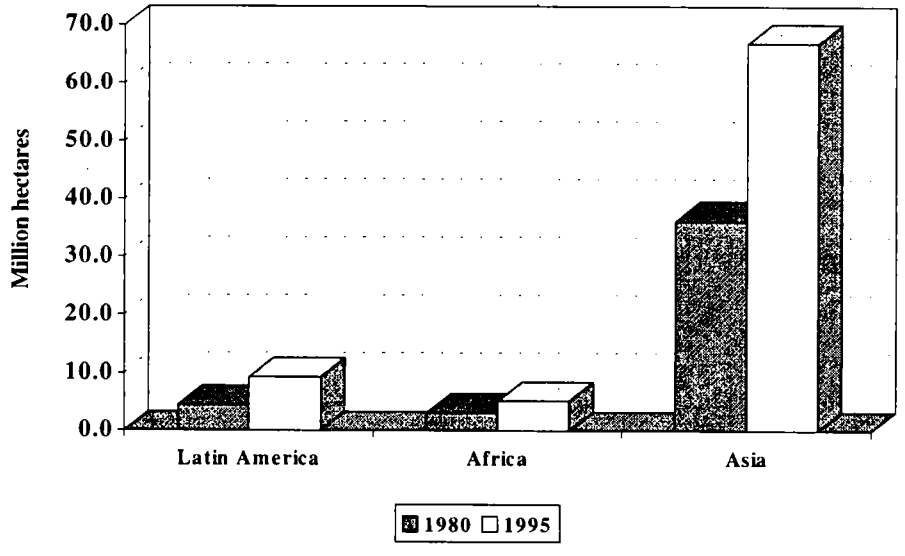
- reforestation of 800,000 ha in Thailand
- extensive reforestation of 35,000 ha of flood damaged forest lands in two national parks in Uganda
- development of agroforestry activities in northeast Chiapas, Mexico

Other countries that have participated in large scale tree planting or other reforestation projects include Pakistan, India, Malaysia, Vietnam, Thailand, and Ecuador. Chile, Brazil, and Uruguay are using incentives to promote establishment of plantations on reforested and afforested lands.

Plantations in Argentina represent only 2% of forest area but account for 60 percent of the country's industrial wood production.

Forest plantations used for fuelwood and commercial logging practices have increased as efforts to prevent further tropical deforestation encourage the use of alternative resources. Industrial plantations can become a major asset to local development by providing raw materials, infrastructure, employment, income and environmental and recreational. The total area of forest plantations in developing countries has more than doubled in the past 15 years. Exhibit 3-14 shows the increase of forest plantations in developing countries by region.

Exhibit 3-14
Forest Plantations in Developing Countries 1980-1995[47]



Source: FAO

The levels of carbon sequestration depend on the end-use of the wood. Plantations used primarily for pulp and paper have a short life cycle, releasing carbon in less than five years.

[47] Food and Agriculture Organization. 1997 *State of the World's Forests,* report of the FAO of the United Nations, Word and Publications, p. 14.

However, forest products such as timber, fiberboard, and wood panels can store carbon for over 50 years.[48]

The growing sector of farm forestry accounts for 20% of Brazil's total plantation area. Large companies contract with individual farmers, providing them with the seedlings and materials, as a means to expand timber supplies. This also contributes to improved forest management practices by land owners and farmers. Plantations of eucalyptus, pines, and bracatinga (a native species) provide 39% of the wood used in industrial processes in Brazil including charcoal used in steel production and fuelwood.

Forest plantations are playing an increasingly important role in national forest and forest preservation programs. Many of the developing countries with large plantation estates (China, India, Indonesia, and Brazil) have indicated that they plan to double their plantation areas between 1995 and 2010. As an alternative to deforestation, plantations play an important role in maintaining and increasing the carbon sinks in developing countries. However, it is important to realize that tree plantations can also be a source of deforestation. In both the Brazil and Indonesia large tracts of forest have been cut down to make room for the more uniform and easily managed plantation species. Forest management principles have had some success addressing these issues.

Forest Management

In addition to reforestation and afforestation activities, developing countries have become interested in formulating forest use plans that go beyond sustained yield forestry and include a more integrative approach to managing forests as ecological systems with multiple economic benefits and environmental values. This has been accompanied by an interest in expanding public participation in the decision making process. This concept is generally referred to as 'sustainable forest management' (SFM). It is an important management trend that is growing in acceptance in many developing countries.

SFM strives for the comprehensive management of forest resources in such a way that the economic needs of current users will be met without jeopardizing the long-term sustainability of these benefits. For example, the Rio Bravo project in Belize includes a component for a sustainable forestry management program designed to increase the total pool of sequestered carbon in a 50,543 ha area of the Rio Bravo Conservation Management Area (RBCMA). Approximately 2,500 ha of the 10,010 ha area of pine savannah will be subject to management aimed at improving stocks of pine through promotion of regeneration. The sustainable forestry regime will be applied over 25,866 ha of broadleaf forest land within the areas of the eastern

[48] H. seppala and V. Siekkinen, The Globalization of Wood Processes, Products and Markets, 1993; p. 208.

RBCMA that are considered suitable for forestry activity. An additional 5,308 ha will be set aside as a conservation zone and will be allowed to regenerate naturally.[49]

Efforts to promote SFM have begun to influence forestry policies throughout Asia, Latin America, and Africa. Significant SFM strategies are being formulated by Indonesia, Papua New Guinea, Malaysia, Cameroon, Guinea, Benin, Togo, and several other African countries. In Latin America several participants in the Tratado de Cooperacion Amazonica/Amazon Cooperation Treaty (TCA) have made commitments to sustainable forest management, including Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname, and Venezuela.

The Forest Stewardship Council accredits certifying organizations who award certification of forests based on the principles and criteria of SFM. Certifications can apply to all tropical, temperate and boreal forests as well as forest plantations and partially replanted forests. While the standards are mainly designed for forests managed for the production of wood products, they are also relevant to forests managed for non-timber forest products and other services. There are ten principles of management outlined by the standards including those adhering to international law, property rights, indigenous people's rights, environmental impacts, maintenance of natural forests, and plantations.

Mexico has six certified forests totalling 117 thousand hectares. Brazil's 7 certified forests include over 386 million hectares.

In all, FSC and their certifying organizations around the world have certified more than 125 forests including a total of 10,518,381 hectares. Forests in developing countries represent 2,763,246 hectares of certified forests, more than 25% of all certified forests. The majority of these forests are being used in private or industrial logging. The certification implies that they are practicing sustainable forestry management.[50]

The two primary objectives of "certification" are "to improve the management of forests in order to achieve their sustainability; and to provide market access for the products from these forests".[51] Certification attempts to use the incentives of the market to influence land use management and conservation. By commanding a higher price, certified products provide an economic incentive to producers to use sustainable practices. In practice, though certification is growing, it is barely visible in the context of international trade, covering between 2.3 and 4

[49] Trexler and Associates. 1998. Personal communication.

[50] Forest Certification Council. Http://www.fscoax.org/html/5-3-3.html

[51] *Ibid,* p. 71

million ha, less than 0.5% of traded wood.[52] Most of the trade in certified products has occurred between the exporting countries of Australia, Brazil, Canada, Finland, Indonesia, Malaysia, New Zealand, Norway, Sweden, and the USA, and the importing countries of Germany, Netherlands, the United Kingdom, and Denmark. Wood products coming from the certified forests will be designated as ecotimber. Recently the FSC withdrew the certification of the Leroy, Gabon logging operations because the logging practices performed were not found to be ecologically sound. The African certification body is also undergoing retraining and a temporary moritorium has been placed on future certifications in the area.

Many countries have begun to define and develop indicators that can be used to monitor forest conditions over time and to provide a basis for evaluating performance relative to national and regional goals. The process of identifying and defining meaningful indicators and criteria is still ongoing, as are efforts to compile and evaluate data. Data availability is a significant problem in some areas; the lack of data can seriously undermine conservation and management goals.

Field implementation projects to support the development of indicators and criteria as well as monitoring and management methods are underway in many countries, including China, Mexico, Russia, and Vietnam. These projects are under the guidance of Canada and aim to develop information on general strategies and methods for sustainable forest management that can be used at the operational scale. In addition, the International Tropical Timber Organization (ITTO) in collaboration with the International Institute for Environment and Development (IIED), and the World Conservation Monitoring Centre (WCMC) has developed the 'Forest Resources Accounting System' in order to standardize the monitoring of forest conditions and management, and to facilitate comparable reporting. Testing of the system is currently underway in Cameroon, Ecuador, and Indonesia.[53]

Another aspect of SFM and an important trend in forestry resource management is participation by local communities and indigenous peoples. The development of participatory management systems has been rapid in many developing countries.[54] These systems allow local stakeholders to participate in day-to-day management and protection of forests. Fashioned to accommodate local conditions, these participatory systems have a variety of names, including joint forest management (JFM); community forestry programs; integrated conservation and development projects (ICDP); and village land management (rapidly developing in West Africa and referred to as 'aménagement des terroirs'). In Ecuador, Peru, and Bolivia, the 10-year, $3 million Oxfam America-AES Amazon Program will help indigenous Amazonians gain legal title to 1.5 million ha of their traditional territories and then assist them in the management of their resources.

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[52] *Ibid*, p. 69

[53] Food and Agriculture Organization, *op. cit.*

[54] *Ibid.*

Joint forest management has been successfully adopted in several Indian states and Southeast Asian countries to the benefit of local community interests. Nepal has instituted a National Community Forestry Program to negotiate between competing forest interests and users. This program promotes a high level of local control, although decision authority remains with the district forest officer. The ICDP approach has been fostered through the efforts of the International Union for the Conservation of Nature (IUCN) and the World Wide Fund for Nature (WWF) and has been recently adopted by the Asian Development Bank and the World Bank for some projects. It encourages sustainable resource management through the use of incentives for efficient local management.[55] For example, local communities may be given control and access to forests for nontimber resources, and they may then be given significant standing in the process of managing the resources.

[55] *Ibid.*

CHAPTER 4
ACTIONS EXPLICITLY SUPPORTING THE FCCC OR DIRECTLY CONTROLLING GHG EMISSIONS

The UN Framework Convention on Climate Change (FCCC) established commitments for the various parties to the Convention, which were later elaborated on in the Kyoto Protocol. A distinction was made in these proceedings between the commitments to be made by developed and transitional economy countries (Annex I Parties) and those to be made by the developing countries (non-Annex Parties), in order to take into account differences in national and regional development priorities, objectives, and circumstances. Exhibit 4-1 summarizes the provisions of the Protocol that bear upon the responsibilities of the various parties.

Exhibit 4-1
Provisions of the Kyoto Protocol Outlining Differentiated Responsibilities

Article 3	Establishes specific targets for quantified emission limitation and reduction commitments for Annex 1 Parties; establishes the concepts of joint implementation and emissions reduction unit trading among Annex 1 Parties.
Article 2	Requires Annex 1 Parties to elaborate and implement policies and measures for achieving targets specified in Article 3.
Article 11	Requires Annex I Parties to provide new and additional financial assistance for transfer of GHG-reducing technologies from developed to developing countries.
Article 12	Extends concept of joint implementation to non-Annex I Parties (through its definition of a " clean development mechanism").
Article 10	Requires all parties to the Convention to take GHG inventories, formulate national action plans and programs, and develop national communications.

This chapter presents a brief overview of the programs and actions that developing countries have implemented to fulfill their FCCC commitments. The extent of the human and financial resources that have been dedicated to this purpose demonstrates the seriousness with which developing countries are taking their responsibilities.

4.1 NATIONAL ACTION PLANS

All of the key countries considered in this report are developing national action plans (NAP) as required under the terms of the FCCC. These plans, particularly the parts describing policies and programs for controlling GHG emissions, form the basis for the national communications packages which are also under development. Prepared under the guidance of key governmental agency officials, the NAPs are intended to provide national guidance by outlining specific policies and measures. The planning committees generally recognize that introduction of new environmentally friendly technologies will benefit their countries both environmentally and economically, and they are using their participation as an opportunity to promote the use of new technologies.

The major GHG-emitting developing countries have all allocated significant resources to the national action planning process. They have developed inventories of their GHG sources and sinks, and they have assigned knowledgeable staff to the tasks of identifying GHG emission mitigation and sink enhancement opportunities and developing national programs to implement new policies and technologies. They have also welcomed and made use of the assistance provided by Annex I countries such as Germany, the Netherlands, and Japan and international organizations such as the UNEP, UNDP, and GEF. Many countries are also taking advantage of provisions of the FCCC that afford assistance in the transfer of technology from the developed countries.

All developing country Parties to the FCCC have prepared (or are in the process of preparing) National Action Plans, inventories of GHG sources and sinks, and National Communications.

Fifty-five developing and transitional economy countries have participated in climate change studies and eighteen have developed national action plans under the auspices of the U.S. Country Studies Program. Each country prepared inventories of GHG sources and sinks and either an assessment of mitigation options or an evaluation of vulnerability and adaptability (V & A) issues. Several countries completed both the mitigation and V&A reports.

4.2 NATIONAL COMMUNICATIONS

Under the terms of the FCCC, each party to the Convention is obligated to develop national communications which are to be submitted within three years of the time that the party becomes subject to the provisions of the Convention, or of the time that it identifies sufficient financial resources to complete the tasks. The national communications are to contain the following five sections: 1) a discussion of national circumstances, 2) an inventory of anthropogenic sources and

sinks of all GHGs not controlled by the Montreal Protocol, 3) a general description of steps to be taken to implement the Convention, 4) other relevant information including financial and technological needs and constraints, and 5) an executive summary. Non-Annex I countries are eligible for full-cost funding of this endeavor.

The development of a national communications package is a vital first step in getting a country to evaluate its current status regarding GHG emissions, to begin developing policies and plans to implement mitigation actions, and to assess its vulnerability and generate policies for adapting to climate change. The national communications package provides a baseline against which the impact of future mitigation actions can be measured. This baseline information will also be needed both for the development of joint implementation projects and for participation in any carbon trading regime.

All six case-study countries included in this report (Brazil, China India, Indonesia, Korea, and Mexico) are completing or have completed their national communications packages. Many other developing countries are not far behind.

The FCCC did not specify a particular format for the national communications documentation, so the non-Annex I Parties (G77 and China) drew up formatting guidelines in a position paper prepared during a seminar held in Geneva, Switzerland, in February 1996. This format is consistent with that being used by the developed countries, except that it does not include an assessment of the impact that each policy or measure will have on GHG emissions.

Brazil serves as a useful illustration of how the format has been used. The national communications drafted for Brazil contains a description of pertinent national circumstances, an inventory of anthropogenic sources and sinks (prepared in accordance with the guidelines established by the International Panel on Climate Change), and a description of the steps that Brazil has taken or plans to take to implement the Convention.

The national communication gives a very detailed sectoral breakdown of energy use and associated GHG emissions from both fossil and biomass resources. The document discusses potential future directions in energy conversion and use. It gives considerable attention to the renewable uses of biomass materials, a very significant energy source in this country. While some biomass is harvested in a nonrenewable mode, sugarcane is considered to be completely renewable and much harvesting of fuelwood is now done in a renewable manner. As of 1994, the baseline year for Brazil's analysis, hydroelectric power, fuelwood, and sugarcane accounted for almost 55% of the gross domestic energy supply; and oil made up a large fraction of the remainder.

The document also identifies a number of steps or programs that Brazil has implemented in the past or is contemplating for the future that should have a favorable impact on GHG emissions. These are of the following types:

- programs related to sustainable development
- programs aimed at slowing climate change and adopting to changes
- research and systematic observation
- education, public awareness, and training
- monitoring of climate change impacts on terrestrial and marine ecosystems
- national and regional capacity building
- integration of climate change concerns into medium and long-term planning

Programs related to sustainable development include:

- national alcohol program (Proalcool)
- energy conservation programs (PROCEL and CONPET)
- cogeneration and biomass power generation enhancement program in Bahia (GEF project)
- hydroelectric power plants
- renewable energy sources
- hydrogen-based public transportation program (GEF project)
- recycling program
- PRODEEM (states and municipalities energy development program)
- charcoal-based steel and iron industry

Programs specifically designed to address climate change and its adverse impacts include:

- nuclear energy development
- natural gas sector expansion
- methane recovery from landfills in São Paulo
- reduction of fugitive methane emissions from natural gas distribution in the City of São Paulo
- reduction of road transport urban emissions in São Paulo (Program Breathe São Paulo)

The programs listed above will all impact GHG emissions over the medium and long term, and some will have also have favorable short-term impacts. Climate change planning will ~~be~~ also be integrated into medium and long term programs through the following activities:

- program for vehicular emission reduction (PROCONVE)
- program for air quality (PRONAR)
- forest fire prevention
- national parks in Brazil (forest conservation units)
- program for deforestation assessment in the legal Amazonia (PRODES)
- measures to combat deforestation in Amazonia
- São Paulo state program on global climate change (PROCLIMA)

The breadth of the initiatives Brazil has taken or plans to take to implement the Convention is indeed impressive. Brazil has extensive experience with climate-friendly technologies of many sorts. In addition, the country has until recently relied to a great extent on renewable energy sources; unfortunately, it will be severely challenged to continue doing so in the face of increasing economic and population pressures and hydropower-related environmental concerns..

4.3 GLOBAL ENVIRONMENT FACILITY (GEF)

The GEF was established to serve as the financial mechanism for the FCCC. The GEF provides grants and concessional funding to recipient countries for projects and programs that protect the global environment and promote sustainable economic growth. Originally set up as a pilot program in 1991, the GEF was restructured and its funding was replenished with over US $2 billion in 1994. The funds are intended to cover the agreed incremental costs of activities in four focal areas: climate change; biological diversity; international waters; and stratospheric ozone. Land degradation activities, primarily decertification and deforestation, are also eligible for funding when they relate to one of the four focal areas.

GEF projects and programs are managed through three implementing agencies: the UN Development Programme (UNDP), the UN Environment Programme (UNEP) and the World Bank. The GEF Secretariat, which is functionally independent from the three implementing agencies, reports to and services the Council and Assembly of the GEF.

GEF projects must be country-driven and include local community participation. In addition, non-governmental organizations must be involved in project implementation where appropriate. Countries may receive GEF funds through either the FCCC or the Convention on Biological Diversity (both have designated the GEF as their funding mechanism on an interim basis). As of March 1998, 164 countries are participating in the restructured GEF.

The GEF has provided US$750 million in assistance for 197 climate change projects.

Through May, 1998, the fund has provided assistance for 551 projects totaling US$1.95 billion. Of this amount, over US$750 million has been allocated to 197 climate change projects. Many of the climate change projects support FCCC-related actions in particular countries. Others are not directly related to country studies or the formulation of national action plans, but are more generally related to the GEF's climate change goals.

Fifteen of the climate change projects are global in nature, covering activities such as project implementation funds, research, capacity building, and support for implementation of the FCCC. Eight regional programs are concentrating on energy efficiency in buildings and industry,

renewable energy technologies, least cost GHG abatement strategies, adaptation, and capacity building in both the energy and forestry sectors. Country-specific projects cover a wide gamut of activities from removing barriers and reducing implementation costs of energy efficiency and renewable energy technologies through support for climate studies and capacity building. A summary of all GEF categories and funding amounts is displayed in Exhibit 4-2.

Exhibit 4-2
GEF Program Categories and Funding Allocations
(through May, 1998)

GEF Program Category	Percent	Total Funding (US$ in millions)
Biodiversity - 1 : Arid and Semi-Arid Zone Ecosystems	4.22%	$82.2
Biodiversity - 2 : Coastal, Marine, and Freshwater Ecosystems	6.73%	$131.0
Biodiversity - 3 : Forest Ecosystems	16.01%	$311.7
Biodiversity - 4 : Mountain Ecosystems	2.53%	$49.2
Biodiversity - EA : Enabling Activities	2.03%	$39.5
Biodiversity - STRM : Short-Term Response Measures	8.19%	$159.4
Subtotal		$773.1
Climate Change - 5 : Removal of Barriers to Energy Efficiency and Energy Conservation	9.61%	$187.1
Climate Change - 6 : Promoting adoption of renewable energy by removing barriers and reducing implementation costs	14.40%	$280.3
Climate Change - 7 : Reducing the Long-Term Costs of Low Greenhouse Gas-Emitting Energy Technologies	5.28%	$102.8
Climate Change - EA : Enabling Activities	3.48%	$67.7
Climate Change - STRM : Short-Term Response Measures	5.88%	$114.6
Subtotal		$752.4
International Waters - 8 : Waterbody-Based Operational Program	5.92%	$115.3
International Waters - 9 : Integrated Land and Water Multiple Focal Area Operational Program	2.54%	$49.4
International Waters - 10 : Contaminant-Based Operational Program	3.97%	$77.3
Subtotal		$242.0
Ozone Depletion	5.88%	$114.4
Multiple Focal Areas	3.34%	$65.0
Total		$1,947.0

The financial commitments made by the GEF and the host countries for climate change projects in the five developing countries highlighted in this report are summarized in Exhibit 4-3. For these five countries, projects with a total cost of US$2.1 billion have been implemented through the GEF. Of this amount, the host countries or private entities are providing US$1.77 billion, or 83% of the total. The size of the host country contributions demonstrate that they are very committed to reducing GHG emissions.

Projects with a total cost of $2.1 billion have been implemented through the GEF in Brazil, China, India, Indonesia, and Mexico. These countries have provided US$1.77 billion in funding, or 83% of the total.

Exhibit 4-3
Funding for GEF Climate Change Projects
Selected Countries
(through May 1998)

	Amount (US$ in millions)		
Country	**GEF**	**Other**	**Total**
Brazil	74.5	264.8	339.3
China	137.5	797.9	935.5
India	104.6	406.6	511.3
Indonesia	30.5	287.6	318.1
Mexico	10.3	13.0	23.3
Total	357.5	1,770.0	2,127.5

4.4 JOINT IMPLEMENTATION

Joint Implementation (JI), also know as Activities Implemented Jointly (AIJ), is a concept that has gone through a limited pilot phase. Over 50 projects, both energy-related GHG emission reduction projects and forestry-based carbon sink enhancement activities, are being conducted under several AIJ/JI pilot programs to demonstrate the feasibility of the JI concept, and 30 more have been approved or endorsed by the designated national authorities for AIJ of the Parties concerned.

Eighty JI projects have either been approved or endorsed by the concerned Parties.

The fact that many countries, both developing and developed, have voluntarily participated in JI projects with no specific benefit regarding carbon offsets accruing to their national GHG budgets indicates the widespread interest in addressing climate change issues through cooperative efforts. Each pilot program implementation is unique, and interpretations regarding concepts such as additionality, baselines and offsets, and leakage have been treated differently. The practical experience being gathered under these JI pilot projects will provide the foundation for a more formal JI project that can be conducted on a larger scale.

The JI concept will most likely be an integral component of an international carbon trading scheme. The Clean Development Mechanism (CDM) that was established by the Kyoto Protocol embodies the principles of JI along with the concept of credit through the use of certified emission reductions.

The World Bank, in collaboration with Norway, established an AIJ program in 1996. The primary purpose of this AIJ pilot mechanism is to gain experience with the concept of JI and a possible carbon trading scheme. The World Bank is particularly concerned with issues such as baselines and additionality and with procedures for certifying and monitoring a carbon trading regime.

There are several pilot projects in the World Bank AIJ portfolio at various stages in the development pipeline. The projects are:

- Mexico: Ilumex Project, High efficiency lighting project using CFLs. Over 1.6 million lamps have been installed and bids have been let for an additional 0.9 million units. This project is based on the predecessor Ilumex project in which 200,000 lamps were installed.

- Poland: Coal-to-Gas Project, The objectives of the project are to stimulate technological and institutional changes to demonstrate inter-fuel substitution and encourage a rapid transition from coal to gas, and introduce more energy efficiency in residential buildings.

- Burkina Faso: Sustainable Energy Management, The project introduces efficient carbonization techniques, community-based forest management, kerosene cooking stoves, and the promotion of solar photovoltaic (PV) systems to rural communities.

- India: Integrated Agricultural Demand - Side Management Project, The project combines four technical measures in an integrated package to generate electricity savings and greenhouse gas emission reductions for the Andhra Pradesh State Electricity Board. The measures are:

    - improvements of the distribution system efficiency by converting from low voltage (LV) feeders to high voltage (HV) feeders;

- reduction in system demand and line losses, as well as improved service to non-agricultural customers through the use of automated load control;
- the provision of customer meters to provide information on energy consumption; and
- improvements in end-use efficiency by replacement of pumpsets and associated pipes and valves with more efficient products.

▸ Barbados: Queen Elizabeth Hospital Fuel Cell Installation Project, The project will entail installation of three 200 kW fuel cells, with a thermal output of 2.1 Mbtu at 140 °F. The 600 kW output of the fuel cells is sufficient to meet the average power demand requirements of Queen Elizabeth Hospital (QEH). QEH will utilize the thermal energy for its laundering applications, replacing the use of diesel and fuel oil boilers.

Because these projects are demonstration and pilot projects designed to test the fundamental JI and carbon trading concepts, much of the funding will come from donor organizations and the AIJ and GEF facilities. Other funding will be provided by government and private sector sponsors. A summary of the current status of funding for the World Bank AIJ projects follows:

Mexico - GEF project and Norway demonstration AIJ project
$3 million: Norway; $10 million: GEF; $10 million: CFE

Poland - GEF project and also a Norway AIJ demonstration project
$1 million: Norway; $25 million: GEF; $22 million: Government of Poland

Burkina Faso - AIJ demonstration
$2.6 million: Norway; other funding from the Dutch, Danes, and Burkina Faso

India - Under consideration as an AIJ demonstration
No decision yet to proceed. Norway and India are considering the DSM project.

Barbados - AIJ demonstration
$0.6 million: Norway; IFC loan to project developer; support from Barbados Light & Power Co. Total cost = $2.5 million

The Netherlands, Germany, Japan, and Australia each are supporting the development of JI demonstration projects. Japan, for example, has approved eleven projects in Asia and Africa, and the Netherlands has supported twenty projects in eleven countries.

Twelve countries (Belize, Bolivia, Costa Rica, Czech Republic, Ecuador, Honduras, Indonesia, Mexico, Nicaragua, Panama, Sri Lanka, and the Russian Federation) are participating in 32 USIJI

projects up through May 1998. A list of these projects is presented below for each of the four rounds beginning in 1995.

- First Round Projects — February 1995
  - Rio Bravo Conservation and Forest Management, Belize
  - Plantas Eolicas S.A. Wind Facility, Costa Rica
  - ECOLAND: Esquinas National Park, Costa Rica
  - Project CARFIX: Stabilize Existing and Expand Forest Cover, Costa Rica
  - Fuel Switching for District Heating System, Czech Republic
  - Enersol Rural Solar Electrification, Honduras
  - RUSAFOR Saratov Afforestation Project, Russia

- Second Round Projects — December 1995
  - Bio-Gen Biomass Power Generation Project, Honduras
  - Dona Julia Hydroelectric Project, Costa Rica
  - Aeroenergia Wind Facility, Costa Rica
  - Rusagas Fugitive Gas Capture, Russia
  - Biodiversifix: Forest Restoration Project, Costa Rica
  - El Hoyo-Monte Galan Geothermal Project, Nicaragua
  - Klinki Forestry Project, Costa Rica
  - Tierras Morenas Windfarm Project, Costa Rica

- Third Round Projects — December 1996
  - Reforestation in Vologda, Russia
  - Reforestation of Chiriqui Province, Panama
  - The Noel Kempff M. Climate Action Project, Bolivia
  - District Heating Improvements in Zelenograd, Russia
  - The Bio-Gen Biomass Power Generation Project Phase II, Sava Site, Honduras
  - The Bel/Maya Biomass Power Generation Project, Belize
  - Forest Conservation — Bilsa Reserve, Ecuador
  - Project Salicornia: Carbon Sequestration and Halophyte-based Industries in Sonora, Mexico
  - Scolel Té — Sustainable Land Management and Carbon Sequestration, Chiapas, Mexico
  - Carbon Sequestration Through Reduced Impact Logging, Indonesia

- Fourth Round Projects — July 1997
  - Carbon Sequestration Through Costa Rican Territorial and financial Consolidation of Biological Reserves Project, Costa Rica
  - Rural electrification Project, Bolivia
  - SELCO - Rural Electrification Project, Sri Lanka
  - APS/CFE Renewable Energy Mini-Grid Project, Mexico

Community Silviculture in Sierra Norte, Oaxaca, Mexico
District Heating Efficiency Improvements, Metallurgichesky, District of Cheliabinsk, Russia
District Heating Renovation, Lytkarino, Russia

If all of these projects are fully financed and implemented, it is estimated that the equivalent of 189 million tonnes of CO_2 will be offset or sequestered during the project lifetimes. And all of these projects are being undertaken in the absence of tradable credits, which demonstrates the seriousness with which both the host countries and U.S. companies and organizations regard the joint implementation process.

Currently 12 of these projects have received full funding, and 12 others have obtained partial funding. All 32 projects have been accepted by the host country governments.

Other USIJI projects under development are listed below. New countries interested in the USIJI projects include Armenia, Cameroon, India, Papua New Guinea, and the Philippines.

Twelve countries (Belize, Bolivia, Costa Rica, Czech Republic, Ecuador, Honduras, Indonesia, Mexico, Nicaragua, Panama, Sri Lanka, and the Russian Federation) are participating in 32 USIJI projects up through May 1998. If all of these projects are fully financed and implemented, it is estimated that the equivalent of 189 million tonnes of CO_2 will be offset or sequestered during the project lifetimes.

Exhibit 4-4
Projects Under Development

Country	Project
Armenia	Wood Energy Crops and Other Biomass to Electricity
Cameroon	Reforestation of the Mountains of the Northwest Province
Costa Rica	Rotational Biomass for Cement Manufacturing
Costa Rica	Colina Blanca International SA (Rainmaker Project/Forest preservation)
Costa Rica	Compania Nacional de Fuerza y Luz SA (Hydroelectric project)
Costa Rica	Monteverde Biological Corridor Carbon Sequestration (Forest management)
Ecuador	Forest Conservation
India	Bagasse-Fired Cogeneration
Mexico	Carbon Sequestration and Sustainable Forest Management (Multicomponent forestry)
Papau New Guinea	Lak Conservation Area Sustainable Forestry Project (Multicomponent forestry)
Philippines	Reforestation of the Mountains of Zambales
Russia	Reforestation
Russia	RUSAGAS-FGC, Fugitive Gas Capture (Fossil fuels/Natural gas project)

ANNEX A
CHINA

A.1 SUMMARY

China is second only to the United States in emissions of carbon dioxide. It accounts for approximately 14% of global CO_2 emissions and its share is expected to increase in the coming years. China's ranking as a major emitter of greenhouse gases can be attributed to its large population (more than 1.2 billion people), its rapid economic growth and dramatic industrialization over the past two decades, and its increasing energy use which draws heavily on abundant indigenous coal resources.

Over the past decade, China has increased environmental spending, adopted market incentives, strengthened lawmaking and enforcement, and promoted nationwide environmental education as part of its efforts to curb GHG emissions. China has also made explicit policy choices regarding industrial structure, power generation, and the preservation of carbon sinks. Environmental problems associated with heavy reliance on coal would be even worse if China had not initiated a widespread energy conservation program in the early 1980s. This program reduced China's energy intensity by 4.5% each year for the past two decades.[1] From 1980-1990, China's energy effiicency programs resulted in energy savings equivalent to 100-140 million tons of coal and catalyzed conservation investments by Chinese industry of $5.7 billion.[2]

China's energy effiicency programs resulted in energy savings equivalent to 100-140 million tons of coal and catalyzed conservation investments of $5.7 billion.

[1] Pacific Northwest National Laboratory, 1998. *China's Electric Power Options: An Analysis of Economic and Environmental Costs*. Washington, DC

[2] Keegan, Patrick et al. 1996 "Seven More Developing Country Examples of Energy Efficiency and Renewable Energy Initiatives." *Examples in Action: Sustainable Energy Experiences in Developing and Transition Countries*. IIEC, Washington DC.

A.2 BASELINE CONDITIONS AND TRENDS

China is the most populous country in the world and the second largest producer of GHG emissions. In 1995 China's emissions of CO_2 totaled 3,192.5 million metric tons, approximately 14% of the world's total. A large amount in absolute terms, it looks slightly less so when considered in relation to China's population. CO_2 emissions per capita were 2.7 metric tons in 1995, far lower than in many industrialized countries. China's contribution to global emissions is expected to reach 15% by 2000 and 25% by 2050.[3]

Energy consumption is the primary source of China's GHG emissions and accounted for 80% of its 1990 emissions. China is the second largest energy consumer in the world. In 1995 China's total primary commercial energy demand was 1,240 mtce. Energy consumption has increased on average 4.5% per year over the last 15 years. Energy-related CO_2 emissions have increased steadily over the past two decades as well, more than tripling between 1971 and 1993.[4] Exhibit A-1 shows a breakdown of these emissions by sector in 1990. Power plants were responsible for approximately 183 million tons of carbon emissions, 29% of the country's total. Three quarters of China's power plants are coal-fired, a fact that explains the power sector's importance as a source of CO_2 emissions.

Exhibit A-1[5]

1990 Energy-Related CO_2 Emissions by Sector

Sector	Share of
Industry	**75%**
Power	24
Energy production	11
Building materials	9
Iron and Steel	7.5
Chemical materials	7.5
Other	16
Agriculture	3%
Transportation	4%
Other	18%

[3] Rose, A. et al. 1996. "Global Warming Policy, Energy, and the Chinese Economy," Resource and Energy Economics, vol. 18, no. 1 (March), pp.1-30.

[4] OECD. *Climate Change Policy Initiatives 1995/96. Volume II: Selected Non-IEA Countries*. p.45

[5] Ye Ruqiu, China Environmental Protection Agency, "Studies on Climate Change Problems and Response Measures in China", published in Proceedings from the International Conference on National Action to Mitigate Global Climate Change, June 1994. UNEP Collaborating Center on Energy and Environment Risø National Laboratory, Denmark, June 1995. Beijing, PRC.

Coal is the largest contributor to energy-related CO_2 emissions. China consumes about 1.4 billion tons of coal each year and relies on coal more than any other country in the world (see Exhibit A-2).[6] In 1993 coal use accounted for 83% of total energy-related CO_2 emissions.[7] Both the power sector and the industrial sector are heavily dependent on coal. Industrial boilers are very prevalent in Chinese industry; there are an estimated 430,000 industrial boilers, most of which are coal-fired. Cement production is another source of CO_2 emissions. In 1990 cement production in China was about 210 million tons, producing emissions of about 29 mtC.

Exhibit A-2
Coal as a Source of Fuel in China

Use	% of fuel supply
Power Generation	76%
Industrial Fuel	75%
Household Energy	80%
Chemical Raw Materials	60%

The transport sector and residential sector are not major sources of GHG emissions. The transport sector contributed only 6.4% of total emissions in 1993 while the residential sector accounted for 13% of emissions. According to projections, the transport sector will still account for only 5% of CO_2 emissions by 2020. However, the absolute amount of energy consumed by the sector could increase from 45 mtce in 1990 to 173 mtce in 2020. China's forests are estimated to have been a net sink of atmospheric carbon in 1990, reducing total GHG emissions by about 1 percent.

A.3 BROAD ECONOMIC REFORMS AFFECTING GHG SOURCES AND SINKS

The Chinese economy is in the midst of a major transition from a command economy to a market-based one. This transition has resulted in rapid economic growth and a fourfold increase in the size of the economy in the past 15 years. Between 1978 and 1995 real GDP per capita grew by 8% per year.[8] Beginning in 1978, China launched a series of economic reforms that have liberalized markets for many products and services, introduced competition in industry, and contributed to China's integration with the world economy.

China's remarkable economic growth over the past two decades may be contributing to increased levels of GHG emissions. There are at least two factors, however, which suggest the link between economic growth (and the economic reforms that spurred that growth) and GHG emissions may not be as strong in China's case as in other countries. First, a World Bank analysis of the factors contributing to China's economic growth reveals that labor force improvements, a

[6] *Op. cit.* 1, p.1

[7] *Op. cit.* 3, p.45

[8] The World Bank. 1997. *China 2020: Development Challenges in the New Century.* Washington, D.C. p.1.

high savings rate, and structural change were important components of economic growth.[9] In fact, only 37% of China's annual economic growth is attributed to growth in capital inputs, according to the World Bank.

Second, China's energy intensity has fallen by 50%, or 4.5% per year, despite the high levels of economic growth. The decline in energy intensity is due in part to efficiency gains in the industrial sector. Changing demands for goods and services has altered China's product mix, producing some efficiency gains.

China's energy intensity has fallen by 50%, or 4.5% per year, despite high levels of economic growth.

The beneficial effects of some economic reforms on GHG emissions are discernible. These reforms are discussed briefly below.

A.3.1 Power Sector Reform

The Chinese government is in the process of restructuring its power sector, which has the potential to enhance energy efficiency and reduce GHG emissions. A more market-oriented power sector should expedite the introduction of improved management techniques, a reduction of transmission and distribution bottlenecks that perpetuate inefficient operation of generation plants, and the transfer of more advanced technologies.

China's power industry previously was overseen by the Ministry of Electric Power (MOEP), which was established in 1993 and whose role was to set energy policy, prepare industry regulation, and plan the industry's development. The MOEP owned all of China's generating assets other than those owned by companies not directly managed by the MOEP (i.e. foreign developers). The MOEP was officially dissolved in April 1998 and was replaced by the newly-formed State Power Corporation (SPC). In principle, this first step represents the "corporatization" of MOEP and is intended to facilitate market-based reforms and investment in the power industry.

In a second stage of reform that will follow, the functions of generation, transmission, and distribution will likely be unbundled. Generators would operate in a competitive market. Distribution and transmission would remain under the control of SPC and the Provincial Power Bureaus for the foreseeable future. A pilot competitive generation market is being established in the East China Power Group Area; if successful, the pilot project could lead to the establishment of competitive power markets throughout China.

[9] *Op. cit.* 4, p.4.

China's efforts to unbundle generation, transmission, and distribution will eliminate some of the discriminatory practices involved in the purchase of power from generation plants. For example, power sector reform will seek to ensure that power plants not owned by local distribution networks receive the same treatment as network-owned plants. The current favoratism shown to network-owned plants means that the more efficient foreign-owned plants are often passed over in favor of a locally-owned plant. Another objective of power sector reform will be to create a national high-voltage network. This would allow regional grids to sell surplus electricity into other regions where supply is insufficient to meet demand. Current transmission bottlenecks mean local power bureaus have limited options for meeting electricity demand and often resort to building new but small plants, which tend to be less efficient than large scale plants, and keeping existing units on line as long as possible. Both changes will mean a more efficient power industry that produces lower levels of GHG emissions.

A.3.2 Trade and Investment Liberalization

Liberalization of trade and investment policies have spurred foreign investment in China and increased competition for industries and businesses. The power sector in particular has attracted significant amounts of foreign public and private investment. From 1979 to 1996, 10% of total investment in the power sector came from abroad. As of early 1998, China had almost 57 GW of foreign-funded electric generation capacity in operation or under construction (China's total installed capacity is approximately 250 GW).

This investment has been critical to bringing in modern, efficient generation plants. The average thermal efficiency of China's power plants is 25-29%.[10] Older plants in particular can be quite inefficient, consuming as much as 25% of the electricity they generate. Based on a survey of U.S. developers investing in China's power sector, about one-third of the developers' plants use advanced generation technologies and one-fifth are cogeneration plants.[11]

To continue to exploit the environmental and efficiency benefits that foreign-funded power plants offer, the Chinese government recently stated that future foreign investment would be channeled into projects with a capacity exceeding 300 MW. This directive is meant to reverse the trend of provincial and local authorities building smaller power plants, which often have diseconomies of scale in design and operation. Approximately 40% of China's generating units are smaller than 100 MW and only 23% of capacity is in units larger than 300 MW.[12]

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[10] Blackman, Allen and Xun Wu. 1998. "Foreign Direct Investment in China's Power Sector: Trends, Benefits, and Barriers". Resources for the Future Discussion Paper 98-50, Washington, DC.

[11] *Op. cit.* 9, p. 27.

[12] *Op. cit.* 9, p. 3.

A.3.3 Energy Price Reforms

Over the past decade energy pricing in China has moved from central government control to a mix of market-driven allocation and government interventions. The result in most cases has been higher prices that more accurately reflect the true costs of supply.

Electricity Prices

China has instituted a number of pricing reforms in the electricity sector to increase the funding sources available to the power sector and to establish tariffs that allow power enterprises to recover the costs of providing power. As a result of these reforms, electric power prices have increased steadily since 1981. On average electricity prices rose 9% per year between 1981 and 1993. The average electricity tariff in 1996 was 283.4 yuan per MWh, 8.1% higher than the average tariff in 1995.[13]

As part of electricity pricing reforms, China established a new policy for the purchase of power from power plants constructed between 1986 and 1992 that are not financed by the central government and from all plants constructed after 1992. These newer plants charge wholesale tariffs that ensure revenues will be sufficient to cover the repayment of loan capital with interest. This new pricing policy produced significantly higher producer power prices. On average, prices of electricity from newer plants is 65-100% higher than prices of electricity generated by older power plants. The recently-promulgated Electric Power Law provides for further reform of electricity prices by providing the broad principles of a new pricing system keyed to the cost of supply of electricity.

Consumer tariffs have also been affected by pricing reforms. Consumers face two types of tariffs: administered prices and guidance prices. The former type of tariff, set by the government, is typically applied to the amount of electricity consumed up to the consumer's 1985 consumption level. Guidance prices are paid on any consumption that exceeds the customer's 1985 consumption level. This second tariff is a markup to cover the higher costs of power purchased from new plants.

Coal Prices[14]

Over the past 3 years, the government has raised or partly deregulated coal prices so that in most areas coal prices now cover the costs

Coal subsidies fell from 37% in 1984 to 29% in 1995; petroleum subsidies fell from 55% in 1990 to 2% in 1995.

[13] Personal communication with State Power Corporation representatives, 1998.

[14] Source for textbox: Zhang Zhongxiang. 1998. "Is China Taking Actions to Limit its Greenhouse Gas Emissions? Past Evidence and Future Prospect." Netherlands.

of production and delivery.[15] Current coal prices are close to the direct economic cost of bringing the coal to local markets.

Oil Prices
China has deregulated oil prices except in certain key sectors such as agriculture and the military. Certain levels of oil production can now be sold at market prices. The majority of petroleum product retail prices equal or exceed world prices.

A.4 SECTOR-SPECIFIC ACTIONS AFFECTING GHG SOURCES AND SINKS

Over the past two decades, China has implemented various sectoral programs that have limited China's emissions of greenhouse gases. These programs have targeted energy consumption in buildings and the industrial and residential sectors, fossil fuel use in power production, and the protection of carbon sinks. This section describes China's activities to reduce GHG emissions.

A.4.1 Reducing Energy Use in Industry and Buildings

Energy consumption per unit of output in Chinese industrial enterprises is variable, but overall it is higher than recognized best practices suggest it should be. In the buildings sector, energy consumption has increased steadily in recent years as urban residents purchase more applicances and demand higher quality heating, cooling, and lighting services. In both sectors, however, China has made significant strides in improving energy efficiency within industry and in the buildings sector.

During the 1980's, China developed a comprehensive set of policy directives, procedures, regulations, and technical assistance programs to promote energy efficiency in industry and buildings. Information dissemination efforts provided reference books on higher efficiency technologies, statistics on energy consumption for various production processes, and seminars on energy efficiency. These efforts were bolstered by training courses for technical managers.

Aggressive program targeting energy-intensive industries has achieved energy savings of 1,414 PJ over 15 years; efficiency improvements in steel industry have reduced consumption by more than 20%.

A key focal point of these policies and programs was China's energy-intensive industries such as steel mills and cement industries. In fact, the most impressive technical

[15] World Resources Institute, 1998. *China's Health and Environment.* Washington, DC. (From the WRI website http://www.igc.org/wri/wr-98-99/prc-laws.htm).

efficiency improvements occurred in the steel industry, where unit energy consumption fell by over 20% during the 1980s. The cumulative effect of energy efficiency measures over nearly 15 years has been energy savings of 1,414 PJ.[16] To achieve these savings, China encouraged the use of specific technologies and processes, such as the recovery of BOF gas and continuous casting.

The Chinese government developed detailed targets, guidelines, and standards on energy consumption and energy conservation for industrial enterprises. These various initiatives resulted in nearly $6 billion in investments in energy efficiency in China. Examples of China's energy conservation initiatives include the following:

- Energy consumption quotas were set to encourage enterprises to consume less energy. Higher prices were charged for any energy consumed above the quota amount. Enterprises that consumed less than their allotted amount received rewards. China also developed standards for energy consumption in several industries.

- To bolster energy efficiency initiatives in industrial enterprises, the Chinese government established special investment funds that provided capital at subsidized interest rates and set up energy conservation centers to offer technical assistance. The Energy Conservation Investment Company and the Energy Conservation Technological Renovation Fund are two primary channels for government investment in energy efficiency. The Energy Conservation Investment Company's funds have grown by 20% annually since 1990.[17]

- Three recently established energy service companies (ESCOs) will undertake a large backlog of efficiency projects, including electric furnace renovation, electric motor upgrades, insulation of pipes and furnaces, and boiler renovations. The World Bank estimates that these 3 companies will undertake projects valued at $730 million between 1997-2006.

China has now turned its attention to improving the efficiency of industrial boilers. Medium and small-scale industrial boilers (defined as boilers which produce less than 65 tons of steam per hour), of which China has more than 400,000, consumed over 350 million tons of coal in China in 1990, accounting for around 35% of the country's coal use and around 30% of GHG emissions from energy consumption.[18] Typical efficiency levels for Chinese coal-fired industrial boilers lie in the range of 60-65%. Similar coal-fired boilers of similar scale and application in developed

[16] Liu Zhiping and J. Liu, Y. Wang. 1996. "Energy Consumption in the Iron and Steel Industry in P.R. China." *Energy for Sustainable Development*, Volume III No. 3, p. 21.

[17] Hamburger, J. 1994. "Linking Energy and Environmental Policy in China." Advanced International Studies Unit, Global Studies Program, Battelle, Pacific Northwest Laboratory. Washington, D.C.

[18] World Bank project document, 1998. "China: Efficient Industrial Boilers" available from the World Bank website.

countries rarely operate below 80% net efficiency. If boiler operating efficiency levels in China were brought into line with those of similar sizes in developed countries, current coal consumption could be reduced by around 60 million tons per annum – a savings of nearly 20%.

China has also developed programs designed to reduce energy consumption in buildings. The building sector accounts for 25-30% of commercial energy use in China. Since 1990, building energy consumption has grown 4.4% per year. In 1994, buildings used about 370 Mtce of energy; coal and electricity respectively accounted for 73% and 21% of the total building energy consumption.[19] One of the best programs China has developed to curb rising energy consumption is the China Green Lights Program.

China Green Light Program will increase use of high efficiency lighting, saving 22 TWh of electricity per year and reducing CO_2 emissions by 7.4 million tons per year.

Established in 1996, the China Green Lights Program (CGLP) is one of China's key national energy conservation programs for the Ninth Five Year Plan. It is managed by the State Economic and Trade Commission and receives technical support from BECon. The project's primary objective is to increase the number of high-efficiency lights in use to 300 million units by 2000, which would generate 22 TWh of electricity savings each year and 7.4 million tons of carbon emissions avoided annually. A second objective is to stimulate increased production of CFLs. Already CFL production has grown from 38 million units in 1993 to around 100 million units in 1996; the number of lighting manufacturers has risen from about 400 in 1993 to 1,000 in 1997. Some of these manufacturers offer product guarantees to stimulate sales of their products.

The results from early pilot projects are promising: one province reduced its peak load by 300 MW as a result of increased use of CFLs. China also has issued its first national standards for efficient lighting. CGLP is currently developing regulations that will add or modify codes for lighting design in residential and commercial buildings.

China's institutional framework for implementing these and other energy conservation programs includes a series of specialized energy conservation units at different levels of government:

- ***Climate Change Coordination Group.*** This national level group was created in 1990 and charged with overall policy formulation for GHG emissions issues.

- ***Beijing Energy Efficiency Center (BECon).*** BECon is non-profit organization whose purpose is to promote energy-efficiency policies and business ventures in China. BECon was founded in 1993. BECon's early activities in the area of energy efficiency included:

[19] Nadel, Steven et al. 1997. *Energy Efficiency Opportunities in the Chinese Building Sector.* American Council for an Energy-Efficient Economy, Washington, DC.

initiating a pilot project in integrated resources planning in Shenzhen in southern China; providing training on energy efficiency standards; and developing a transportation plan for Beijing that takes energy efficiency into account.

- ***China Energy Conservation Investment Corporation (CECIC).*** CECIC was founded in 1994 and replaced the Energy Conservation Investment Company. CECIC has invested in and completed a number of energy conservation, material conservation, and environmental protection projects in energy-intensive industries.

- ***Energy Conservation Information Dissemination Center (ECIDC).*** Established in January 1998, ECIDC will develop a range of information products related to energy efficiency for dissemination among industrial enterprises.

A.4.2 Reducing Energy Use in the Residential Sector

Residential demand for electricity has grown by an average 17.8% per year since 1986 and is expected to continue growing by 15% annually for the next several years. Unmet demand for electrical appliances, including refrigeration and air conditioning, is the main cause of this high growth. In large cities such as Beijing and Shanghai, the market for refrigerators and televisions exceeds 95%s saturation. Air conditioners are now beginning to penetrate urban markets. In response to the growth in household appliances, China has passed minimum efficiency standards for refrigerators, air conditioners, clothes washers, fans, rice cookers, and irons. Standards for refrigerators and air conditioners are being tightened. China's Environmental Protection Agency also bestows Green Labels on refrigerators that do not use R-12, an ozone depleting refrigerant.

Chinese refrigerator designs are generally less than 10 years old and the efficiency of these units is generally better than in many developing countries. Under a joint program with the U.S. EPA, the energy efficiency of Chinese refrigerators should be improved further. This program is working with several Chinese agencies and one of China's major refrigerator manufacturers to develop and commercialize a refrigerator with thicker insulation and high efficiency compressors. This unit will consume less than half of the electricity of current models. The China Refrigerator Project was the first project to receive funding from both the GEF and the Montreal Protocol.

A.4.2 Reducing Fossil Fuel Use in Power Production

The Chinese government has developed a strategy for the sustainable development of the energy sector that involves increased use of clean coal technologies and more development of natural gas, coal bed methane, and renewable energy resources. China's achievements in this area to date include the following:

- China has encouraged foreign participation in natural gas exploration activities and increased its own exploration budget by 50%.

- More than 140,000 small-scale wind turbines provide electricity to China's rural populations, particularly in Inner Mongolia.

- Since 1990 China has installed wind farms with capacity of more than 160 MW, a 12-fold increase over the 1990 level. In comparison, world wind generating capacity increased only 150% between 1990-1995.[20]

- In 1989 China recovered 380 million m^3 of methane from more than 100 coal mines.

- Small hydropower stations (less than 25 MW) supply rural China with about one-fifth of its electricity needs. China currently has 6,000 small hydropower stations.

In addition, China recently agreed with the U.S. to establish the U.S.-China Energy and Environmental Technology Center, which will promote the use of advanced energy and environmental technologies.

Development of renewable energy is regarded by the Chinese as an important means to reduce the power sector's heavy reliance on coal and thereby reduce GHG emissions. Over the past 35 years, China has strongly supported the use of small hydropower, biogas, and small wind turbines for renewable energy sources. This was done in part to provide energy and electricity to rural, isolated populations. The New and Renewable Energy Development Program, announced in 1995 by the government of China, aims to lower production costs and increase the contribution of renewable energy resources to overall energy supply. A World Bank-Global Environment Facility project targeting windfarms and solar photovoltaics will also provide crucial support for the continued development of renewable energy in China.

[20] Ecological Economics Bulletin, "Wind Energy in China: Institutional Barriers," Volume 3, Number 3, Third Quarter 1998.

China's potential wind energy resources are large. The exploitable wind resources are estimated at 250 GW.[21] China's wind energy market has historically been developed for small-scale applications of domestically manufactured wind turbines. Recently, however, demand for larger (300-600 kW), imported wind turbines has increased. China has set a target of developing 1,000 MW of wind energy by 2000, which would require an investment of more than $1.2 billion.

With exploitable wind resources of 250 GW, China has embarked on active wind power development program; target set to develop 1,000 MW of wind energy by 2000.

China has devoted considerable R&D resources and efforts to establish a local manufacturing capacity for wind turbines. There are 11 national standards and 25 industrial standards that govern the development of small wind turbines. The manufacturing capacity and competence for large wind turbines is relatively nascent; China instead relies on imports of foreign technology.

A.4.4 Protecting Carbon Sinks

China is deficient in forest resources, with only 0.11 hectares per capita. The demand for forest products is also quite high, threatening China's stocks of forest resources. To meet demand and protect its forest resources, China has instituted the largest afforestation program in the world. Between 1984 and 1988, China planted an average of 3.25 million hectares per year; the net increase of forested land was about 0.65 million per year.[22] China has also initiated a large-scale protective afforestation program in North China. According to World Bank data, net decrease in forest area since 1990, if China continues to increase its forested area at the rate of the past 5 years, forests will cover more than 15% of its land area by the end of the century (up from 13.6%).

China has implemented the largest afforestation program in the world, planting an average of 3.25 million hectares per year between 1984 and 1988.

A.5 ACTIONS THAT EXPLICITLY SUPPORT THE UNFCCC OR CONTROL GHG EMISSIONS

Prior to the Rio Earth Summit in 1992, China hosted the Ministerial Conference of Developing Countries on Environment and Development. In 1992, China attended the Rio Earth Summit and

[21] *Op. cit.* 9, p.12

[22] World Bank, 1996. "China: Issues and Options in Greenhouse Gas Emissions Control." Wash. DC, p.50.

subsequently ratified the FCCC in 1993. Since the Rio Earth Summit, China has continued to support GHG emission reduction through the development of its Agenda 21 paper, a two-year climate change country study undertaken with support from the U.S. Country Studies program, and by establishing a National Climate Change Coordination Office. A number of studies on GHG emissions and national response strategies also have been completed. The Chinese government has also planned to compile a national inventory of GHG emissions and sinks, to project national energy use and GHG emissions, and to conduct a macroeconomic analysis of global warming.

China's Agenda 21 currently has 128 projects listed in 9 areas, with a total planned investment of over $5 billion. The nine project areas include: capacity building for sustainable development; sustainable agriculture; clean production; clean energy/transportation; natural resource conservation; environmental pollution control; regional development; population, housing and social services; and global change, desertification and biodiversity. By October 1996, 42% of the 128 projects had been completed with a total investment of $1.3 billion. Of this amount, China provided $0.96 billion.

China has supported environmental protection efforts, including the reduction of GHG emissions, through various legislative initiatives. China's first environmental law, the Environment Protection Law, was passed in 1979. Since then, China has enacted five pollution control statutes and ten natural resource conservation statutes, including the National Standards of Air Pollutants for Coal-Fired Power Plants, which became effective on January 1, 1997. Under the leadership of the Environment and Natural Resources Conservation Committee of the National People's Congress, China plans to enact an additional seven environmental statutes in 1998 and potentially 17 more in 1999. The United States, in comparison, has passed approximately 21 major environmental acts in the past four decades.

The Energy Conservation Law, enacted January 1, 1998, requires development of national energy efficiency standards, increased investment in clean and renewable energy, and retirement of older, inefficient products and equipment.

Perhaps the most important of China's legislative efforts for GHG emissions reduction is China's new Energy Conservation Law which came into force on January 1, 1998. This law was formulated with a view to promoting "energy savings throughout society, improving energy efficiency and economic benefits, protecting the environment, guaranteeing national economic and social development..." The law requires the government to formulate an energy conservation policy and incorporate it into the national economic plan. Other actions required under the law include the development of national energy efficiency standards, increased investment in clean energy and renewable energy, and the retirement of old, inefficient products and equipment.

China's Trans-Century Green Project is an important component of the Ninth Five Year Plan (1996-2000) and China's long-term environmental targets for 2010. Phase I of the Green Project Plan identifies more than 1,500 environmental projects, some of which will target air pollution and GHG emissions. China has identified approximately 30 projects to specifically address GHG emissions.

A.5.1 Global Environment Facility

To date, GEF funds have been approved for several projects in China and several other projects are in the pipeline. In addition, with support from the GEF, China has completed a climate change mitigation study that involved a comprehensive analysis of GHG abatement options and their relative costs. GEF-funded climate change projects in China include the following:

- Energy Conservation Promotion Project (World Bank-implemented)
- Capacity Building for the Rapid Commercialization of Renewable Energy
- Energy Conservation and Pollution Control in Town and Village Enterprises (UNDP-implemented)
- Efficient Industrial Boilers (World Bank-implemented)
- Development of Coal-bed Methane Resources
- High-Efficiency Refrigerator Project (UNDP-implemented).

Under the Efficient Industrial Boiler project, China will work to acquire advanced technologies and adapt them to Chinese conditions to improve the efficiency of boilers. The project will encompass approximately 20% of total industrial boiler output over a 20-year period. The technological upgrades will be bolstered by a training program and dissemination efforts. This project is being implemented in conjunction with a World Bank program to address industrial pollution in one of China's major urban centers (Chongqing). The project is expected to save 175 million tons of CO_2 emissions.

The Renewable Energy Development Project aims to develop state-of-the-art wind and solar PV technologies. The project's goal is to install 190 MW of grid-connected wind farms in four provinces and to supply about 200,000 PV systems to households and institutions in remote areas of China.

A.5.2 Joint Implementation

Following COP 1, the Chinese government initiated 3 AIJ projects:

- a coke dry quenching project at Beijing Captial Steel-Iron Group undertaken with Japanese cooperation

- the construction of a thermal power plant using CFBC technology with assistance from Norway
- a building energy efficiency project with assistance from the United States.

ANNEX B
INDIA

B.1 SUMMARY

India is the sixth largest emitter of energy-related CO_2 in the world, according to 1993 estimates from the International Energy Agency (IEA). Per capita emissions are low, only one-fifth the world average, but energy consumption is rising and commercial energy demand is growing at around 6% annually.

CO_2 emitted from coal and biomass combustion accounts for around 82% of India's total CO_2 emissions. Gross emissions of CO_2 in 1989-90 were 1190 million tons (MT); methane, 16 MT; nitrous oxide, 0.08 MT; and chloroflurocarbons, 0.0017 MT.

The Indian government has taken certain initiatives which will act directly or indirectly to reduce GHG emissions. These include:

- introduction of the Electricity Regulatory Commissions Bill, which seeks to eliminate subsidies;
- restructuring of some State Electricity Boards (SEBs), to allow more efficient operation and consequent reduction of transmission and distribution (T&D) losses;
- renovation and modernization of thermal power stations, which will reduce T&D losses, allow gas-based projects to meet power shortages, and promote demand-side management and energy conservation;
- introduction of fiscal and financial concessions for the use of new and renewable energy sources and subsidization of biomass-based cogeneration units and energy conservation/efficiency systems and equipment;
- passage by the Ministry of Environment & Forests (MOEF) of several acts to reduce pollution (vehicular and industrial) and to protect carbon sinks;
- introduction of conservation measures by MOEF's various agencies; and formation of an action plan to phase out ozone-depleting substances entirely by the year 2010; and

- approval and implementation of seven GEF-funded projects and implementation of five pilot phase AIJ projects.

B.2 BASELINE CONDITIONS AND TRENDS

Energy consumption in India is much lower than in developed countries; per capita consumption is 0.23 TOE (compared to 7.7 TOE in the US). The energy sector is expanding rapidly, however, and it will continue to expand in the coming years due to rapid population growth, increased urbanization, greater transport needs, accelerated industrial development, and improvements in standards of living.

As can be seen from Exhibit B-1, India's energy consumption increased 36% between 1990-91 and 1994-95. The country is highly dependent upon its indigenous coal supply. Coal continues to provide nearly 60% of India's primary energy, even though alternative and renewable sources of energy have experienced rapid growth in the recent past.

Exhibit B-1
Primary Energy Sources

Primary Energy Source	1990-91 (MTOE)	1994-95 (MTOE)
Coal	104.6	139.3
Oil	51.8	58.7
Natural Gas	10.9	15.5
Hydroelectricity	6.0	6.0
Nuclear	0.5	8.3
Biomass	-	8.3
Total	173.8	236.1

Source: 1. TERI Energy Data Directory & Yearbook. 1997-98. Tata Energy Research Institute.
2. Annual Reports of Ministry of Power (1996-97), Ministry of Coal (1995-96), Ministry of Petroleum & Natural Gas (1996-97), Ministry of Non-Conventional Energy Sources, (1996-97).

Exhibit B-2 shows energy consumption by sector. Commercial demand is growing at an annual rate of over 6%.

Exhibit B-2
Energy Consumption by Sector

Sector	1990-91 (MTOE)	1994-95 (MTOE)
Power & coal washeries	48.9	86.6
Agriculture	4.9	7.7
Industry	62.9	74.9
Transport	28.0	33.4
Residential	12.6	15.2
Other energy uses	3.9	4.6
Non-energy uses	12.6	13.7
Total	173.8	236.1

Source: 1. TERI Energy Data Directory & Yearbook. 1997-98. Tata Energy Research Institute.
2. Annual Reports of Ministry of Power (1996-97), Ministry of Coal (1995-96), Ministry of Petroleum & Natural Gas (1996-97).

According to IEA, India's energy-related CO_2 emissions are very low on a per capita basis: 0.78 tons of CO_2 per person in 1993, one-fifth the world average of 3.90. Carbon intensity[1] was 0.71 tons per US $1000, just below the world average (0.76) but above the average of developing countries (0.61). In absolute terms, India was the world's sixth largest emitter of energy-related CO_2, with emissions amounting to 701.6 million MT of CO_2 (1993 estimates). Energy-related CO_2 emissions have been growing steadily with average annual growth rate of 5.7% between 1971 and 1993.

The major contributor to total GHG emissions in India is CO2 emanating from combustion of various fuels, particularly coal. Coal is the single largest source, followed most closely by biomass burning, oil, and natural gas. Among end-use sectors, power generation is the biggest contributor to CO_2 emissions (47% in 1993), followed by industry (30%), transport (12%), and the residential sector (6%).

Coal mining contributes a substantial amount of India's methane emissions as well. According to the Central Mining Research Station, total CH_4 emissions from coal mining (both mining and post-mining operations) was around 0.4 million MT in 1990-91.

Another important source of CH_4 emissions is derived from rice cultivation, one of India's most widely grown crops. CH4 emissions from rice cultivation correlate with water management practices, paddy varieties, and fertilizer use. It is estimated that the rainfed, water-logged, and deep/semi-deep category of paddy fields accounts for most of the total CH_4 released from all

[1] The ratio of CO2 to GDP, with GDP measured in 1990 US $ adjusted to reflect purchasing power parity and CO2 measured in tons.

harvested water regimes. Total methane emissions from different sources (rice fields, livestock, coal mining, gas venting/leaking, land fills, biomass burning, and wet lands) were roughly 577 million tons of carbon equivalent in 1987, according to the World Resources Institute report of 1990-91.

With the increased use of chemical fertilizers in India, nitrous oxide (N_2O) has become an important source of GHG emission. Biomass combustion also leads to substantial emissions N_2O in India.

Some key energy and CO_2 emissions data relevant to India are given in Exhibit B-3.

Exhibit B-3
Key Energy and CO2 Emissions Data for India

	1987	1988	1989	1990	1991	1992	1993	% change from 1990 to 1993 (1)
Total Primary Energy Supply, TPES (Mtoe)	150.27	162.69	173.61	184.00	193.39	204.95	211.88	15.1
TPES/capita (toe/person)	0.19	0.20	0.21	0.22	0.22	0.23	0.24	8.6
TPES/GDP PPP (toe/1990 US$ 1000	0.204	0.201	0.203	0.204	0.212	0.214	0.215	5.5
Total Final Consumption, TFC (Mtoe)	100.36	111.85	117.56	123.31	124.67	131.01	131.74	6.8
TFC/capita (toe/person)	0.13	0.14	0.14	0.15	0.14	0.15	0.15	0.8
TFC/GDP PPP (toe/1990 US$ 1000)	0.136	0.138	0.137	0.137	0.136	0.137	0.134	-2.2
'Energy-related' CO2 emissions (Mt CO2) (2)	497.11	534.76	570.63	601.72	635.95	674.23	701.65	16.6
'Energy-related' CO2/capita (tCO2/person)	0.62	0.66	0.69	0.71	0.73	0.76	0.78	10.0
'Energy-related' CO2/GDP PPP (tCO2/1990 US$ 1000)	0.67	0.66	0.67	0.67	0.69	0.71	0.71	6.8
% total World (TPES + bunkers) (3)	2.00	2.09	2.19	2.32	2.41	2.56	2.62	(4)
% total World CO2 from energy (incl. Bunkers)	2.42	2.53	2.65	2.81	2.96	3.16	3.26	(4)
Bunkers (Mtoe)	0.22	0.27	0.23	0.41	0.39	0.45	0.51	22.9
CO2 emissions from bunkers (Mt CO2)	0.71	0.86	0.73	1.29	1.23	1.42	1.60	(5)

1. India has not specified a base year.
2. "Energy-related CO2 emissions" specifically means CO2 from the combustion of coal and coal products, natural gas, and peat. CO2 emissions from hydropower, nuclear power, and other renewables are zero. Emissions from combustion of biomass-derived fuels are not included, in accordance with the IPCC GHG inventory methodology. In addition, data do not include CO2 emissions from non-commercial energy.
3. Emissions from international marine and aviation bunkers are excluded from national totals, but are reported in world totals.
4. This cross-comparison is omitted as it would amplify rounding and other imprecisions inherent in these data.
5. Accurate percentage change cannot be estimated due to rounding.

Source: IEA Database and CEPII.

Recent estimates of India's GHG emissions have been made by the Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS), an ADB-sponsored project implemented by the Ministry of Environment and Forests (MOEF). Data from this project are still under review by MOEF and are not yet publicly available. The most recent data currently available are provided by the Tata Energy Research Institute (TERI), which has undertaken several projects to estimate GHGs and to identify and analyze impacts on climate change. TERI's 1989-90 estimates for India's overall anthropogenic emissions of CO_2, CO, CH_4, N_2O, and CFCs attributable to various activities are summarized in Exhibit B-4.

Exhibit B-4
Estimates of Anthropogenic Emissions in India, 1989-90
(In millions of metric tons)

Activities	CO_2	CH_4	N_2O	CFCs
Energy	614.36	0.493	0.052	-
Coal production	-	0.346	-	-
Coal combustion	428.74	-	0.040	-
Oil combustion	161.65	-	0.010	-
Gas combustion and flaring	23.97	-	0.002	-
Gas venting and leakages	-	0.430	-	-
Industry	23.00	2.350	-	0.0017
Cement manufacture	23.00	-	-	-
CFCs	-	-	-	-
Landfills	-	2.350	-	0.0017
Agriculture and forestry	553.45	12.860	0.030	-
Animal husbandry	-	6.910	-	-
Rice cultivation	-	3.930	-	-
Fertilizer use	-	-	0.012	-
Biomass combustion	553.45	2.020	0.018	-
Total emissions	1190.81	15.600	0.080	0.0017

Source: Achanta, Amrita N., Ed. The Climate Change Agenda, An Indian Perspective. TERI.

B.3 BROAD ECONOMIC REFORMS AFFECTING GHG SOURCES AND SINKS

To encourage faster economic growth, India launched an economic stabilization and restructuring program in July, 1991. The government began privatizing and deregulating some areas of industry and trade in order to open them up to private sector participation. Several reforms directly or indirectly affect GHG emissions.

B.3.1 Reducing Energy Subsidies

Power generation has increased at a compound annual growth rate of around 6.5% since 1991-92, but the industry still cannot meet the demand. The energy deficit during 1996-97 was 11.5% while the peak demand shortfall for the same period was 18%.

In an attempt to address these electricity deficits, the government recently introduced a bill to establish a Central Electricity Regulatory Commission (CERC) at the central level. A State Electricity Regulatory Commission (SERC) was also set up. Apart from other objectives, the bill will improve the financial health of the State Electricity Boards (SEBs) by requiring that tariffs be set so that no consumers can be charged less than 50% of the average cost of supply. A state government may opt to provide subsidies to weaker sections or to the agricultural sector (which is highly subsidized in India) only if it compensates the SEB. Moreover, the SEBs themselves are undergoing restructuring and are phasing out subsidies. In Haryana, where the reform process is currently in place, all the subsidies in the power sector will be eliminated if everything proceeds as intended.

Similarly, prices in the petroleum sector that have been covered under APM (Administered Price Mechanism) since 1987 are being gradually dismantled, to be replaced by a Market Driven Pricing Mechanism (MDPM), which allows prices to reflect the cost of supply. Full implementation is expected to be achieved by 2002.

The energy prices in three Indian metropolises are given in Exhibit B-5.

Exhibit B-5
Current Energy Prices in Three Indian Cities

Electricity Tariff (US $ / KWH)	**Calcutta**		**Delhi**	**Mumbai**	
	CESC Calcutta Electricity Supply Co. (private)	**WBSEB West Bengal SEB**	**DVB Delhi Vidynt Board**	**BSES**	**MSEB Mahonash SEB**
Domestic	0.01-0.04	0.01-0.06	0.02-0.07	0.03-0.08	0.01-0.07
Industrial	0.02-0.06	0.03-0.07	0.07-0.11	0.09-0.11	0.05-0.09
Petrol (US $ / KL)	581.20		563.40	636.90	

Note: Conversion : 1 US $ = Rs. 42.5
MSEB in Mumbai and WBSEB in Calcutta have revised the tariffs
Source: Compiled by Hagler Bailly (India) Ltd., 1998

B.3.2 Restructuring the Energy Sector

The process of restructuring the SEBs has been initiated in several states with aims to:

- unbundle power industry operations, by separating generation, transmission, and distribution;
- introduce competition by allowing private participation in generation and distribution; and
- develop a regulatory framework.

Restructuring of the Orissa SEB was initiated in April 1996. The SEB has been replaced by the Grid Corporation of Orissa Limited and Orissa Hydro Power Corporation Limited, with authority for the functions of distribution and generation, respectively.

The Haryana SEB (HSEB) has received a loan of US $600 million from multilateral agencies for power sector restructuring in the state. The first installment of this loan (US $50 million) was received earlier this year. Under the restructuring program, the state has begun to set up an independent regulatory authority and to unbundle the HSEB into separate generation, distribution, and transmission companies. Subsidies will be eliminated and tariffs raised to put the newly incorporated companies on a sound financial footing.

Andhra Pradesh SEB (APSEB) has received a Norwegian loan of US $4.6 million for improving power consumption and distribution efficiency. APSEB has also been negotiating for a World Bank loan of around US $1 billion for its restructuring process. Rajasthan, Goa, and Gujarat SEBs have drafted reform bills which are currently being finalized. The governments of Karnataka and Assam have undertaken a study of reforms. Kerala is seeking assistance from the Canadian International Development Agency for the Kerala Energy Infrastructure Project and a Memorandum of Understanding was signed last year. Madhya Pradesh, Uttar Pradesh, Bihar, and West Bengal are all at various stages in the reform process.

B.3.3 Financial Incentives

The central government and a number of state governments and union territories have extended financial concessions to both providers and users of New and Renewable Sources of Energy (NRSE). The projects involving NRSE technologies are being financed by the Indian Renewable Energy Development Agency (IREDA) at low interest rates. Schemes involving non-conventional energy sources include the following:

- The Ministry of Non-Conventional Energy Sources (MNES) provides loans at a subsidized interest of 15% for purchase of battery-operated vehicles.

- Bio gas plants are eligible for interest rates of roughly 9.5% and financing of up to 80% of plant installation costs from IREDA. The subsidy varies depending upon the size of the plant, the beneficiaries, and the plant location.

- The central government has sponsored investments in several grid-connected wind turbine projects that are part of a wind farm demonstration project. States undertaking wind projects receive a five-year tax exemption and 100% accelerated depreciation and concessional duties on wind electric generators.

Other financial incentives encouraging the development and use of renewable energy sources include: a subsidy of up to 50% of the cost of electrical, mechanical, and civil works, given by MNES for small hydroelectric power projects; 100% depreciation on renewal energy devices and equipment; and exemption from customs duties on machinery and equipment imported for R&D purposes and concessional customs duties on plant and machinery that will be used for commercialization purposes.

B.4 SECTOR-SPECIFIC ACTIONS AFFECTING GHG SOURCES AND SINKS

A wide range of measures impacting GHG emissions have been implemented throughout India's economy. These include initiatives to conserve energy (fuel) use in industry, to promote clean fuels such as natural gas, to improve efficiencies of thermal power plants, and to implement afforestation programs. Some of the important initiatives are the Sustainable Cities Initiative and the Green Gas Pollution Prevention Project, both undertaken with aid and assistance from USAID.

India is a large market for energy efficiency services. ESCOs that have begun to tap this market include Thermax EPS, Intesco International, Crompton Greaves and Asian Electronics Limited.

B.4.1 Reducing Energy Use in Buildings, Industry, and Agriculture Cooking Stoves

Cooking stoves (chulhas) are the most common combustion device used in India's rural areas. An estimated 103 million cooking stoves consume about 285 million tons of biomass every year. Traditional chulhas have a thermal efficiency of 5 to 10%.

In recognition of the magnitude of potential energy savings from the use of more efficient cooking stoves, a National Program for Improved Chulhas was started in 1985; 17 million improved chulhas have been installed since then. They have NSIC prescribed minimum efficiency of 25%. The improved chulhas are available in fixed and portable types. Many models of fixed type with options of single, double, and triple pots, with or without chimney, and portable types made of metal or metal-clad ceramic are available in different sizes to suit local

food preferences and fuel availability. In addition, the Indian Institute of Science, Bangalore, has done some work on firewood-based dryers to improve the efficiency of large stoves.

Equipment and Technology

A variety of investments have been made in energy efficient equipment and technology. A project to replace incandescent bulbs with compact fluorescent lamps (CFLs) will be implemented in Ley (J&K).. In Ahmedabad, a private electric utility has designed a pumping system retrofit for use in low rise residential multi-storey buildings. This highly cost-effective energy efficiency measure has a payback of less than one year.

Other initiatives to promote energy efficiency in industry and agriculture include:

- The Ministry of Power is collaborating with other ministries and government departments to develop an energy efficient pumping system for the agricultural sector. The project has an estimated cost of Rs. 9 billion and is expected to begin in 1998-99.
- Pilot projects to improve the energy efficiency of agricultural pumpsets are being implemented in Punjab, Haryana, Gujarat, and Andhra Pradesh.
- A manual on energy efficiency for pumping systems is being prepared by the Energy Management Centre.
- The Confederation of Indian Industry is implementing a project to prepare the DPR for rapid displacement heat pulping process in the paper industry.
- An application-oriented training program for first-line engineers of process and engineering industries is being implemented through Andhra Pradesh Productivity Council.
- A research-cum-demonstration project to show how energy can be conserved in aluminum electrolysis by bringing down the operating temperature of electrolyte was completed in 1997-98 by Central Electro-Chemical Research Institute, Tamil Nadu.
- A study of energy in the small and medium sized industries of Kerala was undertaken in 1997-98 by the Energy Conservation Society.

Monitoring and Modeling of Energy Use

The development of energy management systems (EMS) for steel plants has helped managers to adopt a plant-wide perspective on energy use and to take an integrated approach to managing energy resources. The EMS implemented at Bhilai Steel plant has led to optimal use of by-

product gases and minimization of purchased energy resources. Effective energy monitoring, energy modeling, and optimization are the integral components of the system.

Cogeneration

Cogeneration has been successful in a number of industries. Two sugar mills (Daurala Sugar Works, U.P., and the Shree Datta Shakkar Karkhana, Maharashtra) have been sending nearly 1.5 MW of surplus power from cogeneration to nearby industrial units each year. At J.K. Paper Mills, with an installed capacity of 75,000 TPA paper production, cogeneration is extensively used for process. The average peak power requirement is 14.3 MW. At present cogeneration meets 60% of the power demand. The mill is being expanded to 160,000 TPA, which will likely increase the power requirement to 30 MW. The anticipated cogeneration to meet the demand at expanded capacity is 50%.

At Prakash Industries, a sponge iron plant, a waste heat recovery system has been installed to recover sensible heat from waste gases from the kilns. This heat is used to generate steam which can be used in steam turbines to generate electric power. It is reported that almost 100,000 Nm^3/hour of waste gases at 1000°C emanate from the 150,000 tonnes per annum module of a direct reduction plant. Out of the total heat generated from coal in the direct reduction plant, only 35% is used in reduction. The balance is wasted. The waste heat recovery boiler is designed to generate steam at the rate of 46.8 ton/hour, 52 kg/cm^2 and 410°C with normal kiln exhaust flow passing through the unit.

Indian Petrochemical Corporation Limited, Vadodara, commissioned and started commercial operations of a cogeneration plant in 1988. The plant helped to achieve self-sufficiency and stability with low energy index. Demand rose to 65 MS during 1987-88 with the expansion of production facilities, necessitating an increase in captive power generation. IPCL opted for 2 x 36 MW dual fired gas turbine and dual pressure heat recovery steam generators capable of firing gas as well as liquid fuel. The contract demand with the state grid has dropped from 65 MVa to 35 MVa.

B.4.2 Reducing Fossil Fuel use in Transportation

Vehicles more than 15 years old are being retired in New Delhi.

Traffic congestion and vehicular pollution in urban areas have both reached serious levels in India. National highways make up only 1% of the total road network but carry over 40% of road traffic. Steps are being taken to initiate national highway projects through private sector participation. Two bypass projects (Thane-Bhiwandi, Maharashtra, and Udaipur, Rajasthan) and one overpass project in Chalthan, Gujarat, have been awarded on BOT basis. Expected improvements in traffic flow will help reduce GHG emissions from vehicular traffic.

Many other improvements will come about as a result of regulatory measures taken by the government. In Delhi the government has imposed restrictions on commercial vehicles including the phasing out of older vehicles. The Supreme Court of India has ordered that all commercial vehicles more than 15 years old be retired from Delhi roads beginning October 2, 1998. A recent white paper on air pollution in Delhi recommends even more stringent measures. Among the recommendations:

- Two-wheelers powered by conventional two-stroke engines shall be prohibited if they do not meet the norms that come into effect in April, 2000.
- After March 31, 1998, no defense services disposal vehicle or government-auctioned vehicle more than eight years old shall be registered in Delhi.
- After April 1, 1998, only those medium- and heavy-duty motor vehicles (both passenger and goods vehicles) shall be registered in Delhi that have been manufactured since March 31, 1996, and that comply with 1996 mass emission norms; after April 1, 1999, vehicles must meet 2000 AD norms.

To augment its supply of pollution checking facilities, the Delhi government has authorized the establishment of additional facilities in retail outlets and in garages and service stations throughout the region. The Transport Department has authorized 305 of these centers for vehicles and 32 for diesel-driven vehicles, as of September 30, 1997.

The Supreme Court has also directed that all petrol-driven government vehicles be fitted with a catalytic converter or CNG kits. The Gas Authority of India, Ltd. (GAIL) has set up compressed natural gas (CNG) dispensing facilities at Mumbai, Delhi, and Vadodara.

The fuel industry has implemented a number of initiatives that assist the government's efforts. In 1996-97 Bharat Petroleum Corporation Limited began operating a process unit for methyl tetra bythyl ethylene (MTBE) production. MTBE is used as an octane booster for production of gasoline; it replaces tetraethyl lead and thereby reduces lead emissions from vehicular traffic. The company also upgraded to high efficiency boilers, built diesel hydro desulfurization and associated facilities to produce low sulfur diesel fuel, and laid the cross-country Mumbai-Manmad pipeline, thus eliminating much of the road and rail traffic previously required for the transport of petroleum products.

B.4.3 Reducing Fossil Fuel Use in Power Production Equipment and Technology

Throughout India a variety of conservation measures are being devised and implemented to narrow the gap between supply and demand for power. USAID's Sustainable Cities Initiative (SCI) promotes municipal, non-governmental, and private sector investment in energy efficiency and clean energy technologies. In Ahmedabad, USAID and USEPA are supporting the city's

efforts to address some of its environmental challenges by helping the Ahmedabad Electricity Company design and implement three pilot programs to test and install high efficiency equipment. AEC expects to be able to reduce demand by 24 MW, avoiding 133,000 tons of CO2 emissions. The Ahmedabad Municipal Corporation is studying potential savings that could accrue to the city as a result of street lighting upgrades and water pumping improvements.

Supply side management includes research into methods of reducing secondary fuel oil consumption in thermal power stations and detailed energy audits to improve the efficiency of generating stations. The Central Electricity Authority (CEA) has carried out detailed energy audits at Ukai, Durgapur, Panipat, Indraprastha, Neyveli, Raichur and Gandhinagar thermal power stations. Energy audits are also being conducted for the purpose of reducing energy loss in the generation, transmission, and distribution of power. Such projects are being implemented through the West Bengal SEB, the Kerala SEB, and the Haryana SEB. Another was approved in 1997-98 to be implemented under the Punjab SEB.

There have been a number of pilot projects dealing with load management and ways to control T&D losses. These include:

- Installation of 3000 LT switched capacitors in Andhra Pradesh, Haryana, Punjab, and Tamil Nadu, completed in 1997-98.
- Installation of 3000 amorphous core transformers in the distribution network of various SEBs, being implemented through the Rural Electrification Corporation (REC).
- Projects on remote controlled load management, being implemented in the distribution systems of the Rajasthan and Punjab SEBs. Three additional projects were approved in 1997-98 for implementation by the Tamil Nadu, Haryana, and Uttar Pradesh SEBs.
- Conversion to high voltage single phase distribution, being implemented in three states through REC.
- Installation of amorphous core transformers and LT capacitors, being implemented in the distribution network serviced by the Co-operative Electrical Supply Society, Sirsilla (Andhra Pradesh), through REC.
- A demonstration project in Chandi Village, Medak District of Andhra Pradesh, includes converting a low voltage distribution network to a high voltage network through installation of amorphous core transformers; replacing three-phase motors with single-phase motors; and providing compact fluorescent lamps for street lighting.
- A pilot project to introduce 500 electronic meters with time-of-day (TOD) capability, being implementation by the West Bengal SEB.

- A project to set up an energy meter testing and calibration facility at Central Power Research Institute (CPRI), Bangalore, completed in 1997-98.

- An R & D project conducted by the Electric Research Development Association in Vadodra to reduce losses in electricity distribution systems through capacitors using a solid state switch. The project is expected to be completed in 1999.

- An R&D project for the development of an integrated energy efficient Stirling engine battery/inverter system for remote area power generation, under implementation through the CPRI.

- An R&D project on station dynamic voltage restorer completed in 1997-98 through IIT, Delhi.

- A project for power generation through waste heat recovery from existing non-recovery coke ovens in and around Dhanbad (Bihar state), being conducted through the Central Fuel Research Institute, Dhanbad.

Renovating and Modernizing Thermal Power Stations

Renovation and modernization (R&M) programs consist of both short- and long-term strategies. Short-term measures include reducing the gestation periods of power projects, reducing T&D losses, meeting power shortages through gas projects, private sector participation, demand side management, and energy conservation. Long-term measures include accelerating the pace of hydro and nuclear power development and establishing a national power grid.

R&M Program (Phase I). To improve the performance of India's thermal power stations, a country-wide R&M program was launched in September 1984, to be completed during the Seventh Plan period. The program covers 163 thermal units (13570.50 MW) in 34 stations. Total approved cost of renovations was Rs. 11.65 billion, of which Rs. 4.23 billion was to come from Central Loan Assistance (CLA) and Rs. 7.42 billion was to be financed by the states under State Plan/Own resources. In 1984 the government approved Rs. 5 billion in Central Loan Assistance to SEBs for the renovation of old stations. The program has achieved additional generation of more than 10,000 MU units/year, far more than the targeted benefits of 7000 MU/year.

R&M Program (Phase II). Phase II of the program was implemented in 1990-91 during the Eighth Plan. Phase II includes R&M for 44 thermal power stations consisting of 198 thermal units with a total capacity of 20,869.43 MW. The total sanctioned cost of the scheme is Rs. 23.83 billion. The program's expected benefits are: additional generation of 7864 MU/year; increase of 100 MW peaking capacity; a 15-20 year extension of the useful life of 24 of the thermal units.

Aggressive efforts have improved the thermal efficiency of India's coal-fired power plants.

Additional R&M Projects. Additional R&M work will be begun during the Ninth Plan, including R&M for 156 old thermal units installed at 32 thermal power stations. The total estimated cost of this additional work is about Rs. 12.04 billion. There has been an improvement in heat rates from the thermal R&M programs.

The Centre for Power Efficiency and Environmental Protection (CENPEEP), the national technological resource center concerned with minimizing GHGs from thermal power plants, is implementing the "Green House Gas Pollution Prevention Project". The project is intended to improve the overall performance of power plants and is expected to produce financial benefits through reducing fuel costs and the O&M cost per unit of power generated. The NTPC has begun eight tasks:

- a study of coal conversion technologies;
- comprehensive environmental monitoring and study of advanced pollution control systems;
- integrated efficiency and emissions monitoring and general condition assessment;
- monitoring and diagnostics for preventive maintenance;
- identification of ways to extend useful plant life;
- commercialization of large scale ash utilization technologies;
- determination of fuel quality's impact on plant operation; and
- data compilation, management and dissemination.

Renovating and Modernizing Hydro-Electric Power Stations

A program to renovate and modernize hydro power stations was put together by the Central Electricity Authority. 55 projects were identified with a capacity of 9653 MW (210 generating units). The total estimated cost is Rs. 14.93 billion and expected benefit is 2531 MW/7180 MWh. Work on 16 projects has been completed, at a cost of Rs. 1.75 billion, providing 553 MW/1063 MWh.

Renewable and Nonconventional Energy Sources

Several innovative technologies have been introduced in India that utilize renewable and nonconventional energy sources. The Indian Institute of Technology, New Delhi, has developed a process for making charcoal-like material from biomass. The process attracted the attention of several entrepreneurs but ran into problems of carbon yield and material failure. A more successful program is the subsidy-based National Program for Bio-Gas Development (NPBD). More than a million family size bio-gas plants have been constructed in India under this program. India is second only to China in popularizing bio-gas plants in rural areas.

Non-conventional energy sources have been given cabinet-level status in India.

The Ministry of Non-Conventional Energy Sources has active programs supporting two major technologies for utilizing solar energy: solar thermal and solar photovoltaic. The solar thermal applications promote solar cookers, solar dryers, and hot water systems for industrial, commercial, and domestic use. The solar photovoltaic program aims at meeting electrical energy needs.

As of December 1996, 31,289 solar lanterns had been supplied and 10,712 home lighting systems had been installed. Solar lanterns are a solar powered portable lighting system considered a viable alternative to the traditional kerosene hurricane lantern. They have a light output of 380 lumens compared to the 68 lumens of kerosene lanterns. Typically, a solar lantern is a 7 watt compact fluorescent lamp with a 10 watt photovoltaic modules and a 12 V sealed maintenance free lead acid battery.

Subsidized loans or tax exemptions have been created for biogas plants, wind power projects, and small hydropower projects.

The Ministry has also approved 1000 water pumps systems under a special program through IREDA. Wind energy has generated 825 MW since December 1986, and 185 recently installed small hydro projects have generated 133 MW.

Protecting Carbon Sinks

A forest conservation act was passed in 1980 and further strengthened in 1988. It makes mandatory compensatory afforestation in all cases where forests are converted to other uses. An afforestation plan has been in place since 1980, covering 1.5 to 2 million hectares annually. Subsidies for certain forest-based raw materials have been reduced or removed, leading to more efficient harvesting of these materials. National parks and wild life sanctuaries have been established in 12.6 Mha of forest.

Indigenous communities have been enlisted in implementing reforestation and afforestation activities.

To defend against the growing pressure to use forests for fuel and fodder, afforestation has been promoted through the social forestry program (SFP), which plants woodlots on village lands and distributes seedlings to farmers. In the woodlot program, the government undertakes the initial investment of afforestation and the plantations are later handed over to the village communities for protection, management and distribution of benefits. With a budget of over Rs. 1 billion, Orissa's ten-year SFP project covered all districts in the state and included community woodlots, reforestation of depleted forests, and forest farming on private land and for the rural poor. Deforestation activities have also been undertaken on a small scale in certain communities. In West Bengal, members from all households in a given village serve on Village Forest Protection Committees (VFPC) with responsibility for protecting a designated forest area against tree cutting. Members of the committee harvest products such as sal seed and sal leaves for income, but they earn less from this activity than what they could realize by selling firewood. The VFPCs are promised a share of the income that will eventually be realized once the protected timber has grown to an adequate size for harvesting. Beginning with a small-scale experiment in the tribal area of Arabari, the VFPCs now cover many districts of West Bengal.

B.5 ACTIONS THAT EXPLICITLY SUPPORT THE UNFCCC OR CONTROL GHG EMISSIONS

India is a signatory to the following international treaties/agreements relevant to GHG emissions:

- Montreal Protocol on substances that deplete the ozone layer
- Convention on Conservation of Bio-diversity.
- Framework Convention on Climate Change.
- Vienna Convention for Protection of Ozone Layer

The Ministry of Environment and Forests is the nodal agency for participation in international agreements relating to the environment.

Some activities and projects that are being implemented or are under consideration by various funding agencies are listed in Exhibit B-6. The largest is the US$1.008 billion gas rehabilitation and expansion project centered around the Hazira-Bijaipur-Jagdishpur pipeline, to be implemented by the Gas Authority of India Ltd. Other significant projects include the nationwide solar thermal power project, which has a total cost of US$245 million and seeks to demonstrate the operational viability of parabolic tough solar thermal power generation in India and to promote commercial development of this technology, and the US$430 million alternative energy project, which aims to help the Indian Renewable Energy Development Agency demonstrate the

Exhibit B-6
GHG Emissions Reduction Activities Proposed or Implemented

Project Title and Description	Co-ordinating Organization	Scope	Stage	Implementing* and Supporting Organization(S)	Starting Date (length in months)	Total Cost (million) $US	Notes
Reduction of Greenhouse Gases through the Production of Energy from Sea Waves	United Nations Program Department of Ocean Development, Government of India Global Environment Facility	National	Proposal	National Institute of Ocean Technology Indian Institute of Technology	(60)	$ 7.95	Aims to develop a renewable energy source that can meet the sustainable development needs of the country and that can be replicated in other areas of India and around the world.
Improve the Observational Basis for Studies of the Impact of Tropospheric Ozone on Climate in DCs and Build Up of Capacity as Part of the Global Assessment of Tropospheric Ozone as a GHG (PDF)	United Nations Development Program World Meteorological Organization Global Environment Facility United Nations Environment Program	Global	Proposal	N.A.		$0.35	Implemented in Algeria, Botswana, Argentina, Bangladesh, Brazil, Cape Verde, Chile, China, Costa Rica, Cote d'Ivoire, Ecuador, India, Kenya, Malaysia, Mexico, Phillippines, Papua New Guinea, Solomon Islands, Sudan, Vanuatu, Venezuela. This activity has been submitted to the GEF for PDF (Project Development Fund). The major objective is to establish 24 ozonessonde stations in 21 developing countries in the tropics and subtropics. The project may have significant policy implications if tropospheric ozone is found to be of comparable importance to methane as a greenhouse gas, as estimated by IPCC.

Project Title and Description	Co-ordinating Organization	Scope	Stage	Implementing* and Supporting Organization(S)	Starting Date (length in months)	Total Cost (million) $US	Notes
Capacity Building in Integrated Assessment of Climate Change in Developing Countries and Countries with Economics in Transition (PDF)	United Nations Environment Program	Global	Proposal	N.A.		$0.025	This activity has been submitted to the GEF for PDF (Project Development Fund), which is intended to fund the development of project proposals that are in line with GEF operational policy and programs. The project is designed to promote the use of the integrated assessment models and techniques by Non-Annex I parties for capacity building activities. Countries where this will be carried out initially are: China, India, Brazil, Mexico, Kenya and Bulgaria.
Coal Bed Methane Recovery and Commercial Utilization	United Nations Development Program Global Environment Facility	National	Proposal	N.A.	05/97 (48)	$17.3	GEF share of cost = 9.19 million. The project will support technical assistance and in-country capacity building for expanded methane recovery and use. It will introduce advanced techniques of gas resource assessment and harnessing methods relevant to Indian coal mining conditions.
Carbon Emission Reduction through Biomass Energy for Rural India (PDF)	United Nations Development Program Global Environment Facility	National	Development	N.A.		$0.246	This activity has been submitted to the GEF for PDF (Project Development Fund), which is intended to fund the development of project proposals that are in line with GEF operational policy and programs. Aims to establish the commercial viability of various bio-energy options and their potential for widespread adoption at the village level in India so as to actively promote a low CO_2 path to development in India

Project Title and Description	Co-ordinating Organization	Scope	Stage	Implementing* and Supporting Organization(S)	Starting Date (length in months)	Total Cost (million) $US	Notes
Solar Thermal Power Project (IN-GE-43021)	World Bank Global Environment Facility	National	Development	N.A.	3/97 (60)	$245	The main objectives of the project are to a) demonstrate the operational viability of parabolic tough solar thermal power generation in India; b) promote commercial development of solar thermal technology and cost reduction; and c) help reduce greenhouse gas global emissions in the short and longer term. The project would represent the second GEF operation in the energy sector in India. The GEF's share of the project's cost is US$ 50 million, plus US $ 750000 in PDFC funds for project development.
Sustainable Transport in Four Asian Cities: Problems, Policies and Implementation	GTZ (German Agency for Technical Co-operation)	Regional	Development	N.A.	(8)	$0.263	Expected activities of this project include the development of a common framework for analyzing policy options among participating Asian Environment Institute members; the identification and prioritization of policy options in each city; and the formulation of proposals for development into implementable strategies. Cities included are Bangkok, Thailand; Beijing, People's Republic of China; Jakarta, Indonesia; and Delhi, India.
CO_2 Mitigation Strategy for South India	GTZ (German Agency for Technical Cooperation)	National	Development	N.A.	07/96 (18)	$0.414	The activities of this project are aimed at developing a strategy for air quality improvement in South India; development of an action plan for Bangalore City; and implementation of demonstration projects.
Gas Rehabilitation and Expansion Project India, Western Area	Asian Development Bank	National	Implementation	Gas Authority of India Ltd.	12/93(43)	$1008	This project is centered around the Hazira-Bijaipur-Jagdishpur pipeline. It is being financed by the ADB (a loan of US$ 260 million), the EXIM Bank of Japan, suppliers' credit, the Oil Industry Development Board, and the Gas Authority of India Ltd.

Project Title and Description	Co-ordinating Organization	Scope	Stage	Implementing* and Supporting Organization(S)	Starting Date (length in months)	Total Cost (million) $US	Notes
Research Program on Methane Emissions from Rice Fields, GLO/91/G31	Global Environment Facility United Nations Development Program	Global	Implementation	Indian Council for Agricultural Research	04/92 (60)	$5	Implemented in China, India, Philippines, Indonesia and Thailand. Focus on quantifying the impact of different rice growing ecosystems on methane emission and improve knowledge of processes that control methane fluxes from flooded rice.
Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS) Project, RAS/92/G33	Global Environment Facility Asian Development Bank	Regional	Implementation	Ministry of Environment and Forests	12/94 (24)	$9.5	Participating countries are Bangladesh, China, Korea (Republic of), Korea (Democratic People's Republic of), India, Indonesia, Mongolia, Myanmar, Pakistan, Philippines, Thailand and Viet Nam. Focused on the enhancement of existing national and regional capacity to develop least-cost GHG strategies that promote environmentally sustainable economic development in Asia. Funded by the GEF ($8.137M) and ADB ($.1M). Technical assistance approved 2 August 1994. Managed by ADB in close collaboration with UNDP.
"IPCC/OECD National GHG Inventory"	Organization for Economic Co-operation and Development WMO/UNEP Intergovernmental Panel on Climate Change	National	Implementation	N.A.	N.A.	N.A.	Detailed information is being processed. A general update on the status of inventory submissions is published in the IPCC/OECD "Overview of Preliminary National GHG Inventories: Interim Report - January 1994."

Project Title and Description	Co-ordinating Organization	Scope	Stage	Implementing* and Supporting Organization(S)	Starting Date (length in months)	Total Cost (million) $US	Notes
Alternate Energy, 8INDGE001	Global Environment Facility World Ban	National	Implementation	Indian Renewable Energy Development Agency Indian Renewable Energy Manufacturers' Association	04/93 (84)	$430	GEF share of costs = US$26 million. Aims to increase the Indian Renewable Energy Development Agency's ability to mobilize private investment in the sector and demonstrate the commercial viability of generating energy using wind and photovoltaics instead of fossil fuels.
Development of High-Rate Biomethanation Processes as Means of Reducing Greenhouse Gas Emissions, IND/92/G32	United Nations Development Program Global Environment Facility	National	Implementation	Ministry of Non-conventional Energy Sources Department of Economic Affairs, Ministry of Finance	04/94 (60)	$10	Aims to control emissions of methane in India by applying state-of-the-art high-rate biomethanation technology to a number of waste substrates.
Optimizing Development of Small Hydel Resources in the Hilly Regions, IND/92/G31	United Nations Development Program Global Environment Facility	National	Implementation	Ministry of Non-conventional Energy Sources Department of Economic Affairs, Ministry of Finance	04/95(60)	$14.64	GEF share of costs = US$7.5 million. Project aims to reduce carbon emissions and mitigate deforestation in India's hilly region by formulating technical and economic guidelines and promoting the adoption of advanced technologies for small hydroelectric resources.
Cost-Effective Options for Limiting Greenhouse Gas Emissions, IND/93/G31	United Nations Development Program World Bank Global Environment Facility	National	Implementation	N.A.	(24)	$1.5	Assistance to government in assessing specific investment projects and related institutional and policy options for limiting GHG emissions. Project also identifies and strengthens India's institutional, technical and technological capabilities to assess global implications of energy efficiency and other projects which affect emission levels

Project Title and Description	Co-ordinating Organization	Scope	Stage	Implementing* and Supporting Organization(S)	Starting Date (length in months)	Total Cost (million) $US	Notes
Identifying Strategies to Enhance Strategic Options for Adapting to Climate Change in Forest Based Land Use Systems	Swedish International Development Cooperation Agency Stockholm Environment Institute	National	Implementation	N.A.	07/93O	$0.5	This project entails two case studies in India (Himachal Pradesh and Western Ghats). It is part of the SIDA/SEI program on Atmospheric Environment Issues in Developing Countries (total cost since its inception = US$26 million).
Methodological Framework for National Greenhouse Gas Abatement Costing Studies (Phases I and II)	UNEP Collaborating Centre on Energy and Environment	Global	Completed	Tata Energy Research Institute	10/93 (28)	$1.5	Implemented in: Brazil, Denmark, Egypt, France, India, The Netherlands, Senegal, Thailand, Venezuela and Zimbabwe. Phase Two completed. Final report (May 1994) consists of three volumes (Main Report, Country Studies and Guidelines) and an additional booklet ('Comparing the Cost').
Regional Study on Global Environmental Issues: India	Asian Development Bank	National	Completed	N.A.	5/92 (27)	$0.1875	Project aimed to assist countries in assessing the implications of global climate change and identifying policy options to deal with it. The figure in the `total cost' field was calculated by dividing the total amount of funding available within the region by the number of participating countries. It may therefore differ slightly from actual project costs.

commercial viability of wind and photovoltaics and to mobilize private investment in this activity.

B.5.1 Policy Initiatives

Several policy statements and legislative acts are directly concerned with limiting India's GHG emissions. These include the Forest Act (1980), the Air Pollution Act (1981, amended in 1987), the National Conservation Strategy (1992), a policy statement on conservation strategy (1992), a policy statement on the environment and development (1992), and a policy statement on abatement of pollution (1992). Additional progress toward limiting the growth in CO2 emissions is expected to result from the government's energy efficiency and conservation programs and renewable energy programs.

The Planning Commission recently held a workshop on "Climate Change: Its Dimensions and Implications for Planning in India," bringing together policymakers and experts from industry, government, and academia to discuss the Commission's proposals for the Ninth Plan period (1998-2002). During the five years covered by the Eighth Plan, India launched the comprehensive "National Energy Efficiency Program" to coordinate efforts for energy conservation in various sectors of the economy. The government expects to achieve energy savings of around 5000 MW in the power sector and 6 million MT of oil in the petroleum sector during the Eighth Plan period.

MOEF has set out clearly defined policy initiatives to phase out the ozone-depleting substances (ODS) in accordance with the Montreal Protocol. The initiatives were prepared in conjunction with the national industrial development strategy and without undue burdens to consumers. A complete phase out of ODS is envisaged by 2010. The government has prohibited the development of fresh capacities for manufacture of aerosol products, except metered dose inhalers used for medicinal purposes.

B.5.2 National Communications

India intends to meet the requirements of Articles 4 and 12 of UNFCCC by submitting a report related to the implementation of convention provisions.. The preparation of an emissions inventory for a vast country like India, however, will be a considerable exercise, which will require new and additional financial resources from developed countries. MOEF has established several expert committees and task forces comprised of people from the Ministry, academic institutions, the scientific community, and interested private organizations to participate in preparing India's national greenhouse gas emissions inventory.

B.5.3 Global Environment Facility (GEF)

As of January 1998, an allocation of US $ 27.38 million has been made to India under UNDP/GEF. In addition, the government of India and other participating institutions have contributed about US $ 22 million (in-kind) to these projects, which brings the total UNDP/GEF portfolio in India to US $ 49.38 million. The portfolio consists of 4 operational projects, 3 project development fund (PDF) projects, 3 pipeline projects, and 24 small grants program projects. These projects are:

Operational projects

1. Optimizing development of small hydel resources in the hilly regions
2. Development of high-rate biomethanation process as means of reducing GHG emissions
3. Asian Least-cost Greenhouse Gas Abatement Strategy, India component
4. First national report to the Convention on Biological Diversity

Small grants program

5. Overview of the small grants program in India
6. Details of the 24 small grant program projects

PDF projects

7. Strengthening the management of the Gulf of Mannar Marine Biosphere Reserve
8. Carbon emission reduction through biomass energy for rural India
9. Management of coral reef ecosystem in the Andaman Nicobar Islands

Pipeline projects

10. Selected options for stabilizing GHG emissions for sustainable development
11. Coalbed methane recovery and commercial utilization
12. National biodiversity strategy and action plan

B.5.4 Joint Implementation

India considers joint implementation under the Convention (UNFCCC) a complex issue. Given the ambiguities and uncertainties associated with the issue, such as the types of projects, the methods for verification, and the techniques to be used for accounting and tracking emission reductions, India's concern is shared by many other developing countries of the G-77. India's government feels that:

- joint activities should not divert attention away from the immediate priority to achieve emissions reductions in developed countries;

- joint activities should be separate from the national legal obligations of developed countries;
- joint activities under the Convention should be seen as an addition, over and above the commitments already made by Annex II Parties regarding the "new and additional resources";
- discussions on joint implementation should avoid the issue of crediting during the initial pilot phase, which should extend at least to the year 2050;
- developed countries should first comply with the goal of allocating 0.7% of GNP for development assistance, and funds for activities implemented jointly should be separate from development assistance;
- joint activities in the forestry sector will require as a prerequisite the addressing of many problems, such as the calculation of credits and the uncertainty and asymmetry of available information; and
- joint activities should not conflict with the development priorities of developing countries, e.g., joint activities such as efficiency improvement projects should be given priority.

An Activities Implemented Jointly (AIJ) task force has been set up by the MOEF. The pilot phase AIJ projects that have been endorsed by the government of India since December 1997 are listed in Exhibit B-7.

Exhibit B-7
Approved Pilot Phase AIJ Projects

Sr. No.	Name of the Project	Location	Investing Party/Country	Host Party
1.	Direct Reduced Iron (DRI)	Gujarat, India	New Energy Development Organization (NEDO), Japan	M/s. ESSAR, Indian Petrochemicals, Ltd. Gujarat, India
2.	Energy recovering from waste gas and liquid	Gujarat, India	IPCL	IPCL Plant at Vadodara, Gujarat, India
3.	Integrated Agricultural DSM	Andhra Pradesh, India	World Bank	Andhra Pradesh State Electricity Board, India
4.	DESI - Power: biomass gassification	At 20 sites in India	The Netherlands	DESI Power, Development Alternatives, India
5.	Tamarind Orchard Agro Forestry for Dry land	Karnataka, India	USA	ADAT, Bagepalli, Karnataka, India

Source: Development Alternatives. New Delhi, India.

ANNEX C
BRAZIL

C.1 SUMMARY

As of 1995, the intensity of GHG emissions attributable to energy production was less in Brazil than in many other countries, primarily because of Brazil's heavy reliance on hydropower and biomass. The use of renewably produced biomass has kept Brazil's CO_2 emissions levels far below the levels that would have been reached if fossil fuels had been used instead. According to one estimate, the increase in emissions would have been 31%-34% in the years 1990-94.[1]

Brazil's comparatively good performance is a result of both resource endowments and explicit policy choices regarding industrial structure, energy efficiency investments, and energy supply. The Government of Brazil has taken a wide range of measures that reduce the GHG intensity of energy use, such as improving end use efficiency and developing the infrastructure for low-GHG sources of energy to meet growing needs. In some cases such as the alcohol program, the motivation has been to reduce reliance on energy imports. For example, the government promoted the use of electricity rather than fuel oil in industry through the development of hydropower. Also, in response to the 1970s oil crises, the government launched its alcohol program designed to substitute a sugarcane-based fuel for gasoline in motor vehicles.

The macroeconomic reforms that Brazil has been compelled to implement in the 1990s complicate the country's efforts to maintain its low-carbon energy infrastructure. Privatization of the power industry has meant greater reliance on fossil fuels for new capacity. Privatization of the petroleum industry has made it more difficult to maintain incentives that support production of biomass-based ethanol. Relaxation of trade restrictions has encouraged the substitution of imported coal for charcoal in steel production. Austerity measures may reduce government funding available for energy efficiency and renewable energy programs.

Renewable energy sources' share of total energy production in Brazil has diminished slightly since 1990, while the share belonging to fossil fuels has grown. There has been some substitution of coke for charcoal, LPG and fuel oil for firewood, and gasoline for ethanol. A paper prepared by the Ministry of Science and Technology noted that without policies to

[1] Information obtained from www.mct.gov.br/gabin/cpmg/climate/programa/ingl/energyi15.htm

maintain reliance on renewables, Brazil's relative advantage could be jeopardized.[2] At the same time, economic reforms have had the effect of rationalizing energy prices, controlling inflation, and relaxing currency exchange rates, all of which improve incentives to conserve energy.

C.2 BASELINE CONDITIONS AND TRENDS

Brazil's population is over 160 million and growing 1.4% per year. Per capita GDP was $4,950 in 1997. With the spillover from the Asian crisis, economic growth projections have been revised downward to be about 0.5-1% through 1999, increasing to 3-4% thereafter.

In 1995, Brazil's GHG emissions were the 16th largest in the world. In 1995, Brazil's energy related carbon emissions were 66.4 million metric tons and total emissions were 68 million (1.1% of world carbon emissions). Carbon emissions per capita were 0.43 metric tons (vs. 5.4 metric tons per capita in the United States). Brazil's GHG emissions are a function of its population size, income, level of urbanization, and its energy sources. Hydroelectricity and biomass account for about 70% of the country's primary energy inputs. (See Exhibit C-1.)

Exhibit C-1
Supply of Primary Energy by Source (Million Metric Tons of Oil Equivalent[3])

Energy Source	1990	1994
Oil	59.3	64.9
Natural gas	4.2	5.0
Coal	9.5	10.2
Hydropower	59.9	70.4
Biomass	46.1	45.5
Other renewables	0.2	0.3
Total	**181.1**	**199.1**

[2]"CO2 Emissions from the Energy Sector - A Top Down Approach." Prepared by Energy Planning Program, Federal University of Rio de Janeiro for the Ministry of Science and Technology, www.mct.gov.br/gabin/cpmg/climate/programa/ingl/energi11htm

[3]Data downloaded August, 1998, from the following website prepared by the Government of Brazil: http://www.mct.gov.br/gabin/cpmg/climate/programa/ingl/energi11.htm

Exhibit C-2 lists carbon emissions attributable to each sector of the economy, broken down to show the amount contributed by each type of fuel. Liquid fuel used for transport is the largest source of carbon emissions, followed by fuels used in industrial production.

Exhibit C-2
1996 Carbon Emissions by Sector (Thousand Metric Tons)*

Sector	Liquid fuel	Solid fuel	Gaseous fuel	Total
Transport	25,160	0	30	25,190
Industry	8,838	7,256	2,011	18,100
Energy (internal sectoral use)	3,423	0	942	4,366
Electric Generation	1,517	1,305	174	2,995
Other Sectors	2,868	3,343	1,810	8,015
Total	**41,800**	**11,900**	**4,968**	**58,670**

*"A Sectoral Review of Energy in Brazil: Supply and Demand and Opportunities for Reducing Carbon Emissions." Gilberto De Martino Jannuzzi, Universidade Estadual de Campinas, Brazil, June, 1998.

C.3 BROAD ECONOMIC REFORMS AFFECTING GHG SOURCES AND SINKS

Brazil emerged from a period of macroeconomic instability, stagnation, and recession at the end of the 1980s and then went into a period of hyper-inflation. Inflation control became a major economic goal of the 1990s. The government has been very successful in achieving that goal, having brought inflation from 2,500% in 1994 to 16.5% in 1996 and 5% in 1997.

Major trade liberalization efforts began in 1990. Most non-tariff barriers were eliminated in 1990 and a gradual program of tariff reduction was begun in 1991. By 1994 the average tariff was about 14% (versus 32% in 1990), and the maximum tariff about 40% (versus 105% in 1990).

The energy sector had played a large role in Brazil's overall debt crisis of the 1980s. By the mid-1980s, the electricity sector had insufficient revenues to service its outstanding debt and had to seek new loans. As part of the economic restructuring of the 1990s, the sector introduced a series of far-reaching reforms. One result has been that investment to finance the sector's growth is being channeled through private power development and privatization of the utility companies themselves; however, private investment may need to be supplemented to meet the growing needs of the sector.

The net effect on GHG emissions produced by each of these reforms is not always obvious. The discussion below is confined to those reforms with the most direct, identifiable effects.

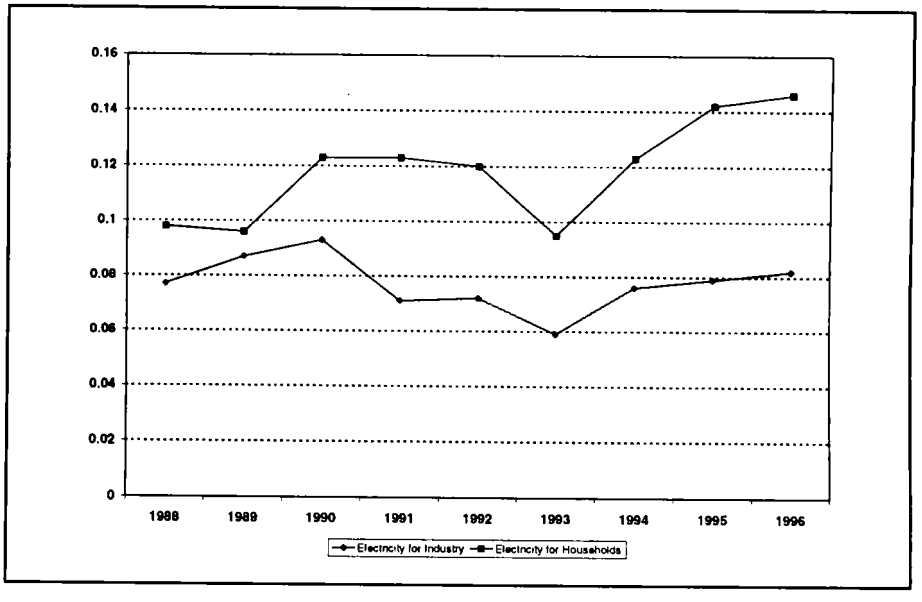
C.3.1 Reducing Energy Subsidies

Brazil has made substantial progress during the 1990s in privatizing its national and state-run energy industries. The national power generation holding company (ELETROBRAS) is being privatized, as are most of the state distribution utilities. Currently, 47% of the distribution sector has been privatized, and the power generation market has been opened to independent power producers.

Although privatization has many ramifications for the way energy is produced and consumed in Brazil, the greatest impact on GHG emissions will come about as a result of the new owners' efforts to bring energy prices more in line with costs.

Electricity tariffs are also moving toward full cost recovery. In the past the government had frozen public utility rates as part of its effort to curb inflation. By 1993, however, the power sector was near bankruptcy. To rescue the industry, the government had to increase the price of electricity by 70%, among other measures, in spite of the competing desire to minimize inflationary pressures. (See Exhibit C-3)

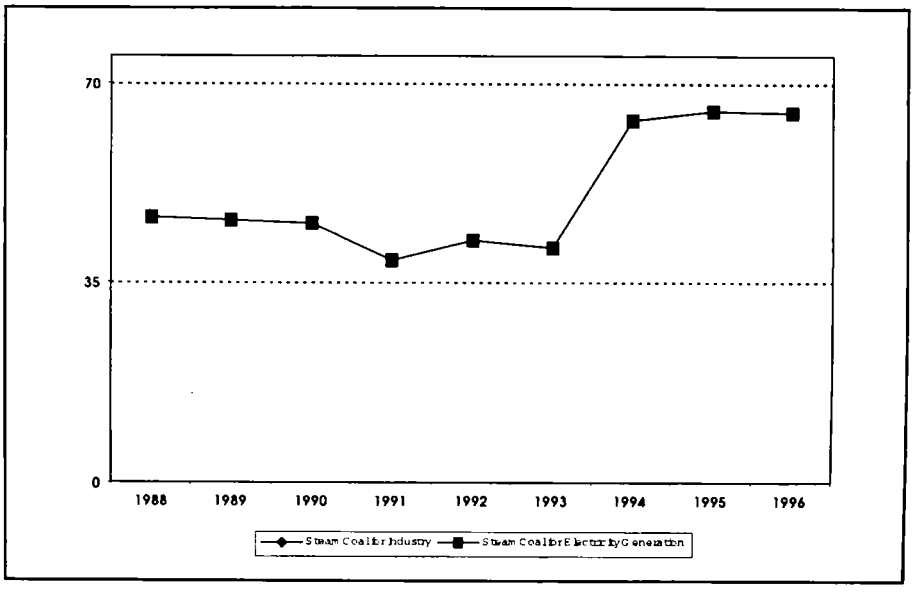
Exhibit C-3
Brazil Electricity Prices in U.S. Dollars/kWh



In 1995 the government stated its intention to phase in full cost recovery pricing for utility rates. It has made significant progress toward that goal. As of 1997, the normal residential rate is about $0.13/kWh. Low income households pay increasing block rates. They are subsidized only at "lifeline" levels of use; consumption of more than 101 kWh per month is charged at the same rate as that paid by other households.

Fuel price trends have been mixed. Prices for coal have generally increased since 1990 (see Exhibit C-4), while gasoline prices have declined, although they are still about twice those in the U.S. (see Exhibit C-5). As part of agreements reached with the World Bank, the Brazilian government has developed a plan to phase out fuel price subsidies and deregulate petroleum product prices within a three year transition period (from August 1977).[4]

Exhibit C-4
Brazil Coal Price Trends in U.S. Dollars/Ton



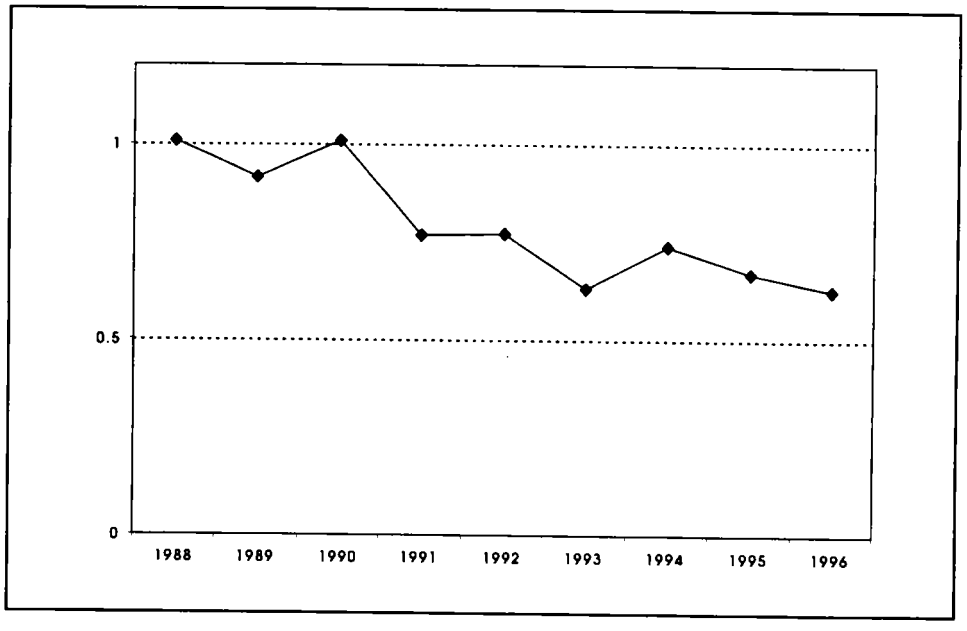
C.3.2 Other Effects of Reforms on GHG Emissions

Subsidy reductions are not the only reform that has implications for GHG emissions. Revising policies that distort the choice of generation technologies is another. For example, the CCC (Conta de Consumo de Combustiveis) is a subsidy to pay the fuel costs of isolated diesel

[4]"International Gas Trade -- The Bolivia-Brazil Gas Pipeline." 1998. Peter L. Law and Nelson de Franco. Private Sector Note No. 144, World Bank, Washington, DC.

generation that has sometimes exceeded $350 million/year. Under recent power sector reforms, this subsidy will be phased out for thermal grid-connected units. It is currently being operated as a fund that supports rural electrification irrespective of the source of power.

Exhibit C-5
Brazil Regular Unleaded Gasoline Prices in U.S. Dollars/Litre



It is thought that sectoral reforms will also result in smaller energy losses. In 1995 electric power system losses nationally were 16% of total power output. In addition to improving energy pricing, privatization of the publicly owned distribution companies is expected to reduce these losses. Loss reduction is a stated policy of the recently privatized utility in the state of Bahia (COELBA). To ensure that energy efficiency continues to be promoted in a privatized electricity industry, the Government of Brazil has created a fund from taxes on electricity sales with $30-$40 million annually to leverage energy efficiency investments.

The effect of reforms on the choice of which type of generation to build is mixed. On one hand, gas is preferred to oil for power generation. On the other hand, the presence of private power developers suggests that thermal generation will be favored over hydro generation, because it requires a lower initial investment and consequently produces a faster return on capital.

developers suggests that thermal generation will be favored over hydro generation, because it requires a lower initial investment and consequently produces a faster return on capital.

Privatization of key public sector industries has also had consequences for Brazil's environmental management. Prior to privatization, there had been little enforcement of environmental policies in the oil and steel industries. Privatization has brought more effective enforcement and has mobilized private capital for abatement and prevention improvements. As part of overall economic reforms, Brazil is privatizing other sectors as well. In July, 1997, the Brazilian Senate approved a new Petroleum Investment Law.

C.4 SECTOR-SPECIFIC ACTIONS AFFECTING GHG SOURCES AND SINKS

Energy, industry, and transport account for about 86% of Brazil's carbon emissions. During the 1990s much progress was made toward improving energy efficiency in buildings, industry, and transportation, by means of a wide range of both publicly and privately sponsored programs. Brazil also developed its capacity to expand such efforts in the future.

PROCEL is the energy efficiency promotion group of Brazil's federal electricity utility holding company Eletrobras; it was established in 1985. In 1995 PROCEL's budget was about $27 million, of which $6 million was for core programs funded through grants and $21 million was for low interest loans from the capital investment fund for the power sector. When Eletrobras is privatized, it is expected that PROCEL will become an autonomously managed group. According to the regulations established for the new structure of Brazil's electricity industry, 1% of electricity revenues will be set aside for PROCEL's efficiency programs. Moreover, PROCEL will serve as technical advisor to the national regulatory body on energy efficiency. To guide its future initiatives in the privatizing energy sector, PROCEL organized a major international conference in October, 1998.

CONPET (National Program for the Rational Use of Natural Gas and Petroleum Products), established by Presidential Decree in 1991, receives funding from PETROBRAS and is operated by representatives of both federal agencies and private enterprise. It operates programs in the institutional, transportation, residential, commercial, agricultural, and power sectors.

Under the auspices of CONPET several programs have been established to reduce emissions and consumption and to encourage greater use of waterways and pipelines for transport. Targeting oil and gas consumption primarily, CONPET has promoted greater efficiency through various incentive and information programs. It has also encouraged commercial and residential customers to switch from LPG to natural gas, and agricultural customers to reduce diesel consumption. CONPET has developed new energy efficient technologies and promoted

technical norms for energy production.[5] Over the next 20 years, CONPET hopes to achieve efficiency gains of 25% in gas and oil products.

INEE (Instituto Nacional de Eficiencia Energetica) is a private nonprofit organization that promotes efficient use of all forms of energy. It seeks to reduce market imperfections by improving the quality of available information and by supporting the creation of norms and legislation promoting energy efficiency. INEE complements the programs run by official agencies, energy companies, and industry associations.

About 30 energy service companies (ESCOs) of various sorts were operating in Brazil as of 1995-96. Some are engineering or consulting firms; others are domestic subsidiaries of international equipment manufacturers. Large firms that are active in Brazil's ESCO market include Johnson Controls, Honeywell, HEC, EPS, and Union RHAC.

C.4.1 Reducing Energy Use in Buildings and Industry

Even though Brazil's high inflation rate made energy conservation investments relatively unattractive until recently, Brazil has made significant progress in improving energy efficiency in buildings and industry. The energy efficiency market in Brazil had an estimated value of $631 million in 1996. Depending on the assumptions used, this market could grow to $2-$3 billion by 2015.[6]

Electricity Use

PROCEL initiated a wide range programs in the 1990s, including energy audits, appliance labeling, and public lighting programs. Energy efficiency standards have been implemented for boilers, refrigerators, small air conditioners, buildings, and electric motors. A recent study shows that energy savings stimulated by PROCEL's programs amounted to 3,600 GWh in 1996.[7] For the same year, electricity savings attributable exclusively to the use of efficient lighting

[5] *Pursuit of Sustainable Energy Development in the Americas: A Look at Recent Progress.* Dan Biller and Suzanne Maia, Environment Unit, LAC Technical Department, Regional Studies Program, Report No. 42, World Bank, Washington, DC, 1996.

[6] *The Energy Efficiency Market in Developing Countries: Trends and Policy Implications.* Business Focus Series. Prepared for USAID Office of Energy, Environment, and Technology by Hagler Bailly, November, 1997.

[7] "Brazil Fourth Quarterly Report." Prepared for USAID Office of Energy, Environment, and Technology, by Howard Geller, May, 1997.

technologies are estimated to be 111 GWh. (Total savings from the use of efficient lighting products are much higher, almost 3,000 GWh in 1996.[8])

Savings from PROCEL programs are documented in Exhibits C-6 and C-7. This level of achievement has been made possible both because of the rapid growth in PROCEL's budget, projects, and influence, and because work in some areas has been going on for over a decade and the cumulative impact is now being felt.[9]

Electricity savings are likely to continue to grow for several reasons. First, there is a large backlog of efficiency projects that have been approved by the RGR but have not yet been implemented. Second, the risk of electricity shortages will persist, causing some companies and utilities to increase investment in efficiency measures. Third, the private provision of energy efficiency services is expanding. Fourth, the internationalization of the Brazilian economy is leading local companies to become more efficient. In the future, PROCEL will focus its efforts on ways to transform markets for energy efficiency products.[10]

Exhibit C-6
Total Energy Savings Resulting from PROCEL Programs*

	1994	1995	1996	1997	1986-97 Cumulative
Annual Investment (R$ million)	9.5	30	50	122	235.5
GWh/year saved	344	572	1970	1758	4,885

*Data obtained from PROCEL website July 15, 1998 (www.eletrobras.gov.br/procel)

[8]*The Efficient Use of Electricity in Brazil: Progress and Opportunities.* Howard Geller et al. American Council for an Energy Efficient Economy. Washington, DC. 1997.

[9]*The Efficient Use of Electricity in Brazil: Progress and Opportunities.* Howard Geller et al. American Council for an Energy Efficient Economy. Washington, DC. 1997.

[10]*Evaluation of the Energy Savings Due to Brazil's National Electricity Conservation Program (PROCEL).* Howard Geller et al., American Council for an Energy Efficient Economy. Washington, DC. 1997.

Exhibit C-7
Energy Savings from Individual PROCEL Programs*

Program Element	GWh Savings in 1997
Refrigerators	332.2
Motors	216.0
Air Conditioning	49.4
Lighting	592.7
Audits	19.0
Public Buildings	6.3
Education	26.6
Industry	19.9
Installation of Meters	228.1
Generation and distribution	194.3
Utility programs	72.3
Total	**1757.8**

*PROCEL

In 1996, energy savings from lighting efficiency programs in Brazil saved an estimated 2.8 Twh, about 1.1% of total electricity use. Programs implemented by the energy conservation organization of Brazil's power sector (PROCEL) resulted in cumulative savings of 4.9 Twh/yr. from 1998-1997.

The private sector has also initiated energy savings programs. The organization of the Brazilian lighting industry (ABILUX) has developed a pipeline of lighting efficiency projects valued at $20-30 million. If $20 million worth of these projects can be implemented, the ABILUX program could generate electricity savings of 200 GWh/year (2,000 GWh over the life of the program). This is equivalent to nearly 1,000,000 tons of CO2 reductions.[11] Energy savings of 60% or more are technically feasible in the lighting of commercial and public buildings.

Still, there is a large efficiency potential remaining to be tapped. A 1991 study estimates a national energy savings potential of 111 TWh by 2010, considering only end use efficiency

[11] "Trip Report Brazil Energy Efficiency Financing Program." Prepared for USAID Office of Energy, Environment, and Technology by Hagler Bailly, February, 1998.

improvements with an average cost of saved energy of $24/MWh.[12] For industry as a whole, a national audit program indicated a savings potential of 8-15%, based on low-cost measures like replacing oversized motors, improving transmission systems between motors and subsequent equipment, replacing overloaded lines, adjusting overloaded transformers, correcting low power factors, etc. Additional savings are possible through more costly investments such as energy-efficient motors, variable speed drives, improving electric furnaces and boilers, electrolytic process improvements, and cogeneration. Motor systems account for about half of industry's total electricity use.

Fuel Use

CONPET has introduced several programs to reduce fuel use in buildings and industry. In 1994 a program was started to upgrade gas-fueled household appliances through a three-stage process:

1) review of Brazilian norms, incorporating modifications already in effect in the European Community;

2) accreditation of manufacturers' and the certificatory agency's testing laboratories, as stipulated by these norms; and

3) modernization of assembly lines, restructuring manufacturing processes to produce stoves, ovens and water heaters that comply with these norms.

LPG is used by over 80% of Brazil's households. Potential reductions in consumption achievable through CONPET's project are estimated at 13%, representing a savings of some 600,000 tons per year.

Another aid to the development of more efficient products was the introduction of the Energy Efficiency Seal. This will be awarded every year to the gas-fueled stove and water heater with the best results in energy performance tests.

ABRACE is an association that represents 54 companies responsible for 35% of all industrial energy consumption. The association's members are increasingly turning to independently generated cogeneration.

[12] *Efficient Electricity Use: A Development Strategy for Brazil.* Howard Geller. American Council for an Energy Efficient Economy. Washington, DC, 1991.

Petrobras

Energy use at Petrobras' refineries is being managed through the use of combined cycle cogeneration plants. These systems will generate extra power to be sold to the grid by partnerships with private enterprise. To date, agreements have been signed for implementing two projects, for a total of 570 MW capacity available to the grid[13] and an additional 1,800 MW planned over the next ten years.

Several years ago Petrobras implemented an in-house energy conservation program involving all departments. The program is based on assessing the potential for reducing energy outlays, developing conservation programs, and education. Results are shown in Exhibit C-8.

Exhibit C-8
Energy Savings at Petrobras

	1992	1993	1994	1995	1996	1997
Electricity Savings (MWh)	23,150	31,347	31,442	1,472	18,010	27,618
Fuel Oil Savings (m3)	74,330	39,256	109,993	81,870	53,553	39,481
Natural Gas Savings (1,000 m3)	175,680	43,800	29,600	52,950	62,364	88,967
Diesel Savings (m3)	14,576	10,448	660	360	2,147	2,055
LPG Savings (t)			7,337	477	546	
Carbon emissions (t)	222	78	125	115	101	100

Steel Production

Steel and pig iron production are the largest industrial energy uses in Brazil. Although the energy intensity of steel production in Brazil is still somewhat higher than that in the U.S., it dropped from 34 Gigajoules per metric ton in 1990 to 30 Gigajoules per metric ton in 1994.[14]

Brazil's steel mills have traditionally burned charcoal instead of coal-based coke, and depended on tree plantations to supply the needed charcoal. This has allowed the large energy needs of the steel industry to be supplied at a relatively low cost in net carbon emissions.

One steel mill maintains more than 68,000 hectares of eucalyptus plantations to produce charcoal for its blast furnaces. Compared to the native vegetation (the alternative source for charcoal), a

[13]Data from Petrobras website on July 15, 1998.

[14]Price, L., Worrell, E., Martin, N., Farla, J., Schaeffer, R. 1997. " Energy Efficiency in the United States Iron and Steel Industry." Proceedings of the 1997 American Council for an Energy Efficient Economy Summer Study on Energy Efficiency in Industry. ACEEE, Washington, DC.

eucalyptus plantation stores about 10% more carbon per unit area (including above ground biomass, below ground biomass, leaf litter, and soil carbon).[15]

Recently the use of charcoal for steel production has diminished, because of the removal of barriers to importing less expensive coking coal and coke. The mills now have less incentive to implement reforestation projects.

C.4.2 Reducing Fossil Fuel Use in Transportation

The transportation sector is the largest source of GHG emissions in Brazil. Gasoline, diesel, and other liquid fossil fuels accounted for 77.3% of CO2 emissions from fossil sources in 1994.[16] Efforts to reduce energy use in the transportation sector leverage substantial GHG gains.

In 1997 CONPET introduced the "Economizar Project," which targets cargo and passenger transportation companies that maintain their own garages. Trained technicians visit these companies to assess fuel consumption, audit fuel use management methods, and check exhaust emissions. The project is underway in 17 states, with 10 participating federations. Diagnostics held on more than 860 companies showed an average reduction of 13% in diesel consumption by audited fleets. (See Exhibit C-9.) This program is an extension of a pilot project developed in 1993 with four Rio de Janeiro bus companies.

In partnership with the Brazil's national petroleum distribution company, CONPET initiated a road cargo transportation project that installed checkup centers at gas stations along Brazilian highways. The centers assess fuel consumption and provide truck drivers with educational materials on how to rationalize fuel consumption. Mean savings in diesel oil for trucks serviced under this project are projected to reach 15%.

Exhibit C-9
Savings Achieved through CONPET Economizar and SigaBem Projects*

Program	Vehicles Affected	Diesel fuel savings (1,000 liters)	Avoided emissions (1,000 t Carbon)
Cargo and passenger fleet project	12,932	36,209	28
Road Cargo Project	19,391	145,433	112

*Data from PETROBRAS website, July 15, 1998 (www.petrobras.com.br/compet)

[15]"Biomass Plantations and Carbon Storage." David Taylor. *REPSource*. Vol. 3, No. 2. Winrock International, p. 10.

[16]Www.mct.gov.br/gabin/cpmg/climate/programa/ingl/energi12.htm

The government has also begun educating the public on fuel use. By Presidential Decree an energy efficiency label was created to be used to identify the light vehicle with the best performance rating in each of several categories.

Brazil has adopted fuel efficiency labeling for motor vehicles.

Local governments are also implementing programs to reduce energy use in the transportation sector. For example, the City of Curitiba's buses now carry 50 times more passengers than they did 20 years ago. In addition, despite the second highest per capita car ownership rate in Brazil (one car for every three people), Curitiba's gasoline use per capita is 30% below that of eight comparable Brazilian cities.[17] Curitiba has used zoning and public housing policies to direct population growth and economic development to designated transit corridors. The high volume and efficiency of the system permit the city government to operate transit services in partnership with private carriers.

As a result of land use policies, public transit accounts for 70% of the average daily commuter trips in the City of Curitiba, Brazil.

In 1993, the City of Sao Paulo passed a law creating a Secretariat for the Environment which is responsible for activities affecting both sources and sinks of GHGs. Diesel-powered vehicles will be replaced by natural gas vehicles in municipal fleets, bikeways are being built, and a comprehensive tree planting program is being implemented.

Sao Paulo will replace diesel-powered buses with buses fueled by natural gas.

Ethanol Program

In response to the first oil crisis, Brazil launched its alcohol program to replace dependence on oil with an indigenous resource. Since then, Brazil has been producing ethanol from sugarcane, an activity with significant GHG benefits. Carbon is sequestered in the growing sugarcane; if sugarcane is replanted at the same rate it is harvested, the sequestered carbon offsets the carbon emissions released during combustion. Because Brazilian sugarcane varieties are nitrogen-fixing, high yields are possible without using great quantities of fertilizer. Furthermore, most of the energy inputs needed to produce the alcohol are also derived from sugarcane.

The substitution of ethanol for gasoline has reduced total CO2 emissions from fossil fuel use by approximately 15%. Although cane-derived ethanol is not yet competitive with gasoline, it could

[17] "Integrated Transport Planning in Curitiba, Brazil," Birk, M.L. and P.C. Zegras, International Institute for Energy Conservation, 1993, taken from www.crest, org/planning/curitiba.

become so if advanced technology now being developed in Brazil makes possible the cogeneration of electricity from cane residues.[18]

Today all cars and light duty vehicles sold in Brazil must be able to run on a minimum of 22% ethanol. Increasing the use of ethanol was made possible by three government actions: 1) a commitment that Petrobras would buy a specified amount of ethanol; 2) incentives for companies willing to produce ethanol such as low interest loans; and 3) price subsidies for consumers (the ethanol price is only 59% of the gasoline price).[19] Part of the tax on gasoline was used to offset the hight cost of producing ethanol, which has dropped by over 50% from 1980 to 1990.

The future of Brazil's ethanol program is in doubt. Because of low international oil prices and insufficient incentive policies, production has not increased since 1989. Privatization of Petrobras is resulting in reduced subsidies for the program. The production of ethanol-fueled cars dropped to almost zero in 1997.[20]

C.4.3 Reducing Fossil Fuel Use in Power Production

Brazil's power system has had low GHG emissions, being dominated historically by hydro power (87%-95%). Thermal plants have been primarily used to supply isolated communities and to supplement the hydro system during droughts.

In the future, the generation mix will diversify. From 1998-2007, new capacity will be hydro power, nuclear power, and gas and coal plants developed by independent power producers. Almost a third of the new capacity will be thermal, with most of rest hydro other than a 1,300 nuclear unit scheduled for 2000. Thermal and nuclear may account for as much as 20% of total generation by 2015.

Diesel generation has been the mainstay power source for isolated communities. Moreover, fossil fuels are used for lighting in rural households. Greenhouse gas reductions are possible to the extent that these energy services can be made less dependent upon fossil fuels.

Brazil took significant steps during the 1990s to increase its use of renewable energy. For grid-power, Eletrobras initiated a program designed to encourage electricity production from small power producers, notably small hydro power generators, cogenerators, wind generators, and

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[18] *Energy After Rio: Prospects and Challenges.*" Amulya Reddy, Robert Williams, and Thomas Johansson. UNDP, New York, 1997.

[19] "The Brazilian Fuel-Alcohol Program," Jose Goldemberg, Lourival C. Monaco, and Isais C. Macedo. *Renewable Energy: Sources for Fuels and Electricity*. Island Press, Washington, DC, 1993.

[20] Information obtained from: www.mct.gov.br/gabin/cpmg/climate/programa/ingl/energi17.htm

producers of agricultural wastes. In addition, CEPEL (the Center for Electric Energy Research) undertook several demonstration projects on renewable energy and established a reference center for solar and wind energy. Several state utilities have also implemented demonstration projects.

Agricultural and forestry wastes and residues are used by many rural industries for on-site process heat and/or power production. The total amount of energy supplied by such applications is not known. Biomass use for off-site energy use, however, is recorded. In Sao Paolo state, the installed capacity of bagasse-based cogeneration is about 115 MW, of which 18 MW is exported.[21] Currently modest, export capacity is growing. One utility (CPFL) has a program to purchase 16 MW of bagasse-based cogeneration, still a small fraction of the potential capacity in its service area. As of mid-1997, there were two reported bagasse-fueled cogeneration projects under development in CPFL's territory with a total potential capacity of 375 MW.[22]

Brazil has also taken steps to exploit its wind potential. Installed wind capacity in Brazil is about 2.5 MW with another 60 MW currently under development in the State of Ceara.

Besides developing low-carbon sources of grid power, the government is promoting renewable energy sources such as solar home systems for off-grid households and communities. About 20 million people in Brazil do not have electricity. These people currently use diesel generators, candles, and kerosene, all of which release carbon emissions. In collaboration with the federal Ministry of Mines and Energy (MME), several state governments and utilities have sponsored demonstration projects to show how renewable energy sources can be used to replace these fuel sources. According to MME, the two million households that still will not be connected to the grid by the end of the next ten years constitute a 15-20 GW market for renewable energy systems.

Renewable energy equipment has been installed in rural areas through the efforts of a federal government program called PRODEEM (the State and Municipal Program for Energy Development). PRODEEM installed over 300 photovoltaic and wind systems in 1996 for public lighting, water pumping, and energy systems for various community purposes. Funding for similar projects is projected to grow from R$15 million in 1997 to R$50 million in 1999.[23] PRODEEM is beginning to adopt a more commercial orientation.

Several different deployment models are being implemented. Some organizations are selling systems with revolving fund financing; others are leasing them: still others are offering battery-charging services. Besides the several distribution utilities that have implemented pilot or

[21] *International Cane Energy News*, August, 1995, p. 6

[22] "Using Area-Specific Cost Analysis to Identify Low-Incremental Cost Renewable Energy Options: A Case Study of Co-Generation Using Bagasse in the State of Sao Paulo." Prepared by E4, Inc., Boulder, CO, 1997.

[23] PRODEEM, Program for Energy Development in States and Municipalities. MME, fact sheet, Brasilia, undated.

demonstration projects, a few including CEMIG and COELBA have expressed interest in serving off-grid areas as a new business activity. Because they are granted concessions to serve large unelectrified areas, privatized utilities have the potential for ramping up pilot projects to a commercial scale. Private entrepreneurs and NGOs active in this market include Siemens, Golden Genesis, Fundacao Teotonio Vilela, Instituto de Desenvolvimento Sustentavel e Energias Renovavais (IDER), a farmer's cooperative (APAEB), and other local NGOs. Idaho Power and General Public Utilities International have also expressed interest in Brazil's off-grid market.

The government of Brazil is also improving the availability of capital for renewable energy projects. The Banco do Nordeste do Brasil has established a financing mechanism specifically for renewable energy projects in the northeast region. The mechanism provides a credit line for installing renewable energy equipment for commercial activities and for small entrepreneurs who operate battery-charging stations. The National Social and Economic Development Bank has recently agreed to expand the battery-charging program to rest of the country.[24]

Compared to other countries, photovoltaic equipment has been expensive in Brazil due to a combination of high taxes and the lack of competition among equipment suppliers. Since 1990 Brazil has reduced import and domestic taxes on several types of renewable energy equipment.

In addition to renewables, Brazil is seeking to increase the use of natural gas (which has the lowest carbon intensity of the fossil fuels) for power production. In February, 1993, Brazil signed a 20 year agreement with Bolivia to import natural gas. Construction of a 3,000 km. $2 billion natural gas pipeline from Bolivia is expected to stimulate the use of natural gas and increase its share of Brazil's primary energy consumption from its current level of about 3%. Brazil also plans to boost domestic production and is negotiating with neighboring countries for natural gas exploration and delivery to Brazil. Much of the additional supply will be used for power generation.

In late 1997, several types of renewable energy equipment were exempted from an 18% state value-added tax.

As a result of these activities, Petrobras expects natural gas to account for 10% by 2010.[25] CONPET promotes the use of combined-cycle generation based on non-diesel fuels. In early 1997, the first power project in Brazil to use Argentine natural gas was awarded with a long term power sales agreement for less than US$0.03/kWh.

[24]"Brazil: Northeast Development Bank Provides Financing for Renewable Energy Project." Osvaldo Soliano Pereira. *REPSource*, Vol. 3, No. 1, 1998.

[25]U.S. Energy Information Administration, Country Analysis Brief, Brazil. Retrieved on July 13, 1998 from www.eia.doe.gov/emeu.

C.4.4 Protecting Carbon Sinks

Brazil's forests play an important role in its net carbon emissions. Between 1990 and 1994, net CO2 emissions from burning biomass decreased from 20,701 gigatons to 15,619 gigatons. This trend takes account of carbon sequestration by growing biomass; otherwise there would have been a modest increase in net emissions over this period.[26]

Brazil's vast carbon sinks are under threat from logging, fires, and encroachment of agricultural, urban, and other land uses. Small fires that have been set to clear land sometimes burn out of control -- especially when conditions are dry as they have been in 1998. The rate of deforestation in Brazil has been a matter of intense controversy. Using LANDSAT images, the Brazilian National Space Research Institute calculates that the annual deforestation rate slowed from a peak of 0.54% during the 1980s to 0.30% in 1990. The average annual change in forest area 1980-90 was -__%; during 1990-95 the average annual change improved modestly to -__%.[27] Since 1994, the area affected by forest fires has increased.

Brazil has taken several measures to protect its carbon sinks. In response to international criticism, Brazil modified its forest policy in the 1990s. Phased out were most of the financial incentives for logging in the Amazon, which had been offered under regional development programs. To slow deforestation, pulp and wood-processing industries are required to obtain raw materials from planted forests, a step in the right direction even though enforcement needs to be improved. Lumber exports were prohibited, agricultural and cattle raising subsidies were eliminated, and restrictions on logging and clearing were tightened.[28] Fire prevention and control efforts are being undertaken by a network of local organizations in the Amazon region.

Forest planting projects are taking hold in several parts of the country. In the States of Sao Paulo and Minas Gerais, forest replanting funds, creating from taxes paid by timber consumers, are being used to plant over ten million trees. The area covered by fast growing plantations for industrial purposes is about 5.5 million hectares (cite from WRI draft piece by Salati and Amaral).

Forest policy is still changing. As of 199_, bout 5% of Brazil's total forest area was under some type of protection (FAO). In the spring of 1998 Brazil unveiled an ambitious plan to triple the forest area under protection, bringing protected status to about 10% of the Amazon. Currently, only 3.5% of the Amazon region is protected, with another 16% in Indian reserves. To

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[26]Information from www.mct.gov.br/gabin/cpmg/climate/programa/ingl/energi14.htm

[27]Data Table 11.1, *1998-99 World Resources Report*, World Resources Institute, Washington, DC.

[28]From "Brazil's Pollution Regulatory Structure and Background." David Sharman. World Bank, September 9, 1996. Obtained from www.worldbank.org/nipr/brazil/braz-over.htm.

discourage invasion of the Amazon by landless groups, the government will also stop granting land deeds for new settlements over 100 hectares and will scrap land reform rules that encourage owners to cut down trees.

Brazil has implemented several projects that improve management of the Amazon and other carbon sinks. Several initiatives involve the private sector. For example, in 1995 a National Biological Trust Fund was established that disburses $30 million for biodiversity conservation initiatives.

C.5 ACTIONS THAT EXPLICITLY SUPPORT THE UNFCCC OR CONTROL GHG EMISSIONS

Brazil ratified the UNFCCC in 1994. Since acting as host of the 1992 Earth Summit, Brazil has been a leader among developing countries in raising issues pertaining to sustainable development, including climate change. Recently Brazil proposed creation of a "Clean Development Mechanism" as a vehicle for stimulating investment in climate-friendly development projects.

C.5.1 National Communications

Brazil is preparing its first National Communication to the COP. The communication will contain an inventory of GHG emissions, a general description of steps taken to control these, and other information on policy measures, technologies, and research related to climate change. A further aim is to provide a permanent mechanism for regular periodic updating of the information required for the national inventories.[29]

C.5.2 Global Environment Facility

Brazil has initiated several GEF projects to date. In the energy sector, PROCEL has implemented an energy efficiency project that will support supply-side loss reduction investments; promote integrated supply and demand side management projects; create mechanisms to finance investments in energy efficiency by utilities, consumers and ESCOs; and provide capacity-building to support conservation programs, financial mechanisms, policies, regulations, and standards.

[29]Information from www.Unfccc.de/fccc/ccinfo.bra.htrm last updated 7/14/97. Also from www.mct.gov.br/gabin/cpmp/climate/programa/ingla/energia11.htm

Another energy sector project has set up a public/private consortium to demonstrate biomass integrated gasification gas turbine technology for cogeneration of electricity on a commercial scale. The 30 MW demonstration plant will run on wood chip fuel from plantation forests. It is an outgrowth of a pilot project in Northeast Brazil undertaken to determine the technical, economic, and agronomic feasibility of Biomass Integrated Gasification/Gas Turbine technology using bagasse and sugarcane trash as fuels.

In addition, Brazil has implemented pilot forestry projects whose goal is to protect carbon sinks and reduce GHG emissions by developing alternatives to slash-and-burn agriculture.

Finally, a proposal for a $100 million grant for biodiversity protection is being prepared.

C.5.4 Joint Implementation

To date, there are no completed IJI/AIJ projects in Brazil.

ANNEX D
INDONESIA

D.1 SUMMARY

Indonesia is responsible for less than 2% of the world's total GHG emissions. Although Indonesia may have been a "net-sink" due to the native forest's ability to absorb carbon emissions, it is now a net-source due to a combination of economic growth and poor forest management. In 1997, Indonesia was overwhelmed by a financial crisis which has slowed economic activity and consequently GHG emissions.

During the 1990s, government initiatives related to the reduction of GHG emissions were concerned with establishing capability rather than designing and implementing on-the-ground projects. In 1995, the National Energy Conservation Masterplan (RIKEN) was completed and calls for: energy conservation measures that will diminish the investment needed for new energy conversion facilities; development of a domestic energy services industry; and measures to reduce environmental degradation. A target of 15% energy savings was set for 1999. To date, the only tangible results seem to have come about through Indonesia's demand side management programs such as the promotion of compact fluorescent lamps.

Importantly, progress has been made in the power sector, where the government has taken steps to reduce dependence on fossil fuels. In 1997, the Plan for New and Renewable Energy Development was created to promote use of geothermal, hydro, solar, wind biomass, and nuclear energy sources. Furthermore, the national utility's small power purchase program emphasizes and offers incentives for the use of renewable energy.

The current financial crisis, which has now affected much of the globe, is likely to have both positive and negative implications for the environment generally, and for climate change efforts in Indonesia, specifically. Price reform measures have not been instituted nearly as quickly as was hoped due to continuing political unrest. Furthermore, oil commodities, for example, are still being paid for in Rupiah despite the currency's staggering depreciation which means that Indonesia is still paying a lot for oil whose dollar-denominated prices have dropped. In terms of providing competitive power production, attention to the promotion of IPPs and the privatization process has fallen by the wayside. These factors, are playing a role in Indonesia's current inability to achieve the kind of financial stability and political transparency that is necessary for the development and successful implementation of programs aimed at the environment. On the bright side, it is likely that energy conservation programs will be more viable as real incomes have dropped because, unlike during the boom years, energy bills will constitute a much larger

percentage of income. The responsibility of promoting renewables and the use of natural gas, rather than oil and coal, will fall entirely upon government subsidies and bilateral/multilateral assistance. During this time of crisis, environmental benefits are likely only to be the result of cost-efficiency measures aimed at putting the economy back on its feet. True long-term, sustainable practices may be implemented but only if they are considered fiscally wise.

D.2 BASELINE CONDITIONS AND TRENDS

In 1990, transportation, industry and electricity production were most responsible for contributing to Indonesia's GHG emissions (see Exhibit D-1). Fossil fuel production (particularly LNG) and the manufacturing and construction industries have also played an increasingly significant role in the emission of GHGs.

Exhibit D-1
National GHGs Inventories, 1990

GHG Source & Sink	CO_2	CH_4	N_2O
All Energy Sources	**140,102.44**	**1,886.21**	**81.79**
Fuel Combustion	140,102.44	2.42	81.79
Energy & Transformation Industries	53,207.37	0.19	79.35
Electricity & Heat Production	22,184.64	0.14	79.35
Petroleum Refining	9,391.32	0.0024	0.000012
Solid Fuel Transformation & Other Energy Industries	21,631.41	0.05	0.00056
Industry	32,073.94	0.87	2.44
Transport	34,917.64	0.0045	0.002
Small Combustion in Residential & Commercial	19,903.50	1.36	N/A
Fugitive Emissions	—	1,883.79	—
Solid Fuels	—	32.61	—
Industrial Processes	**17,900.50**	—	—
Net Emissions	158,002.98	1,886.21	81.79

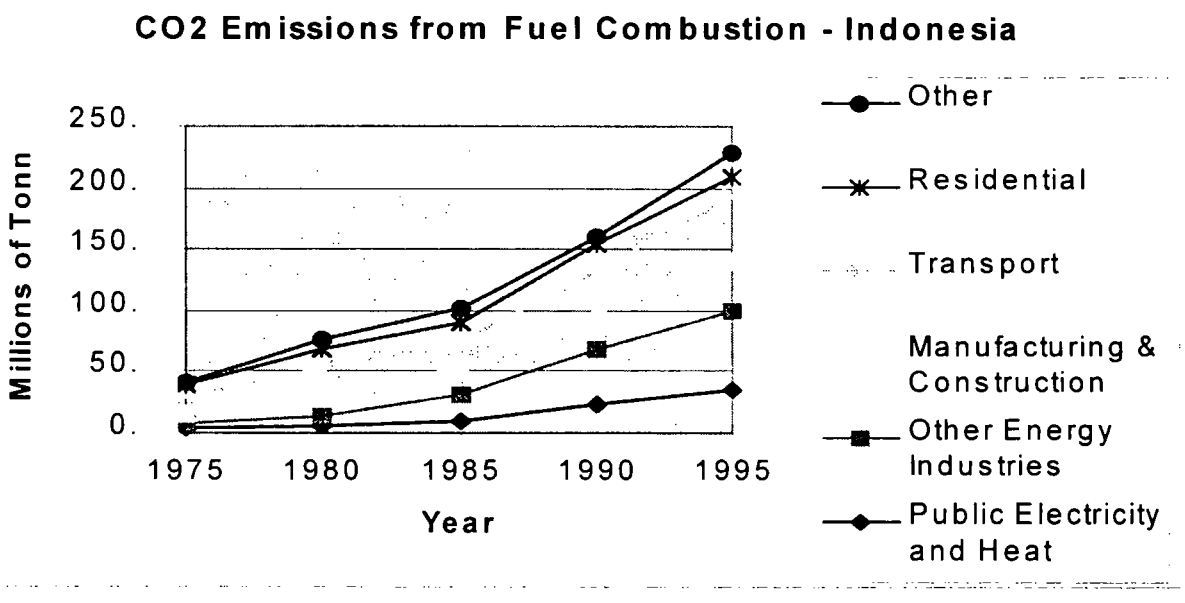
Source: ALGAS, 1997

Near term GHG growth from these and other sectors has slowed due to the economic crisis. Indonesia's economy was once among the most robust in Asia; however the events of the past 12 months will have complex direct and indirect implications for the future of trade and energy. Indonesia's GDP dropped at an annual rate of 12.2% during the first half of 1998 and poverty rates have risen to their mid-1970's levels. Over 17% of the workforce are unemployed, inflation

shows no sign of easing, and at least one fifth of the population faces a critical food shortage. A fourth agreement with the IMF focuses on emergency measures, an agreement that encouraged the government to issue yet another draft budget. The economy is expected to experience further contraction over the next two years and the GDP is expected to fall by 15% this year, to be further compounded by a 2.3% slide in 1999.

In the context of climate change, this economic contraction may come to be seen as a real benefit. While Indonesia was growing at unbridled rates, CO_2 emissions from fuel combustion rose to nearly 75 million tonnes from 1990 to 1995. Not surprisingly, the residential, transport, and building and manufacturing sectors dominated carbon emissions as shown in Exhibit D-2, below. But construction and development have come to a virtual standstill, providing an opportunity for Indonesia to assess its previous carbon output and remedy potential causes prior to continuing commercial development.

Exhibit D-2



Source: IEA Statistics, "CO2 Emissions from Fuel Combustion", OECD, 1997

The table below demonstrates measures the government is taking to combat the high emission rates in all major sectors.

NATIONAL ENERGY CONSERVATION PROGRAM

Information

1. Energy saving campaigns through mass media to increase awareness, motivation, and willingness to save energy in the industrial, transportation, and household sectors.
2. Energy saving information to increase understanding of energy users of the methods of energy conservation.
3. Energy conservation training to increase technical knowledge of energy conservation to energy managers, auditors, and employees.
4. Education aimed at younger generations aired on national television programs.
5. Award program for individuals, groups, and enterprises that are voluntarily active and successful in energy conservation, in order to motivate participation.
6. Pilot projects to demonstrate effective energy-saving technologies, equipment, and systems.

Incentives/Disincentives

7. Tax relief to encourage the use of energy efficient equipment.
8. Import duty exemptions for energy efficient equipment for the industrial, commercial, and transportation sectors.
9. Soft loans to increase the financial attractiveness of energy conservation of energy conservation measures.

Regulation

10. Energy managers appointed to achieve well planned, directed, and controlled energy use.
11. Energy audits to identify energy saving and cost reduction potential of energy conservation efforts.
12. Energy consumption monitoring to analyze the ongoing development of both consumption and efficient use of energy.
13. Energy intensity targets for the industrial sector production of unit goods and services.
14. Energy saving designs required in feasibility studies for establishment or extension of a building.
15. Energy Efficiency Standards for equipment, appliances, and vehicles.
16. Energy saving products manufactured and labeled for consumers.
17. Vehicle testing for both public and private vehicles.
18. Land transportation system improvement including traffic management, public transportation systems, and road facilities.

Energy Pricing

19. Economic price for energy to increase efficiency and provide opportunities for alternative energy.
20. Adjustment of tariffs for electricity automatically to accommodate changes in value of factors influencing the energy economy.

Source: Rencana Induk Konservasi Energi Nasional (RIKEN), 1995.

D.3 BROAD ECONOMIC REFORMS AFFECTING GHG SOURCES AND SINKS

In response to Indonesia's devastating political and economic crisis, the government has introduced several reform measures. Perhaps one benefit of the political crisis is the resulting transparency of the government which, in turn, has contributed to the speedy implementation of reform programs. Although such reforms are not directed at GHG emissions, some may reduce net emissions indirectly:

- Privatization of state-owned companies such as PERTAMINA and PLN.[1]

- Promotion of natural gas use in all energy-use sectors such as power generation, transportation, industry and residential. Gas prices are currently high in Indonesia due to a lack of distribution infrastructure but have the potential for becoming more competitive.

[1] Sasmojo, S, Tasrif, M. 1998, *Persoalan Mendasar yan perlu diatasi dalam Menegakkan Tatanan Sistem Energi Nasional yang Lebih Tangguh.* Paper presented at the Symposium titled, "Search for New Directions for the National Energy System Management," Bandung, 31 July 1998.

- Promotion of energy efficiency through a new labeling scheme, lower taxation on energy efficient appliances, and a nationwide campaign for efficiency and conservation. Though the labeling of household appliances has yet to be implemented,[2] RIKEN (Rencana Induk Konservasi Energi Nasional) and the Ministry of Mines and Energy are working under the support of the Asian Development Bank to develop an institutional base for "eco-labeling" activities in the future.

- Detailed policy changes in the forestry sector have (a) increased the transparency of the forest concession licensing process; (b) resulted in the revocation of collusive forestry permits; and limited forest exploitation.[3] Detailed policy changes were published by the Ministry of Forestry in June 1998 when the document was made public.

PLN Small Power Purchase Program

Increasing private sector participation in the power sector as well as creating a sustainable and efficient small power market, is an explicit policy goal of the GOI. In August 1995, Perusahann Listrik Negara (PLN), or the State-owned power company, and the Directorate General of Electricity and Energy Development (DGEED), with advice from the World Bank, reached agreement on a concrete program designed to realize this policy objective. The program commits PLN to the annual purchase of electric power from small producers, with particular emphasis on renewable energy.

This small power purchase program, the PSKSK (Pembangkit Skala Kecil Swasta dan Koperasi) initiative, aims to increase the volume of small power transactions in the market via a simple, transparent mechanism incorporating: (a) a published purchase price not to exceed PLN's avoided cost; and (b) a standard power purchase contract to be applicable to all transactions.

DGEED and PLN published the initial PSKSK tariff in January of 1996. The tariff is open to all power project types, but renewable projects must comprise at least 75% of all participants. Special incentives are offered to renewable energy projects, including a 100% receipt of avoided capacity, as opposed to the 75% receipt of avoided capacity by fossil fuels. Letters of Award have been issued for a total of 281 MW of new capacity while power purchase agreements (PPA) are being signed between PLN regional offices and small power developers. These projects are

[2] DGEED, *Rencana Penerapan Labelisasi Energi pada Peralatan Listrik Rumah Tangga,* Directorate General of Electricity and Energy Development, Ministry of Mines and Energy, 1998.

[3]
- Playing with Fire: The Accused Companies, JAKARTA POST, October 4, 1997
- *Pengusaha yang bakar hutan dicabut izinnya,* KOMPAS, pp 154, Wednesday, July 1, 1998
- *Digugat, tiga perusahaan pembakar hutan, KOMPAS,* Tuesday, February 10, 1998.

divided as follows: hydroelectric (59%), biomass-fueled (25%), and geothermal (16%). Approved projects are seeking necessary GOI permits and commercial bank financing.

PLN Demand-side Management Pilot Programs Project

The objective of this project is to design, implement, and evaluate demand-side management (DSM) programs for PLN in the residential, commercial and industrial sectors. The extent to which DSM can improve PLN's financial performance and serve as an economically least-cost power sector resource will be determined by the pilot program's implementation results.

The industrial/commercial programs will emphasize load management, power marketing, and customer retention. Evaluation of market research and customer, substation and feeder data was completed in early 1997. The program envisioned the development of "resource acquisition contracts" (RACs) for curtailable load and captive generator dispatch and the provision of incentives to participants consistent with the Small Private Power Purchase framework which was approved by the GOI.

The residential programs will provide for the dissemination of compact fluorescent lamps in R-1 (450 VA limited) households through direct retrofits, direct installation at the time of wiring new connections, vendor-administered lamp subsidy programs, and subsidized sales through PLN payment points. Evaluation of the market research study covering 830 urban and rural households in five regional areas (wilayahs) of PLN was completed and the proposed program design prepared in early 1997. The program plans to help reduce R-1 subsidies and reduce peak demands, which are primarily driven by residential lighting loads.

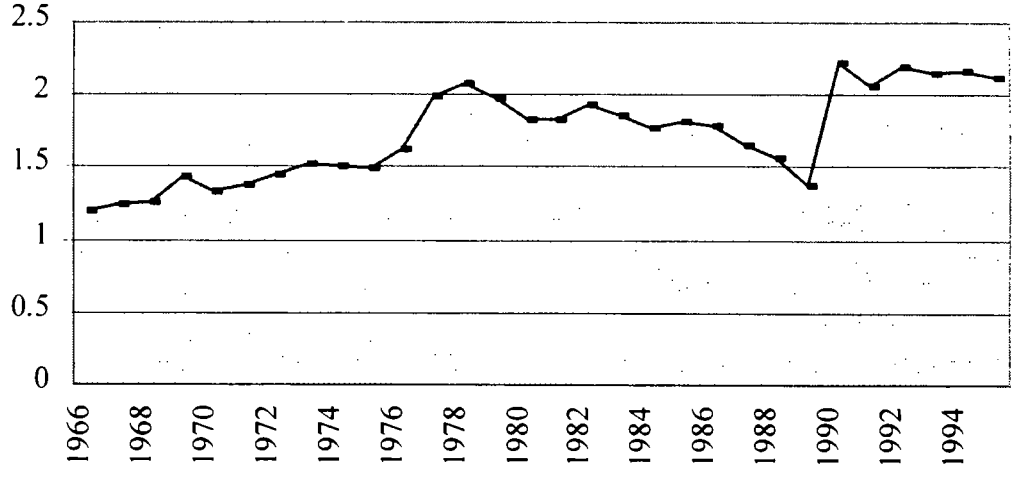
D.4 SECTOR SPECIFIC ACTIONS AFFECTING GHG SOURCES & SINKS

Energy Conservation
RIKEN

Compared to other ASEAN countries, energy intensity is likely to remain high as Indonesia's economic structure changes from agricultural to industrially dominated. Exhibit D-3 below, illustrates Indonesia's industrial CO_2 intensity for a nearly 30-year period.

Exhibit D-3

CO_2 emissions intensity (kg per 1997 US$ of GDP)



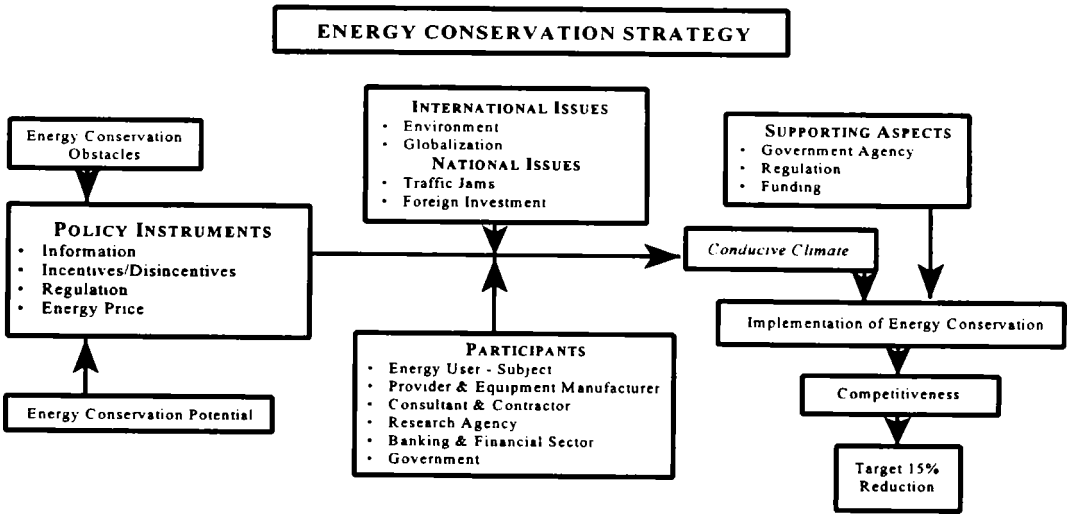
In 1993, the National Policy Guidelines outlined a national energy policy that included measures for energy intensification, diversification, and conservation. The Rencana Induk Konservasi Energi Nasional (RIKEN), or National Energy Conservation Masterplan, was completed in 1995 to encourage the timely implementation of energy conservation activities in Indonesia.

The RIKEN provides energy conservation measures to deal with high energy intensity to (a) reduce needed investment to build new energy conversion facilities; (b) develop a domestic industry of energy efficient goods and services; and reduce environmental degradation. The potential for energy conservation was established via energy audits to be 15-30% for industry, 10-30% for the residential and commercial sectors, and up to 25% for the transportation sector. As shown below, an energy conservation target rate of 15% by 1999 was set.

The RIKEN describes twenty activity measures (Exhibit D-4) and provides specific energy conservation initiatives that are divided between policy instruments and targeted energy-use sectors (industry, commercial, transportation, and residential). The second portion of the Energy Conservation Program provides implementation guidelines, which specify activities, targets, and schedules for each of seventeen related institutions, including the Ministries of Mines & Energy, Industry, Transportation, and Forestry.

Reducing Fossil Fuel Use in Industry

Exhibit D-4



Fuel oil is the single most used energy source in industry. Industry also consumes a considerable amount of final energy (38% of total national consumption at the end of REPELITA V (plan 5)). During Plan 6, the demand for fuel oil by the industrial sector rose 9%, however, so too did the demand for other energy sources (see Exhibit D-5).

Exhibit D-5
Estimates of Energy Needs for Industry During REPELITA VI (MMBOE)

	1994/95	1995/96	1996/97	1997/98	1998/99
Fuel Oil	72.77	68.84	77.30	86.81	95.99
Geothermal	28.41	32.12	38.17	45.75	49.29
LPG	1.41	1.53	1.60	1.68	1.76
Coal	19.65	24.21	30.63	39.29	58.93
Electricity	23.57	29.66	32.58	35.91	39.26
Total	**145.81**	**156.36**	**180.28**	**209.44**	**245.23**

Source: Directorate General of Electricity and Energy Development (1994).[4]

[4] 1994, REPELITA VI, Energy and Electric Power Sector, Ministry of Mines and Energy, Directorate General of Electricity and Energy Development (DJLPE), Jakarta, Indonesia.

The government is promoting clean and efficient energy use in non-energy industries and the commercial sector which contribute roughly 10% of total GHG emissions in Indonesia. The following actions are being taken:

(1) *A mandatory energy audit for companies that fall into the category of high GHG emitters.* The government is committed to developing a highly energy efficient industrial sector and will introduce a mandatory regulation that will require various industries to undergo an energy audit as part of a government feasibility study. This regulation has been drafted by the Ministry of Trade and Industry in collaboration with the Ministry of Mines and Energy and will be jointly reviewed with industry associations to determine means of implementation.

(2) *The promotion of efficient, clean production.* This measure is intended to help industries save energy and material, while also reducing GHG emissions. This effort to promote clean production was initiated by the *Environmental Impact Management Agency (BAPEDAL)* in 1994 which was followed by a joint forum in 1996 called *the Roundtable Conference on Production Efficiency Through Pollution Prevention (KMB-EP3).* The conference included members of the public and private sectors, NGOs, independent consultants and academics and was successful in introducing the relatively new concept of clean production. The Ministry of Trade and Industry will further support the promotion of clean industrial production by encouraging the development and application of related new technology. The Ministry of Trade and Industry, will receive assistance from The Agency for the Assessment and Application of Technology (BPPT), research universities, and other non-governmental research agencies in further developing clean production technology.

(3) *Introduction of initiatives focused on mitigating climate change.* Some ideas include: Catalytic Oxidation, CO_2 Recovery, Selective Non-Catalytic Reduction (SNCR), Combustion-Air Preheat, Low NOx Burner (LNB), Selective Catalytic Reduction (SCR), and Disposal. Other options use variable speed motors and the co-generation of heat and power for captive power, as motor appliances dominate the industrial sector. There exists tremendous energy saving potential if proper motor use is implemented, particularly if the assumption that motors consume 75 percent of total industrial electricity is accurate. If the government of Indonesia is truly committed to motor-related energy efficiency, all ordinary motors will be replaced by variable speed motors and all new motors installed after the year 2000 will be required to use a variable speed motor or equivalent. By 1995, variable speed motors already accounted for 10% of total motor installations. Assuming recent potential is realized, 25% of all motors could be variable speed models by the year 2010, increasing to a 50% share by 2020. Utilizing variable speed motors can significantly reduce electricity consumption. Ordinary motors that have an average use of 20 hp (availability of 60%, 5256 hours p.a., capacity factor of 80%), and a load factor of 60% require 37.64 MWh p.a. of electricity. However, utilizing variable speed motors under the same conditions will reduce electricity consumption by 12%, down to 33.20 MWh p.a.

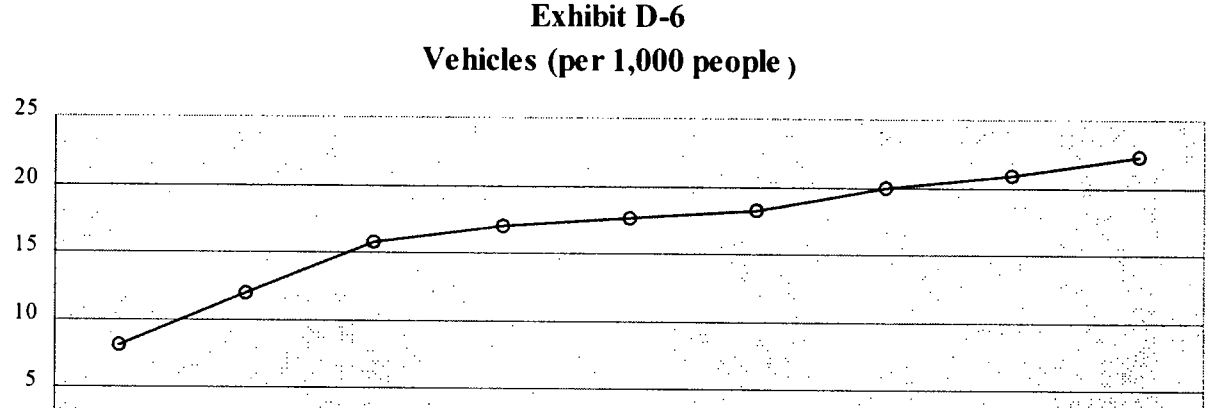
Reducing Fossil Fuel Use in Transportation

Transportation is the second largest GHG emissions source after industry (ADB, 1994) and was responsible for around 37% of total energy consumption at the end of REPELITA V. Energy demand (dominated by fuel oil) during REPELITA VI from the transportation sector increased at a rate of about 9% per year.

The transportation sector emitted 34,917 Gg of CO_2 in 1990, accounting for 21.3% of total energy sector emissions. The transportation sector is largely responsible for air pollution and loss of productivity due to traffic congestion (particularly in Jakarta). Furthermore, as evidenced in Exhibit D-6, vehicular ownership rates nearly quadrupled in the years between 1980 and 1996. In response, the State Ministry for the Environment has initiated a Blue Sky Program (*Program Langit Biru*), which is aimed at controlling air pollution. The measures to reduce transportation sector GHG emissions are twofold. First, the government plans to develop the public transportation infrastructure and encourage commuters to make use of it, easing traffic congestion. Second, the government intends to internalize emission costs via levies and incentives.

One method the government is using to reduce vehicular emissions is to shift its policy focus toward the development and promotion of an electric train infrastructure. Comparatively speaking, electric trains emit far less GHGs than vehicles such as buses and individual cars. As a result, the Ministry of Transportation intends to center its transportation development policy around the building of electric trains rather than the development of a vehicle-centered infrastructure and conduct public campaigns that promote the use of electric trains. The first step

Exhibit D-6
Vehicles (per 1,000 people)



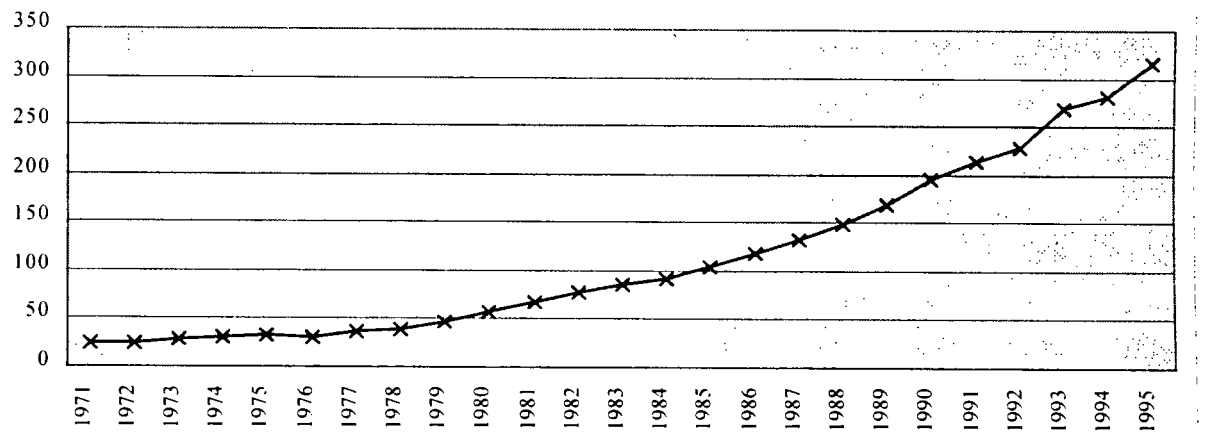
was scheduled to begin in mid 1998, but construction has been postponed indefinitely due to the financial crisis. Road pricing schemes will also favor the use of electric trains, using levies to cross-subsidize the cost of development and maintenance.

In addition to a government focus on electric train transportation, comfort, reliability and efficiency of existing public transportation are issues of top priority. The Ministry of Transportation, and the government at both the provincial and sub-provincial level, are working together with both public and private-sector transportation companies to find ways to gradually increase the capacity of public transportation. One immediate measure is the addition of new buses to Indonesia's large public fleet in Jakarta and Bandung. Utilizing available public transportation and carpooling will also be strongly encouraged by government plans to increase toll road prices during peak rush hours. For the Blue Sky Program to be successful however, the government will also enforce measures to reduce vehicular emissions. Proposals include the imposition of a mandatory smog check upon payment of annual vehicle taxes and the promotion of clean fuels. The Jakarta City government has initiated a program called "Segar Jakarta!" (My Fresh Jakarta!) which aims to reduce dangerous emissions via clean fuel use. The government is sponsoring development of low GHG transportation fuels: Compressed Natural Gas (CNG) Vehicles, the Ethanol Vehicle, and Fuel Cell Vehicles (FCVs).

Reducing Fossil Fuel Use in Power Production

Reducing the GHG intensity of power production is critical because per capita demand has been steadily increasing. As shown in Exhibit D-7, 1971 produced a mere 25 per capita kWh figure. By 1995 per capita consumption had increased to well over 300.

Exhibit D-7
KWh per Capita



Electricity is generated in Indonesia using: hydropower, coal, natural gas, geothermal or fuel oil. Installed capacity of electricity using fuel oil during the period from REPELITA I to REPELITA V was the highest and the use of coal, natural gas, and geothermal energy for electricity began in REPELITA III. Natural gas use for electricity in REPELITA V increased significantly compared to other sources with an annual rate of natural gas use of 55.7%, while other sources totaled less than 12.3%. In REPELITA I; however, production of electricity from fuel oil accounted for 60%, while hydropower comprised the remaining 40% of total production.[5] Exhibit D-8 below provides a summary of electricity generation by energy source and Exhibit D-9 illustrates the percent of total electricity production by fuel source.

Exhibit D-8
Electricity Generation by Energy Sources (GWh)

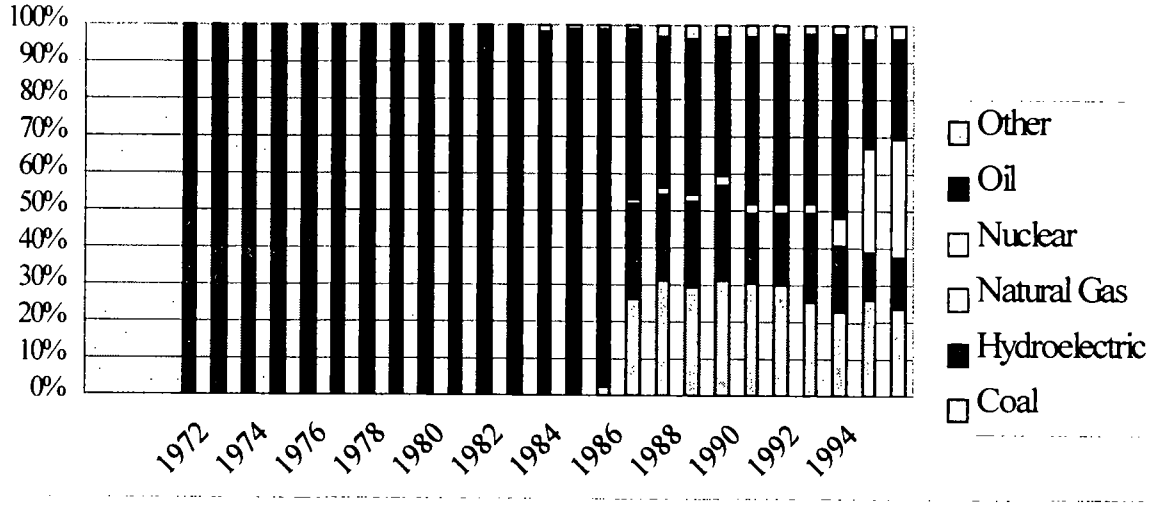
Year	Hydropower	Coal	Natural Gas	Geotherma l	Fuel Oil	Total
1968/69	757.4	0.0	0.0	0.0	624.4	1,381.8
REPELITA I	3,831.5	0.0	0.0	0.0	5,063.8	8,895.3
REPELITA II	5,857.3	0.0	0.0	0.0	12,140.6	17,997.9
REPELITA III	7,541.9	0.0	113.0	287.0	37,162.9	45,104.8
REPELITA IV	19,726.9	17,347.6	1,667.0	2,404.2	53,015.5	94,161.2
REPELITA V	34,403.2	54,039.1	10,738.9	5,470.9	86,094.6	190,746.7

Source: Directorate General of Electricity and Energy Development (1994)[6]

[5] Sumiarso, L. 1998. *Identifikasi Arah Baru dalam Pengembangan Sub-Sektor Tenaga Listrik.* Paper presented at the Symposium titled, "Search for New Directions for the National Energy System Management," Bandung, 31 July 1998.

[6] 1994, REPELITA VI, Energy and Electric Power Sector, Ministry of Mines and Energy, Directorate General of Electricity and Energy Development (DJLPE), Jakarta, Indonesia.

Exhibit D-9
Electricity Production by Fuel Source in Indonesia

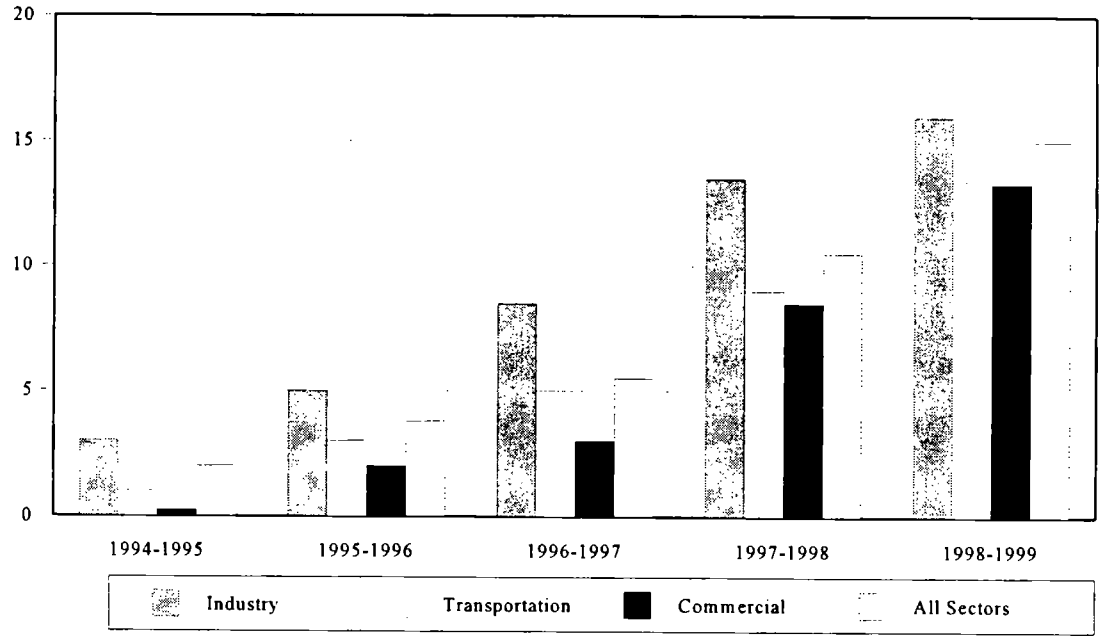


With regard to non-fossil fuels, Indonesia has 75 GW of hydropower and 16 GW of geothermal power. According to official data from the Ministry of Mines and Energy, Indonesia's potential geothermal energy reserves could support the operation of power plants with a capacity of 19,658 MW, compared to the mere 1,000 MW of total capacity for existing plants. In April 1996, the Ministry of Mines and Energy announced its support of a joint venture between PT Aneka Tambang (state-owned general mining firm) and PT Tambang Timah (state-owned tin company). The new geothermal station is known as PT Geothermal Indonesia. This and other joint ventures is seen as a new means by which to realize energy efficient practices.

RIPEBAT

In 1993, the National Policy Guidelines outlined a national energy policy that included measures for energy intensification, diversification and conservation. In accordance with and pursuant to this policy of increasing energy diversification, the Plan on New and Renewable Energy Development (RIPEBAT) was created in 1997. The RIPEBAT calls for the utilization of non-fossil fuel energy sources such as geothermal, hydro, solar, wind, biomass, and nuclear, the potential of which has yet to be realized in Indonesia. It is planned that renewable energy will be used in rural or isolated areas, primarily in the eastern part of Indonesia where 80% of the region receives its source of electricity from PLN and the remainder from renewables. There is no English version of the RIPEBAT to date, but Exhibit D-10 presents expected energy savings rates in the major sectors in the event that NRE use displaces fossil fuel use.

Exhibit D-10
Expected Energy Savings



Natural Gas

Indonesia has proven natural gas reserves of 109 Tcf. In 1995, Indonesia produced an estimated 5.5 billion cubic feet per day (Bcf/d) of gas. About 60% of this output was used for the production of liquefied gas (LNG). Gas consumption is expected to rise from 2.2 Bcf/d in 1995 to almost 9 Bcf/d by 2000 as the nation attempts to reduce its reliance on oil while also planning for the expansion of its gas distribution network.

Highly limited accessibility to Indonesia's natural gas reserves has resulted in the inability to meet domestic demand. High distribution and transport costs compound the situation, keeping the development of the resource economically unfeasible. These issues have not discouraged Perusahaan Gas Negara – PGN (State Gas Company) however, which has initiated short, medium, and long-term development plans for natural gas distribution and utilization for power generation and industrial activities.[7]

Reducing Fossil Fuel Use in the Residential & Commercial Sectors

[7] Tjandranegara, A.Q. 1998, *Peningkatan Pemakaian Gas Alam di dalam negeri untuk Mengurangi Beban Subsidi BBM.* Paper presented at the Symposium titled, "Search for New Directions for the National Energy System Management, Bandung, 31 July 1998.

Residential Sector. There is considerable potential within the residential sector for GHG abatement. Implementation of demand-side measures is expected to increase energy savings and reduce emissions created during transmission, distribution, and transformation. Exhibit D-11 illustrates household energy use, while Exhibit D-12 shows GHG emissions from fuel-combustion activities in both the commercial and residential sectors.

Exhibit D-11
Estimates of Energy Needs for Household During REPELITA VI (MMBOE)

Type of Energy	1994/1995	1995/1996	1996/1997	1997/1998	1998/1999
Fuel Oil	60.14	57.14	55.02	53.35	53.59
Geothermal	0.06	0.08	0.10	0.11	0.13
LPG	3.29	3.57	3.73	3.92	4.12
Coal	1.90	7.40	11.80	15.90	18.20
Electricity	14.04	16.00	18.08	20.41	22.99
Total	**79.43**	**84.19**	**88.79**	**93.69**	**99.03**

Source: Ministry of Mines and Energy (1994)

Exhibit D-12
1990 GHG Emission from Fuel Combustion Activities in Residential and Commercial Sectors

Fuel Type	Consumption	CO_2	CH4	N2O
Kerosene	269.82	19,197.12	1.35	N/A
LPG	11.12	693.61	0.012	N/A
City Gas	0.23	12.76	0.00032	N/A
Total	**281.71**	**19,903.50**	**1.36**	**N/A**

Source: ALGAS (1997)[8]

In the residential sector some efforts have included:

- Substituting conventional ballasts with electronic ballasts of fluorescent lamps
- Substituting incandescent light bulbs with compact fluorescent lamps (CFL)
- Substituting kerosene lamps with solar home systems (SHS)
- Improving refrigeration efficiency

[8] ALGAS, 1997, *Mitigation Options for the Energy and Non-energy Sectors: Indonesia Case,* Technical Report of Task B-3.

- Improving air conditioning efficiency
- Substituting kerosene stoves with LPG stoves.

The government is actively promoting the use of alternative energy sources such as briquette fires for cooking and natural gas for electricity. Unfortunately, the development of a complex infrastructure is necessary to meet the demand for natural gas; a demand that is being satisfied by fossil fuels.

Commercial Sector

There have been efforts to study energy efficiency potential in the commercial sector (offices, hotels, hospitals, shops, restaurants and entertainment centers) for many years in Indonesia. One relevant example is an energy audit and study that was conducted by the Research Agency of the Bandung Institute of Technology and BPPT Energy Laboratory (LSDE). Their combined research demonstrated that:

- Public buildings, such as hospitals, demanded energy in the following manner: air conditioning (57%), lighting (19%), utilities (16%), and laundry systems (3%)

- Energy demanded office buildings resulted in the following breakdown: air conditioning (56%), utilities (17%), lighting (15%), transportation (15%), and all other energy consumption units (3%).

- Hotel energy consumption was dominated by air conditioning (49%), followed by utilities (19%), lighting (17%), transportation (8%), other (5%), and laundry systems (2%).

Development of clean biomass energy sources, coupled with a reduction in government subsidized fossil fuel production has also been a reform priority in the commercial sector. Several biogas generation projects have been under implementation for over 10 years on dairy farms in Boyolali, Central Java, West Java, and Pangalengan. In Boyolali, for example, there are nearly 100 biogas reactors in which methane is produced and used for meat drying and cooking activities. In 1996-1997, Institute Teknologi Bandung (ITB) conducted a pilot project in Pangalengan to determine whether gas produced from manure could be packaged for local use. Project results showed that the 33 m3 biogas reactor is capable of generating 20 m3 methane/day under STP.[9]

Lighting

[9] Adisasmito, S. *Biogas Rumah Tangga dan Pedesaan.* Paper presented at the Seminar Nasional Iptek dan Seni, Cisarua, Indonesia, 1996.

Energy consumption for lighting in commercial buildings accounts for about 15-19% of total energy consumption in this sector. A number of energy saving lighting controls are now available, such as multi-level switches, timers, photocell controls, occupancy seniors and daylight dimming systems. In compliance with Indonesia's emissions reduction efforts, there is potential for the following:

- 60% of the electronic ballast share could be replaced by magnetic ballasts.
- 80% of incandescent lights could be replaced by CFLs by 2020
- 40% of CFLs could have reflectors and control systems.

Air Conditioning

Air conditioning is responsible for roughly 53% of the commercial sector's energy consumption. The GOI has determined that air conditioning systems can be made more efficient through improved internal equipment insulation; larger heat exchangers; higher evaporation temperatures; variable speed compressor motors to reduce on-off cycling; more efficient rotors and compressors; advanced refrigerants; and more sophisticated electronic sensors and controls. Efforts to improve technology in the future could result in a 30-50% reduction in air conditioning electricity consumption.

Protecting Carbon Sinks

Forest

The protection of forests (carbon sinks), which absorb a significant amount of CO_2, is challenged by the results of poor forest management such as forest fires, deforestation and change in land-use. According to a 1997 ALGAS study, Indonesian forests provide a sink that absorbs CO_2 at the rate of 686,790 Gg annually with forestry sector activities contributing the highest amount of CO_2 emissions (42.5% of Indonesia's total GHG emissions) as compared to other sectors.

Indonesia's natural forest area totals 141.8 Mha and is divided into five categories (Ministry of Forestry 1992): protected forest (29.6 Mha); preserved forest (19.2 Mha); limited production forest (29.6 Mha); regular production forest (33.4 Mha); and convertable forest (30.0 Mha).[10]

Continued land-use change (deforestation) will compound already substantial GHG emissions. Poor management and population growth stands to further threaten Indonesia's vulnerable forests, calling the country's historic net-sink status into question. In 1991, when the U.S. Food

[10] Departemen Kehutanan, 1996, Statistic Kehutanan Indonesia 1994/1995. Biro Perencanaan, Departemen Kehutanan, Jakarta, Indonesia.

and Agriculture Organization (FAO) first recognized Indonesia as a net-sink, it also conducted a study of the rate of deforestation, whose results are shown below.

Exhibit D-13
Rate of Deforestation in Indonesia

Activities	Rate (ha/year)
Development of estate crops	160,000
Transmigration	300,000
Shifting Cultivation	300,000
Forest Fire	100,000
Other reason (spontaneous transmigration, illegal lodging, mining, urban development, etc.)	77,000
Total	**937,000**

Source: FAO (1991)

The exploitable area of Indonesia's natural forest totals 108.57 Mha[11] of which 60 Mha could potentially be managed for wood harvesting. The following threats; however, make determining and following GHG emission rates a constant challenge.

- Forest fires resulting from forest clearing, present a formidable threat to Indonesia's sink capacity. Currently, mitigation policies in the forestry sector call for preventing forest fires through better preparatory measures, replenishing thinner forest areas, and reforestation activities in various urban areas.

- Land-use change, exemplified by a shift from forest to plantation contributes an inordinate amount of GHG emissions.[12] In order to accommodate plantation development, large sections of forest must be burned. These "clearing" methods were banned by the government in 1995; however, weak local enforcement led to what became one of Indonesia's worst forest fires ever in 1997. In response, the government implemented several new measures that, for example, require forest concession owners to be solely responsible for the reforestation process. Non-compliance results in heavy fines, which will ultimately be used to replenish the forests anyway. Strict punitive measures will also be taken against any local authority with knowledge of future criminal activity related to the destruction of forested areas.

[11] Indonesian Forestry Action Programme, 1991.

[12] USEPA Indonesia Country Study Program, 1996, *Inventory of Greenhouse Gas Emissions and Sinks in Indonesia,* The State Ministry of Environment, Jakarta, Indonesia.

Not only are these and other factors leading to an increase in GHG emissions, but a change in forest area is reducing the sink's ability to absorb emitted carbon. Indonesia's forests are second only to China in total land area and accounted for nearly 24% of Asia's forests in 1990. By 1995, Asia's total forest area decreased by 16,640 (thousand ha.) and, again, Indonesia's loss constituted more than 25%.

El Nino played a major role in stoking the 1997 forest fire that ravaged much of Indonesia's natural forest. Its magnitude forced the government to seriously consider preventative measures for the future. Currently, the Ministry of Forestry is collaborating with various provincial governments to replenish burned forest area. Assuming financial support continues, it could take up to 50 years to satisfactorily reforest damaged areas. Already scientists have identified the best trees, if planted in existing soil with expected rainfall, for reforestation; a process that could even exceed 50 years.

The government's commitment to the reduction of GHGs extends well beyond the immediate forest borders. It has been determined that air quality in urban areas will improve subsequent to the planting of trees which urged the government to implement the *Program Sejuta Pohon* or "One Million Trees Program" which is a rather straightforward initiative to increase tree planting activity in large urban areas. This trend can be seen on a much larger scale as Indonesia's afforestation effort develops. It has been determined by forestry experts that reforestation alone cannot shoulder the burden of GHG emissions. Simultaneously, the government has been working to develop agroforestry methods as well. It is expected that proper agroforestry methods will yield sustainable benefits and reduce the deforestation process. Trees that dominant the agroforestry sector include rubber, coconut and oil palms, and the wood of old trees, which is usually used as fuel for cooking.

Another protective measure is the prohibition of logging in both protected and conservation forests. These two categories of forest still maintain a perfect source/sink balance, making any protection efforts critical to keeping Indonesia's total emissions relatively low. The success of this activity has been enhanced by certain forest harvesting restrictions. One example prohibits the harvesting of any tree under 50cm in diameter, a restriction that goes further to provide that if trees with a diameter of 25cm or greater number fewer than 25% of the total population, even those that are larger than 50cm may not be cut.

In summary, the Indonesian government has designed some good forest management programs but many efforts to reforest and implement protective and preventative measures are currently at a standstill. There is tremendous potential to improve the forest's sink capacity but very few financial resources with which to realize it.

Agriculture

The agriculture sector has a relatively low capacity for absorbing GHGs due, in large part, to rice cultivation, which emits methane (CH4). Areas that demand immediate attention due to their high emissions of CH4 include: East, West and Central Java as well as South Sulawesi and North Sumatra. The focus in these regions is on emissions reduction through the advancement of irrigation and seeding technology.

D.5 ACTIONS TO SUPPORT THE UNFCCC OR CONTROL GHG EMISSIONS

National Action Plans

As discussed earlier, Indonesia's Climate National Action Plan focuses on forestry, agriculture, transportation, energy and international cooperation. Indonesia's plans, in theory, are quite ambitious, but the process of implementing them has already encountered some serious obstacles. The country is so preoccupied with simply addressing the economic crisis, that there is little time and resources available for climate change considerations. Still, the government hopes to take the following steps in the sections outlined below:[13]

Forestry

- Review and revise present forest and land management policies
- Prevent the occurrence of forest fires through better preparatory measures
- Replenish forests in rural areas and replant trees in urban areas.

Agriculture

- Promote agricultural practices that contribute the least amount of GHG emissions
- (Long-run goals) Promote consumption of staple foods other than rice and high methane-emitting crops.

Transportation

- Promote use of public transportation
- Implement road-pricing in regularly congested areas
- Control vehicle emissions and promote use of clean fuel.

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[13] ▸ 1998, *National Action Plan on Climate Change: A Guiding Document,* The State Ministry for the Environment, Jakarta, Indonesia.

▸ 1997, *Independent NGO Evaluations of National Plans for Climate Change Mitigation: OECD Countries,* Fifth Review, Coordinated by the Climate Change Network Europe with assistance from the US Climate Action Network.

Energy

- Gradual removal of energy market distortions such as fuel and electricity subsidies
- Promote use and development of renewable energy
- Encourage public adoption of energy efficiency and conservation
- Promote clean and efficient energy use for industry and commercial sectors
- Price restructuring for various energy sources.

National Communications

The idea of a National Communication tool was introduced by the Global Environmental facility (GEF) and initially mentioned at the Kyoto Protocol under article 10-12. Development of the program is currently in the discussion stage, though future implementation is listed as a top priority. The National Communication tool will employ an electronic database system allowing all interested parties access to information regarding government efforts to deal with climate change and GHG emissions. Furthermore, there is discussion regarding the possible establishment of a Climate Change Institute which will oversee the National Communication database among other responsibilities.

Clean Development Mechanism & Joint Implementation

1.) Regions and projects are being considered and Clean Development Mechanisms (CDMs) are being discussed by the State Ministry for the Environment and National Committee on Climate Change.

ANNEX E
MEXICO

E.1 SUMMARY

Mexico is the world's fourteenth largest producer of GHG emissions (based on 1994 statistics) and accounts for approximately 2% of the total. An inventory of Mexico's emissions compiled by the National Ecology Institute (INE) shows that energy production and consumption are the largest sources of Mexico's greenhouse gases, but that changes in land use patterns and deforestation are also significant.

Because of its status as a developing country, Mexico has not yet made a commitment to reduce its emissions under the 1993 United Nations Framework Convention on Climate Change (UNFCCC), but at the 1997 Kyoto Conference it made a public declaration of its intention to do so. The country has actively participated in international climate change negotiations and it seeks to take a leadership role within Latin America, particularly during the Conference of Parties to be held in Buenos Aires in November, 1998.

In collaboration with the National University of Mexico, INE has analyzed a series of mitigation strategies and studied a number of different energy and non-energy technologies to determine the potential for GHG reductions in Mexico. The next step will be to run pilot tests on these technologies to demonstrate their potential economic and environmental benefits.

Mexico has already acted to implement some measures that will reduce GHG emissions and other sources of air pollution. These include economic reforms such as adjusting energy subsidies to favor cleaner fuels, installing energy efficient technologies, and liberalizing trade policy to allow private participation in power production.

Conservation measures include the summer time change implemented in 1996 and programs to encourage the adoption of energy efficient equipment. One of the most successful programs has been the substitution of compact fluorescent lamps for standard incandescent lighting in buildings and industry. Other effective efforts include outreach and education on energy conservation, stricter emission standards in the transportation sector, reduction fossil fuel in electricity generation, and programs to protect forests as carbon sinks.

E.2 BASELINE CONDITIONS AND TRENDS

As a basis for developing national policies to mitigate GHG emissions in Mexico, the government compiled an inventory of sources and sinks. Among the various CO_2 sources fuel combustion was the largest (68%), followed by forest cleaning (30%) energy production. (See Exhibit E-1, top/down measurement of sinks and sources).

Agiculture and cattle raising represented 42.22% of methane emissions followed by fugitive emission from mining sector (28.53% and waste (14.44%).

E.3 BROAD ECONOMIC REFORMS AFFECTING GHG SOURCES AND SINKS

E.3.1 Reducing Energy Subsidies

Mexico's new Energy Regulatory Commission is currently studying how to phase out most subsidies related to electricity production over the long-term.[1] Although the mission of the Energy Regulatory Commission was originally limited to the electricity subsector, it has grown to include overseeing the liberalization of the growing natural gas market as well. Currently the markets are still heavily regulated, with tariffs determined by a complex set of economic, financial and social considerations.[2]

Despite government price controls, most energy prices have increased significantly since 1990. For example, fuel oil prices for industry have risen from $61/ton in 1989 to $100/ton in 1997. Unleaded gas has gone from $0.23/liter to $0.39/liter over this period. Household electricity prices have risen from $0.04/kWh to $0.05/kWh.[3]

E.3.2 Restructuring Energy Sectors

Within Mexico's National Development Plan is an Energy Sector Development and Restructuring Program for 1995-2000, which includes a National Energy Conservation Program to reduce energy consumption through the use of more energy efficient technologies. Mexico recognizes that improved energy efficiency may reduce the need to expand power generating

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[1] Natural Resource Defense Council (NRDC), *The Road to Enlightened Energy in the Americas*, 1996.

[2] *Ibid.*

[3] *Energy Prices and Taxes, Fourth Quarter 1997.* International Energy Agency. IEA Statistics. OECD, Paris.

capacity and may provide other social and economic benefits as well. Nevertheless the way these benefits will be achieved has yet to be determined.[4]

[4] Natural Resource Defense Council (NRDC), *The Road to Enlightened Energy in the Americas*, 1996.

Exhibit E-1
GHG Emissions in Mexico in 1990 (Tons)

GHG sources and sinks	CO_2 Top/down	CO_2 bottom/ up	CH_4	N_2O
Total emissions - removals	459,278.333	444,378.674	3,641.275	15.788
All Energy Fuel (combustion and fugitive)	311,800.000	296,900.341	1,080.978	7.971
1. Fuel Combustion	311,800.000	296,900.341	41.398	7.971
Energy and Transformation Industries		108,475.773	3.442	2.323
Industry (ISIC)		64,971.198	1.540	0.061
Transport		95,944.448	35.934	3.916
Small Combustion		23,554.988	0.459	0.090
Other		3,953.934	0.023	1.581
2. Fugitive Emissions from Fuels			1,039.580	
Solid Fuels			70.270	
Oil and Natural gas			969.310	
Industrial Processes	11,621.000	11,621.000		
Agriculture			1,793.297	5.817
Enteric Fermentation			1,700.905	
Manure Management			48.101	
Rice Cultivation			35.000	
Agricultural Soils				5.510
Prescribed Burning of Savannas				
Field Burning of Agricultural Residues			9.291	0.307

GHG sources and sinks	CO_2 Top/down	CO_2 bottom/ up	CH_4	N_2O
Land Use Change and Forestry	135,857.333	135,857.333	241.000	2.000
Uptake by managed forests	-31,551.667	-31,551.667		
Forest clearing	217,734.000	217,734.000	241.000	2.000
Uptake abandoned lands	-50,325.000	-50,325.000		
Waste			526.000	
Solid waste disposal on lands			468.000	
Wastewater treatment (urban)			58.000	
Waste incineration				

Source: "National Climate Change Action Plans: Interim Report for Developing and Transition Countries." USCSP Oct. 1997

Recent changes in energy sector policies have allowed independent power producers (IPPs) to enter the Mexican market for the first time. The most likely projects to be first affected by these changes are natural gas-fired plants.[5] In fact, the Energy Regulating Committee (Comisión Reguladora de Energía, CRE) published new regulations inFebruary, 1998, to standardize the format and requirements of new project agreements between private electric power generators and public electricity companies. Previously, Central Light and Power (Luz y Fuerza del Centro, LFC) and the Federal Electricity Commission (Comisión federal de Electricidad, CFE) had set specific conditions for these projects. Rules regulating surplus trading have not yet been formulated. The established regulations will be particularly useful in promoting the development of renewable energy projects such as wind power generation.[6]

Mexico has complied with its commitment under the North American Free Trade Agreement (NAFTA) to allow the private ownership and operation of electric generation plants for self generation, cogeneration, and independent power production. In November, 1995, Mexico issued the first regulations allowing private sector participation in the transportation, distribution and storage of natural gas.

E.4 SECTOR-SPECIFIC ACTIONS AFFECTING GHG SOURCES AND SINKS

Several programs to mitigate GHG emissions have been developed by the Mexican Secretariat of Environment, Natural Resources, and Fishing (SEMARNAP). These programs were designed to accomplish other national development goals as well, such as reducing urban pollutants and introducing more restrictive industry emission standards before they become mandatory in 1998. Technologies being developed for the energy sector are consistent with the goals of the Energy Saving National Commission (Comisión Nacional para el Ahorro de Energía), and mitigation alternatives in the forestry sector are in line with the objectives of the national forestry program.[7]

Mexico's formulation of a National Development Plan for 1995 to 2000 represents a firm step toward adopting policies that will have a positive impact on reducing GHG emissions and increasing sinks.[8]

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[5] Natural Resource Defense Council (NRDC), *The Road to Enlightened Energy in the Americas*, 1996.

[6] The Economist Intelligence Unit, *Mexico Country Report*, 2nd quarter 1998.

[7] United States Country Studies Program (USCSP), *National Climate Change Action Plans: Interim Report for Developing and Transition Countries*, 1997.

[8] *Ibid.*

Energy use in Mexico has recently been increasing at a rate of 7.1% a year, somewhat faster than the rate of increase in GNP (5.1% for 1996 and 7.0% for 1997).[9] In 1997 Fideicomiso para el Aborro de Energia (FIDE) developed a wide-ranging energy savings program for Mexico. Its results to date include:[10]

- Implementation of a summer time change. This achieved both energy savings and great acceptance among the public.

- Greater participation by the residential, industrial, commercial, municipal and service-providing sectors in the energy savings program. Municipalities are consolidating their energy savings programs and enlisting the help of private and development banking in the financing of public lighting projects.

- Participation of FIDE together with international agencies and electricity industries in other countries in the design of national programs for energy conservation. Such involvement confirms Mexico's leadership in this area in Latin America. An example of this is Mexico's participation in the "Sustainable Markets for Sustainable Energy" program in Argentina with the Inter-American Development Bank (IDB), and the program with CEL in El Salvador.

- Sustainability of energy saving projects in Mexico even after termination of FIDE's programmed initial technical support.

- Greater availability of energy efficient equipment manufactured in Mexico at competitive prices.

- Greater consulting expertise in the energy sector. This has provided a basic structure to support the creation of ESCOs and the use of financing models such as guaranteed or shared savings.

Education and dissemination of information on case studies, programs, incentives, and available technologies and services was one of the priorities of the 1997 FIDE energy savings program. The energy efficiency education and outreach activities are summarized in Exhibit E-2.

Exhibit E-2
FIDE Outreach and Education, 1997

[9] FIDE. 1998. "Informe de Labores 1997: FIDE."

[10] Fideicomiso para el Ahorro de Energía (FIDE), *Informe de Labores*, 1997, 1998.

Publications	Amount
12 issues of the magazine NOTIFIDE	300,000 copies
4 issues of the magazine Energía Racional	68,000 copies
20 pages of successful case studies	45,707 copies
8 pages of successful case studies	13,700 copies
25 sets of books about energy saving measures	40,300 copies
Flyers, posters, bulletins, etc	515,200 copies
Summer time change publications	4,618,000 copies
Energy efficiency incentive publications	1,910,000 copies
Home energy saving publications for kids	120,000 copies
Presentations & Expositions	
"Electron" theater play presentations	104 presentations with total audience of 5,702 p
Energy efficiency information stands	28 expositions in different cities of Mexico
Radio messages promoting energy conservation	469 broadcast during 45 days in Mexico City
Permanent expositions about saving energy	5 in museums and ecology education centers
Incorporation of school energy saving education	10 teacher centers, 76 schools, 2,432 5th graders
Energy saving week activities in Yucatan	6,000 students from 50 schools
Technical Assistance	
Capacity building in industries, universities, etc.	99 courses in 39 cities and 4000 participants*
FIDE support in organization and development	35 seminars and 100 conferences
Consolidation of energy saving committees	3 in the commercial sector
Industries requesting information from FIDE	150
Assistance to commercial and service providers	73 organizations
Demonstrative projects	248 in small industries and commercial entities
Rehabilitation of water and public lighting	40 municipalities

* 70% higher than previous year

Source: "Informe de Labores 1997: FIDE" FIDE, 1998

As a consequence of these activities, FIDE received a large number of requests for demonstration projects and consulting services, as seen in Exhibit E-3. Mexico's main economic activities are all represented here, as is the whole range from small industries and service providers to the country's large corporations, commercial chains, and municipalities.[11]

Exhibit E-3

[11] Fideicomiso para el Ahorro de Energía (FIDE), *Informe de Labores*, 1997, 1998.

Response to FIDE's Outreach and Education Campaign

New contracts for demonstration projects:	
Industrial sector	76
Commercial and service sectors	56
Municipal services	19
Consulting to users	74
Increase in number of projects over 1996	61%

Source: "Informe de Labores 1997: FIDE" FIDE, 1998

E.4.1 Reducing Energy Use in Buildings and Industry

The federal government implemented a summer time change in 1996 to save energy and reduce costs. This change affects the period from October to April; it receives sufficient press coverage to ensure that the population is adequately informed about it. This measure alone is estimated to have produced a reduction of 1,100 GWh in energy production and 550 MW in energy demand in 1997.[12]

Equipment and Technology

Incentives to use energy efficient equipment are available to both residential and industrial customers. The residential program seeks to achieve energy savings by replacing conventional lighting systems with compact fluorescent lamps (CFLs). These lamps are available at competitive prices and users pay for them on a four-month installment plan together with their monthly power bills. The Electricity Federal Commission (CFE) provided the financial resources to purchase the lamps, and the management, monitoring and evaluation of the program. It is expected that CFE will sell 6.1 million lamps by the year 2000, thereby reducing demand by 137 MW and bringing consumption to 401 GWH. The program has 42 sales offices in six states; it has already achieved over 10% of its goal.[13] The success of this program will diminish the need for expanded power generating plants, translating into decreased fossil fuel use and lower operating costs.[14]

The objective of projects in the production sector is to commercialize energy efficient equipment in the industrial, commercial, and services sectors through the granting of special economic

[12] Fideicomiso para el Ahorro de Energía (FIDE), *Informe de Labores*, 1997, 1998.

[13] *Ibid.*

[14] *Ibid.*

bonuses to users of such technologies. A loan from the Inter American Development Bank (IDB) for US$23.4 million provides half of the resources for this project. The remaining 50% is provided by domestic FIDE and CFE grants. The program includes incentives to purchase 155,000 energy efficient electric motors, 6,000 efficient compressors, and 1,250,000 units of commercial and industrial lighting over a five-year period. The anticipated effect of these measures is an estimated 2,722 GWH reduction in consumption and 300 MW decrease in demand.[15]

Progress to date includes completion of the computer program to control and monitor incentives for purchase of electric motors; definition of operating conditions for compressors and lighting systems; and identification of objectives and strategies for commercialization and financing.[16] It is likely various demonstration projects will also develop new financing and commercialization alternatives and new ways to monitor savings.

These programs saved power users US$617 million in reduced energy bills. Power suppliers saved over US$2.5 billion in deferred capacity expansions and reductions in fuel and operating costs. The monitoring of these results has allowed for the demonstration of investment profitability in energy efficiency. In fact many municipal lighting projects in Mexico do not rely on FIDE funds, but instead upon private bank financing.[17] Exhibit E-4 summarizes the results of the FIDE program for 1997.

Exhibit E-4
Results of the FIDE program for 1997

Actions	Number	Energy Savings	
		Demand MW	Consumption GWH/year
Residential:			
Sales of CFLs	985,000 CFLs	93	158
Home insulation	52,618 homes insulated		
Energy diagnoses	4,451 energy diagnoses		

[15] Fideicomiso para el Ahorro de Energía (FIDE), *Informe de Labores*, 1997, 1998.

[16] *Ibid.*

[17] *Ibid.*

Industrial: Demonstrative projects Diagnoses per sector and region Pilot program Short-term financing	364 enterprises	123	643
Commercial and service industries: Demonstrative projects Projects for new constructions	96 businesses	8	34
Municipalities: Demonstrative projects in public lighting and drinking and sewer water pumping	107 municipalities	10	516
All Mexico: Summer time change		529	943
All sectors: Incentives program	335,000 CFLs	8.5	22
Totals		771.5	2,316

Data from: "Informe de Labores 1997: FIDE" FIDE, 1998

E.4.2 Reducing Fossil Fuel Use in Transportation

Air pollution due to transportation has been an ongoing problem in many Mexican metropolitan areas. It was not until 1989 that an emergency program was implemented in response to public concern over increasing levels of air pollution. The government introduced the following measures to reduce vehicular air pollution (World Bank, 1997):

- Stricter emissions standards for vehicles manufactured after 1990 Driving ban prohibiting vehicles from driving one day of the week
- A 5% increase of MTBE in gasoline to compensate for a decrease in lead and to reduce HC and CO2 emissions
- A vehicle maintenance and inspection program
- Replacement of certain bus engines with engines meeting California 1990 emission standards, and the rehabilitation vehicular of appearance and mechanical condition
- Expansion of an air quality monitoring network

In September of 1990 the Mexican government announced the Integrated Program Against Air Pollution. This program consisted of 42 specific measures that targeted the following: oil industry and fuels, the transport sector, private industry and services, thermoelectric plants, reforestation and sanitary measures, research, communication and education (World Bank, 1997).

Modifications of fuel composition to reduce pollutant emissions was one of the measures taken by the oil industry and fuels sector. Changes included making unleaded gasoline available, reformulating leaded gasoline to reduce pollutant emissions, and desulfurizing diesel fuel and fuel oil (World Bank, 1997).

The measures to control transport-related emissions included: changing emissions standards for gasoline-fueled vehicles; requiring emissions control by catalytic converter; replacing the fleet of high use vehicles such as taxis and microbuses with new vehicles meeting emissions standards; converting gasoline-fueled cargo trucks to LPG or CNG; improving the maintenance program and the drive-ban day for private vehicles, taxis and buses; improving traffic and parking management systems; expanding the metro and surface electric transport systems; and authorizing new private bus routes (World Bank, 1997).

The air quality management strategy used in the Metropolitan Area of Mexico City has effectively reduced the concentration of some pollutants such as lead, carbon monoxide, and sulfur dioxide and has stabilized the upward trend of other pollutants such as ozone and PM-10. The success of the program can be attributed to a coordinated effort of the Mexican government,

research institutions, and NGOs. The USEPA verifies the air quality monitoring network twice a year (World Bank, 1997).

E.4.3 Reducing Fossil Fuel Use in Power Production

Since 1993 the Energy Secretariat has been responsible for national fuel policies in Mexico. Among the goals adopted by the Secretariat for the period 1994-2005 are to reduce consumption of fuel oil with high sulfur contents and to significantly increase natural gas' share of the fuel market.[18]

The Energy Regulating Committee (Comisión Reguladora de Energía, CRE) has continued to auction gas distribution permits, awarding a 30-year concession with a five-year exclusivity period. Winners are the bidders that offer the lowest prices for consumers and the most ambitious expansion plans for distribution in the area. They must also purchase the existing distribution network from the Federal Electricity Commission (Comisión Federal de Electricidad, CFE). In April of 1998, a consortium formed by Bufete Industrial, Gaz de France and Mexigas received the permit for several cities along the Mexico-US border. Mexican and international companies have won bids for other regions. Participants have made specific proposals to increase gas consumption in their respective areas. The government is currently opening new regions for bidding.[19]

In environmentally critical areas 70% of thermoelectric plants using fuel oil will convert to natural gas. Furthermore, environmental protection norms will be taken into account during the planning process, when the government considers alternative fuels.[20]

In May of 1995, Mexico took its clean energy policies a step further when it changed the Regulatory Law of Article 27 of the Constitution to allow the participation of social and private sectors in the transportation, storage, and distribution of natural gas. This amendment also enabled these sectors to build, operate, and own natural gas pipelines, installations, and equipment.[21]

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[18] Estados Unidos Mexicanos, *México Primera Comunicación Nacional ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático.*

[19] The Economist Intelligence Unit, *Mexico Country Report*, 2nd quarter 1998.

[20] *Ibid.*

[21] *Ibid.*

E.4.4 New and Renewable Energy Development

Mexico is currently exploiting 753 MW of geothermal power and it is planning on bringing on line 250 MW more by the year 2000. Other sources of renewable energy include the expansion of wind generating capacity in the state of Oaxaca. The new policies governing the energy sector also support the financing of energy efficiency projects and generation using renewable-energy.[22]

Mexico has made one of the largest investments in Latin America to provide electricity to schools, clinics, and individual homes in rural areas through the use of photovoltaic systems.[23] However, programs for rural household photovoltaic electrification have faced certain problems because they have lacked funding to cover repairs and maintenance of equipment (e.g. batteries), proper education, and user training. Photovoltaic programs elsewhere have been successful partly because users have paid for the costs of the system using a credit scheme that requires monthly payments of equipment, operations and maintenance costs. This ensures that only those who want the system will get it and that the systems will be properly maintained. Although this may exclude those who cannot afford the costs, experience with rural electrification projects has demonstrated that for most poor rural people the need for electricity is insignificant compared to the need for arable lands and improved farming techniques. In these cases electricity availability does not increase economic productivity.[24]

Baja California Sur has set an example of the application of a hybrid solar-wind-diesel generator to improve economic productivity in a rural area. This project involving Arizona Public Service, the Mexican government and the government of the state of Baja California Sur has allowed the electrification of two isolated fishing villages. These villages can now refrigerate their catch and pay off the costs of the electric generation system through the increased economic returns and the small tariffs paid by individual households.[25]

E.4.5 Protecting Carbon Sinks

One of the main strategies of Mexican environmental and natural resource policies is to prevent the depletion of natural resources and promote sustainable production processes. In 1996 the government announced the 1995-2000 Natural Protected Area Program. One of the objectives of

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[22] Natural Resource Defense Council (NRDC), *The Road to Enlightened Energy in the Americas*, 1996.

[23] *Ibid.*

[24] Morgenstern, J. forwarded email to rsvp@mail.nrel.gov regarding research on renewable energy done by author in Mexico.

[25] *Ibid.*

the program is to increase the areas under protection and improve biodiversity conservation. The government implemented 27 pilot projects in these areas and provided funding and technical and management support.[26]

Mexico currently has 6% of its territory under protected area status, a total of 99 natural protected areas covering 11,687,563 hectares. The government allocated 28,840,000 Mexican (approximately US $3,622,000 in 1997) pesos for 11 pilot areas in 1997. The GEF and the World Bank are financing 14 other pilot areas. The private sector is providing financial support in the amount of 10,000,000 (approximately US $1,256,000 in 1997) Mexican pesos annually, to support management of 7 protected areas. Petróleos Mexicanos (PEMEX) has committed 4,700,000 Mexican pesos (approximately US $590,000 in 1997) for the same purpose.[27]

In addition to the protected areas programs, the government created the National Reforestation Program (Programa Nacional de Reforestación, PRONARE). This program focuses on the restoration of strategic areas, enrichment of forest species, appropriate species introduction, and agroforestry (crops and trees mixed plantations) programs. One of its objectives is to produce 340,000,000 trees.[28]

Mexico has over 12 million hectares that are suitable for reforestation. Given this potential, the Mexican government created a Program for the Development of Commercial Tree Plantations (PRODEPLAN). This program intends to plant 875,000 hectares in the next 25 years.

E.5 ACTIONS THAT EXPLICITLY SUPPORT THE UNFCCC OR CONTROL GHG EMISSIONS

Mexico joined the climate change agreement in 1994 and then developed a national inventory of GHG emissions. In the 1995 First Conference of the Parties, Mexico agreed to strengthen measures to reduce its national greenhouse gas emissions.[29]

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[26] Estados Unidos Mexicanos, *México Primera Comunicación Nacional ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático.*

[27] *Ibid.*

[28] *Ibid.*

[29] Natural Resource Defense Council (NRDC), *The Road to Enlightened Energy in the Americas*, 1996.

E.5.1 National Action Plans

The objectives of Mexico's climate change action plan are to meet the country's commitments to the United Nations Framework Convention on Climate Change (UNFCCC) by the end of 1997; assist in the development of the criteria for joint implementation; increase domestic awareness of the impacts of climate change and evaluate high priority adaptation measures; develop Mexico's technical capabilities of personnel and mitigation technologies to address climate change; and gain national support for the implementation of national action plans (NAP) and other climate change policies.[30] The plan's priorities and measures are summarized in Exhibit E-5.

Exhibit E-5
Summary of Plan Priorities and Measures

Priority Sectors and Subsectors	Proposed Measures
Mitigation	
Energy: Power Generation	▸ Use renewable energy sources, specially large-scale wind plants ▸ Fuel substitution
Energy: Industrial	▸ Industrial cogeneration ▸ Efficient electric motors ▸ Improved industrial boilers ▸ Atmospheric circulating fluidized bed combustion ▸ Potable water pumping
Energy: Transportation	▸ Expansion of public transportation and increased use of electric vehicles in the Mexico City Metropolitan Area
Energy: Commercial and Residential	▸ Introduce energy-efficient lighting
Forestry	▸ Introduce forest management options for carbon sequestration
Agriculture and Livestock	▸ Implement options to mitigate methane and other GHGs
Adaptation	
Agriculture and Livestock	▸ Use of climate forecasts in Agricultural Activities in Tlaxcala (January-November 1997)
Forests	▸ To be established in second phase of the country study

Source: "National Climate Change Action Plans: Interim Report for Developing and Transition Countries." USCSP Oct. 1997

The government agency in charge of addressing climate change issues and establishing national policies in regard to those issues is the National Institute of Ecology (Instituto Nacional de Ecología, INE), an arm of the Ministry of the Environment, Natural Resource and Fisheries (Secretaría de Medio Ambiente, Recursos Naturales y Pesca (SEMARNAP). INE created a

[30] United States Country Studies Program (USCSP), *National Climate Change Action Plans: Interim Report for Developing and Transition Countries*, 1997.

working group of experts from the Engineering Institute of UNAM and representatives from other ministries [31] for the sole purpose of tackling the climate change issue.

The national GHG inventory determined that energy production and consumption were the main sources of GHG emissions in the country. About 85% of final energy use and 61% (1995) of power generation is produced by burning fossil fuels. Given these results and the conclusions of other directly related studies, the working group proposed to the Steering Committee that it place an emphasis on technological mitigation options. Consequently, the greatest number of technological advancements is being made in the energy sector (some technological development does address land use changes and livestock emissions as farming practices and deforestation, together, are the second highest GHG emitters in Mexico.[32]

The country studies team has pursued the further integration of the National Action Plan into the National Development Plan by including climate change issues in Mexican environmental law. The National Institute of Ecology (INE) is the coordinating agency and therefore it enhances the leverage of the country studies team.[33]

Exhibit E-6 summarize mitigation measures, impacts, and leading agencies:

Exhibit E-6
Summary of Mitigation Measures, Impacts and Leading Agencies

Measure	Lead Agency	CO_2 Reductions in 2000* (Tons)	CH_4 Reductions in 2000 (Tons)	Other Environmental Benefits
Energy				
Industrial cogeneration	INE	1,971,190.9 (1990-2005)		
Electric motors in the industrial sector	INE	61,183.620 (1997-2010)	.227	CO: 170.925 NO_x: 829.491
Potable water pumping	INE	512,000 p.a.		
Wind generation	INE	15.042,000 (2000-2010)		

[31] United States Country Studies Program (USCSP), *National Climate Change Action Plans: Interim Report for Developing and Transition Countries*, 1997.

[32] *Ibid.*

[33] *Ibid.*

Measure	Lead Agency	CO_2 Reductions in 2000* (Tons)	CH_4 Reductions in 2000 (Tons)	Other Environmental Benefits
Electric vehicles in Mexico City	INE	861,331 p.a.		CO p.a.: 9,234.9-30,008 NO_x p.a: 91.8-1,096.3
Commercial and residential efficient lighting	INE	1,038,700-3,319.730 (2000-2010)		NO_x: 3,680-11,880 CO:240-771
Forest management mitigation options	INE	15,272,727 p.a.		
AIJ ILUMEX Project	Federal Commission of Electricity (Mexico) Norwegian Gov. World Bank	726,675 (1995-2006)	18.57	So_x: 10,986 NO_x: 1,982 HC: 746 CO: 188 Particulates: 5,363
Forestry				
AIJ project for salicornia cultivation in Sonora	Genesis Salt River Project Halophyte Enterprises EIC Corporation	1,080 (equivalent)		
AIJ Scolel-Té project	ECOSUR INE Union de Crédito Pajal University of Edinburgh IEA GHG R&D Program Federation Internationale de l'Automobile EIC Corporation	230,000 (over 30 years)		

Source: "National Climate Change Action Plans: Interim Report for Developing and Transition Countries." USCSP Oct. 1997
p.a.= per annum
* Annual emissions reduction expected by 2005

E.5.2 National Communications

Mexico has created several policy frameworks in response to international environmental treaties aimed at addressing climate change. Among these are the Program to Address the Sustainable Development Agenda (Programa para Atender la Agenda de Desarrollo Sustentable, PAADS), also known as the Agenda 21 of Mexico. This was created in response to the 1992 United Nations Conference on Environment and Development. In this program Mexico defined a national strategy to address air pollution and how to incorporate the environmental dimension in

important national public policies. Mexico submitted a 1997 Report to the Sustainable Development Commission of the United Nations, outlining Mexico's follow up response to agenda commitments.[34]

Regarding the Agenda's GHG mitigation, Mexico created several programs to reduce industry and vehicular emissions as well as programs to increase carbon sinks. In May of 1997, Mexico made an amendment to its Forestry Law in response to concerns from several social and private organizations.[35] The provisions of this amendment include:

- Strengthening the link between environmental and forestry regulations;
- Regulations to minimize environmental impacts and to provide legal security for those who work in potentially hazardous environments;
- Improving timber transportation control systems to reduce illegal harvesting; and
- Strengthening penalties for illegal timber harvests and forestry regulations.

In addition, the government created official norms aimed at preventing the degradation of forests due to firewood extraction, and at regulating the use of fire in farming activities, thereby reducing forest fires. Currently, the government is also creating other laws to protect humid and moist soil areas and to restore the fertility of degraded grazing lands.[36]

E.5.3 Joint Implementation

According to Article 6 of the Kyoto Protocol, Joint Implementation will not take place only between Annex I countries to assist them in reducing their emissions. However, Article 12 of the Protocol makes provisions for the Clean Development Mechanism (CDM). The purpose of the CDM is assist non-Annex I parties to achieve sustainable development. It can also provide certified emissions reductions (CER) that Annex I countries can use to meet their emissions limitations.

The CDM is consistent with Mexico's National Action Plan, particularly to meet the country's commitments to the United Nations Framework Convention on Climate Change (UNFCCC) and

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[34] Estados Unidos Mexicanos, *México Primera Comunicación Nacional ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático.*

[35] *Ibid.*

[36] *Ibid.*

to develop Mexico's technical capabilities of personnel and mitigation technologies to address climate change. Furthermore, according to Geraldo Translosheros, general director for international organizations at the Secretariat of Trade and Industrial Development, Mexico will pay special attention to the creation of the rules for the CDM during COP-4 in Buenos Aires because this will provide excellent opportunities for clean development in the country.

Most likely, projects under the pilot phase of Joint Implementation in Mexico and other non-Annex I countries such as those described below will now fall under the CDM. It is important to note that CDM does not contemplate carbon sequestration projects, yet it is expected to include these in the short future. Formerly Mexico indicated its willingness to participate in activities implemented jointly, including schemes between Annex I and non-Annex I countries under the following conditions:

- Activities implemented jointly should support and be compatible with national socio-economic, environmental, and development priorities;
- Activities must be approved by the governments of participating countries;
- Activities should reduce GHG emissions;
- Funding for JI projects should be in conjunction with financial support provided by Annex II countries; and
- Technical projects must provide sound technology transfer.

CDM follows these conditions therefore most likely Mexico will support CDM activities domestically as it did the JI pilot activities such as the ILUMEX projects and other projects described below.

The ILUMEX project was the first to be developed under Joint Implementation. Mexico's counterpart in this project is the Federal Electricity Commission (Comisión Federal de Electricidad, CFE). The international participants include the Government of Norway and the Global Environmental Facility and they are involved in an eleven-year project lasting until 2006. One goal of this demand side management project is to initially replace 200,000 fluorescent standard lamps with compact florescent lamps (CFLs) in Monterrey and Guadalajara. The latter consumes 25% less power than its counterpart and therefore will greatly contribute to the reduction of GHG emissions associated with the production of electricity. It is expected that by the end of this project in 2006 1.7 million lamps will have been replaced by their more energy efficient partner.[37]

[37] Estados Unidos Mexicanos, *México Primera Comunicación Nacional ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático.*

Another project, approved in 1996, was the Salicornia Project. This has been a 30-hectare demonstration project focused on cultivating the salicornia plant in Sonora, Mexico and evaluating its use in providing carbon sequestration. The project team consists of the following organizations: Salt River Project, Phoenix, AZ; University of Arizona's Environmental Research Laboratory (ERL); the Electric Power Research Institute (EPRI); Econergy International Corporation, Boulder, CO and Washington, D.C.; Halophyte Enterprises, Inc., Phoenix, AZ; and Genesis , SA de CV, Hermosillo, Sonora, Mexico. The following phase of the project anticipates a fully operational 50,000 hectare, commercial farm incorporating products and materials derived from salicornia. Salicornia is a member of the halphyte family of plants, which can be irrigated with sea water and — in the case of *salicornia bigelovii* — is ideally suited for cultivation in desert or near-desert, coastal regions.[38] It is hoped that by using products dried from salicornia, such large-scale farming would be sustainably feasible.

There are several carbon sequestration and local sustainable development projects that could be approved under the Joint Implementation criteria such as the Scolel Té project. This is a pilot-level demonstration of sustainable forestry and agroforestry (tree/crop system) management practices in 9 indigenous Mayan communities. Many of these communities lie in the humid lowland and dry mountainous terrain of the northeast Chiapas. The villagers have identified approximately 2,400 hectares of communal farming land suitable for improved agricultural practices. There will be a 3-year implementation phase to be followed by more than 27 years of social, economic, and environmental benefits. Furthermore, if this pilot project receives full funding and is successful, reduced carbon emissions could total 230,000 metric tons. Scolel Té seeks to develop a model that will provide technical assistance to farmers increasing carbon sequestration from the project coalition. Funds will largely be provided by investors seeking to benefit from greenhouse gas reduction. Project partners are: El Colegio de la Frontera Sur; Union de Credito Pajal; Instituto Nacional de Ecologia; American Forests; Ecoenergy International Corporation; University of Edimburgh; IEA Greenhouse Gas R&D Programme; and Federation International de Automobile.[39]

[38] JI Web Page, www.ji.org/projects/proj1.htm projects by country, Mexico.

[39] *Ibid.*

ANNEX F
KOREA

F.1 SUMMARY

As of 1995, 35% of Korea's GHG emissions came from industry, followed by electricity generation (23%), and then transport (22%). Emissions from electricity generation grew the fastest from 1990 to 1995, reflecting a high rate of power demand growth.

Although the Government of Korea has supported energy efficiency and conservation programs since the 1970s, these efforts have been strengthened in the 1990s, partly in response to environmental concerns. In 1997, it established the National Committee for Energy Conservation to improve implementation of energy conservation policies.

Korea has achieved significant savings in specific sectors. In industry, the Government's investment of $2.9 billion from 1992-97 achieved a 14.8% savings compared to 1991 energy consumption. The next phase of this effort (1997-2001) has a goal of saving 10% among targeted large companies. In addition to these and other industrial programs, the Government expects to build 33 cogeneration plans by 2001, partly stimulated by electricity sector restructuring in the wake of the financial crisis.

In the buildings sector, the Government has building energy requirements and provides financing to add insulation for existing buildings. It also has introduced energy efficient guidelines for building design, offers energy audits, and promotes the growth of energy service companies. Finally, the Integrated Energy Supply Act of 1991 paved the way for expanding the country's district heating system.

In the transportation sector, the Government has supported seven policies to encourage conservation: 1) fuel economy ratings, 2) establishment of fuel economy targets, 3) encouragement of options to single occupant commuting, 4) promotion of fuel efficient cars, 5) imposition of a progressive emissions tax by engine size, 6) reduction of oil tanker truck traffic, and 7) promotion of LPG as a motor fuel.

In the power sector, the Government and the major utility are seeking to mitigate GHG growth through increasing the share of low and no GHG sources of power and promoting demand side management. In 1996 alone, DSM programs reduced demand by 1,818 MW. Use of LNG has increased from 0% in 1986 to 13% in 1996. Energy supplied by renewable sources grew at about 23% annually between 1991 and 1996.

Korea has also been active in supporting the goals of the UNFCCC. It is preparing a national action plan and has provided financial support to the GEF. In 1998, Korea has announced that it will voluntarily take action to reduce GHG emissions beginning in the year 2018, becoming the first non-Annex 1 country to express such intentions.

F.2 BASELINE CONDITIONS AND TRENDS

The land area of the Republic of Korea is 99,313 km^2, 65.9% of which is mountainous forest. Its population in 1997 was 46 million. Recently population growth has been about 1% per year (measured during 1990-97), slightly higher than the 0.7% average growth rate in developed countries, but significantly lower than developing countries' 2.1%. Korea's GNP was US$ 485 billion and per capita GNP was US$10,550 in 1997.[1] The average economic growth rate was 9.5% per annum between 1980 and 1990, and 7.2% per annum between 1990 and 1997. Energy consumption per capita was 3.2 TOE in 1995 (vs. 7.9 TOE in the United States). In 1995 Korea depended on imported energy sources for 97.8% of its commercial energy needs.[2]

Fossil fuels such as oil, coal, and natural gas accounted for 83% of Korea's total primary energy consumption in 1990 (see Exhibit F-1). As of 1995 this ratio had changed little, with 87% of primary energy consumption accounted for by fossil fuels.

Exhibit F-1
Energy Consumption in Korea
(in 1000 TOE)

Primary Energy Source	1990	1995
Petroleum	50,175 (53.8%)	93,955 (62.5%)
LNG	3,023 (3.2%)	9,213 (6.1%)
Coal	24,385 (26.2%)	28,091 (18.7%)
Nuclear	13,222 (14.2%)	16,757 (11.1%)
Hydro	1,590 (1.7%)	1,369 (0.9%)
New & Renewable Energy	797 (0.9%)	1,051 (0.7%)
Total	**93,192 (100%)**	**150,437 (100%)**

Source: *Yearbook of Energy Statistics.* Korea Energy Economics Institute, 1997.

[1] *World Development Report: Knowledge for Development.* World Bank, 1998/99, p. 190.

[2] *World Development Report* by the World Bank indicates that Korea's energy dependency is 86%. However, this does not include fuel imported for nuclear power generation which equals nearly 12% of Korea's energy supply. Ibid., p. 208.

Korea's anthropogenic emissions of greenhouse gases[3] in 1990 are shown in Exhibit F-2. Net CO_2 emissions in 1990 were 230.3 million tons (MT), equivalent to 62.8 MT of carbon. Total CO_2 emissions were 256.5 MT, with the absorption of CO_2 by forests estimated to be 26.2 MT, or 10% of total emissions. In 1990 Korea's carbon emissions per capita were 1.5 metric tons (vs. 5.4 metric tons in the United States).

Exhibit F-2
Korea's GHG Emissions by Sector (1990)
(in 1000 tons)

	CO_2	CH_4	N_2O	NOx	CO	NMVOCs
Net Emissions*	230,278	1,362	12	851	1,056	152
1. Energy-Related Emissions	238,990	264	11	851	1,056	152
A. Fuel Combustion	238,990	17	11	851	1,056	152
1. Energy Transformation	37,934	0.3	2	193	7	N.A.
2. Industry	87,282	1	2	135	25	N.A.
3. Transport	42,198	6	2	401	600	152
4. Residential and Commercial**	64,592	7	3	105	364	N.A.
5. Public and Other***	6,985	0.5	4	16	39	N.A.
6. Biomass Burning	-	2	0.02	0.6	20	N.A.
B. Fugitive Fuel Emissions	-	246	-	-	-	-
1. Coal Mining	-	230	-	-	-	-
2. Oil and Gas Systems	-	16	-	-	-	-
2. Industrial Processes	17,512	5	-	-	-	-
A. Cement Industry	14,841	-		-	-	-
B. Limestone and Dolomite Use	2,459	-		-	-	-
C. Soda Ash Use	212	-		-	-	-
D. Chemical Industry	-	5		-	-	-
3. Agriculture	-	599	1	-	-	-
A. Rice Fields	-	414	-	-	-	-
B. Enteric Fermentation	-	144	-	-	-	-
C. Animal Excrement	-	41	-	-	-	-
D. Nitrogen Fertilizers	-	-	1	-	-	-

[3]The emission-source classification used in Exhibit F-2 follows IPCC (International Panel on Climate Change) guidelines. Greenhouse gases (GHG) consist of: carbon dioxide (CO_2), methane (CH4), nitrous oxide (N2O), nitrogen oxides (Nox), carbon monoxide (CO), and non-methane volatile organic compounds (NMVOCs).

	CO_2	CH_4	N_2O	NOx	CO	NMVOCs
4. Waste Management	11	495	-	-	-	-
A. Waste Incineration	11	-	-	-	-	-
B. Landfills	-	200	-	-	-	-
C. Household Wastewater	-	21	-	-	-	-
D. Industry Wastewater	-	274	-	-	-	-
5. Total	256,513					
6. Removals (Absorption)	-26,235	-	-	-	-	-
7. International Bunkering	7,140	-	-	-	-	-

* Net emissions do not take into account international bunkering.
** Non-CO emissions are those from residential and commercial sectors in 1989.
*** Non-CO_2 emissions are those from public and other sectors in 1989.
Source: *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. viii.

As shown in Exhibit F-2, energy-related emissions amounted to 239 million tons, 93.2% of total CO_2 emissions. Exhibit F-3 shows the percentage of energy-related CO_2 emissions contributed by each sector. The industrial sector contributed the largest share, 36% of the total; the residential/commercial sector was the second largest source, contributing 27% of the total; and the transport, public, and electricity generation sectors accounted for 18%, 3%, and 16%, respectively. The average annual growth rate of total CO_2 emissions was 9.4% from 1990 to 1995.

Exhibit F-3
Energy-Related CO_2 Emissions by Sector
(in 1000 tons)

	1990	1995	AAGR (%)
Industry	87,282 (36%)	132,768 (35%)	8.8
Residential and Commercial	64,592 (27%)	69,374 (19%)	1.4
Transport	42,198 (18%)	80,868 (22%)	13.9
Electricity Generation	37,934 (16%)	86,472 (23%)	17.9
Public and Others	6,985 (3%)	4,622 (1%)	-7.9
Total	**238,990 (100%)**	**374,104 (100 %)**	**9.4**

Source: *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 35.

A lower rate of growth in CO_2 emissions is forecast for 1998, due to the impact of the Asian financial crisis on Korea's economy. Nonetheless, without policy interventions, CO_2 emissions

are expected to increase substantially. The government projects that the per capita emissions rate will rise from 2.3 tC (1995) to 3.2 tC in 2000 and to 4.4 tC in 2010.[4]

F.3 BROAD ECONOMIC REFORMS AFFECTING GHG SOURCES AND SINKS

In 1998, a financial crisis triggered by foreign exchange liquidity problems shook the Korean economy. Short-term foreign loan funds were quickly withdrawn and the value of the Korean won fell by nearly 50% against the dollar. Domestic annual interest rates rose to 30%, the highest in modern Korean history. Under these economic conditions, GDP shrunk by 3.8% in the first quarter and 6.6% in the second quarter of 1998.[5] According to the Ministry of Labor, the unemployment rate is expected to rise to 8.3%, leaving 1.8 million people jobless at the end of this year. Such large scale lay-offs are unprecedented for the Korean economy.

In response to the events of late 1997 and 1998, the Korean government is calling for significant reforms. Virtually every national economic policy is being reexamined. The significant changes to date are: 1) restructuring of the major business and banking organizations; 2) capital market liberalization (including the opening of financial markets to foreign investors); 3) promotion of mergers and acquisitions with foreign partners; 4) restructuring of the electricity industry; and 5) privatization of state-owned industries.

Because of its high dependence on foreign loans, the energy industry will be more affected by the financial crisis than other industries. Some impacts are already evident. First, imported fuel prices have increased dramatically, which in turn has raised production costs. According to a 1997 analysis by the Korean Energy Economics Institute, the 37.9% increase in the foreign exchange rate (as of December 1997) had triggered price hikes of 25.4% in petroleum, 15.7% in natural gas, and 9.7% in electricity.[6] Second, energy demand growth has slowed due to lower GNP growth. Energy consumption in the first quarter of 1998 was 42,695TOE, 8.9% lower than the 46,848TOE for the same period in 1997. GNP for the first quarter of 1998 recorded negative growth of 3.8%.[7]

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[4] *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 41

[5] Bank of Korea, reported by Korea Herald. August 28, 1998

[6] On the other hand, the IMF crisis may improve terms of trade, resulting in the net positive balance of 1.5-2 billion dollars (*Foreign Exchange Crisis and Energy Industry*. December 1997. Korea Energy Economics Institute (KEEI))

[7] *Korea Energy Review Monthly.* August 1998. Korea Energy Economics Institute

F.3.1 Pre-Existing Energy Policies

Before the financial crisis, Korea, with its export-oriented dependence upon foreign energy sources, had implemented energy policies mainly focused on securing stable and cheap fuel supplies. These policies favored the industrial sector, especially energy-intensive industries such as steel, petrochemicals, and cement. The share of national primary energy consumption by energy-intensive industries increased dramatically from 14.4% in 1980 to 34.7% in 1992, boosting Korea's energy intensity above that of other major industrialized countries (see Exhibit F-4).[8]

Exhibit F-4
Energy Intensity (1995)
(Commercial energy use in TOE/1000 US$GNP)

U.S.A.	France	Japan	Germany	Korea
0.29	0.17	0.10	0.15	0.33

Source: Calculated from *1998-99 World Resources*. World Resources Institute, 1998, pp. 236-237 and *World Development Report 1998/99*. World Bank, 1998, pp. 208-209.

Prior to the 1997 Kyoto Protocol, Korea initiated several national strategies: 1) restructuring the industrial sector to favor energy-efficient and less CO_2-intensive industries; 2) strengthening the energy conservation and efficiency incentives to consumers and businesses; 3) increasing the share of clean energy sources including LNG, and improving energy system efficiency through the promotion of cogeneration and the development of combined heat and power (CHP) facilities; 4) extending energy efficiency labeling to major energy saving equipment; and 5) partial deregulation of energy markets.

The recognition that environmental problems must be addressed by the entire global community began to be reflected in Korea's energy policies after it became a signatory to the U.N. Framework Convention on Climate Change (FCCC) in December 1993. Until then, Korea's environmental policy had concentrated on the regulation of emissions of nitrogen and sulfur oxides as by-products of the combustion of fossil fuels.

But the government's recognition of the global warming issue made it necessary to consider a comprehensive effort to reduce the generation of carbon dioxide. As a consequence, the country is now more aggressive in its pursuit of energy efficiency and the development of clean energy options. This year Korea has announced that it will voluntarily take action to reduce GHG

[8] *National Communication of the Republic of Korea.* 1998 Submission of the ROK under the United Nations Framework Convention on Climate Change

emissions beginning in the year 2018. Korea became the first developing economy to express its intent to reduce GHG emissions.[9]

The Korean government has supported energy efficiency and conservation programs since the 1970s. The Heat Management Act was enacted in 1974 to allow systemic implementation of energy conservation policies and the Rational Energy Utilization Act was enacted in 1979 to encourage comprehensive development of energy efficiency options.[10] These efforts were strengthened following the Earth Summit in 1992.[11] In particular, the government established the National Committee for Energy Conservation (NCEC) in 1997 to ensure more effective implementation of energy conservation policies.

Key Government Agencies

The Korean government has long been actively involved in the energy sector. Prior to 1978, the Ministry of Trade and Industry (MTI) was responsible for energy related matters. In 1978, the energy division of MTI was separated to form the Ministry of Energy and Resources (MOER). This Ministry was in charge of planning and guiding all energy-related policies, with the exception of the nuclear power program which remained under the Ministry of Science and Technology. In 1993, MOER was again merged with MTI to form the Ministry of Trade, Industry and Energy (MOTIE) which was renamed in 1998 as the Ministry of Commerce, Industry and Energy (MOCIE). In cooperation with the Ministry of Finance and Economy, MOCIE maintains a strong degree of control over all aspects of energy policy formulation and implementation. In addition, the government has directly funded major energy research institutes and energy corporations either directly owned or controlled by the government[12]:

- The Korea Energy Economics Institute (KEEI) is the country's principal energy policy research organization. It conducts basic research on conservation and energy efficiency policy for the national government, maintains a comprehensive energy data base and carries out a full range of analytical studies on all major aspects of energy supply, distribution and use in the country.

- The Korea Energy Management Corporation (KEMCO) is a government-owned enterprise in charge of implementing energy efficiency and conservation policies and programs

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[9] "One Down," *Down to Earth*, August 15, 1998. The article is available at http://www.oneworld.org/cse/html/dte/dte980815dte_fort.htm.

[10] *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 45.

[11] *Korea's Energy Policy to Mitigate Climate Change.* Ministry of Commerce, Industry and Energy, 1997, p. 8, and *Ibid.*

[12] Information obtained from *National Communication of the Republic of Korea.* Republic of Korea, 1998 (pp. 47-49) and *Energy Policies of the Republic of Korea,* OECD, 1995.

developed by the government. KEMCO has a wide range of programs related to the major end-use sectors and manages funding for energy conservation related activities.

- The Korea Institute for Energy Research (KIER) is responsible for energy related technology research, development and demonstration. KIER has substantial RD&D commitments in the areas of energy efficiency and renewable energy options.

- The Korea Electric Power Corporation (KEPCO) is a vertically integrated electricity monopoly that is responsible for maintaining and expanding the electric supply system.

- The Korea District Heating Corporation (KDHC) is the largest 'district heating utility' in the country. Through KDHC, the government supports district heating projects with loans at favorable terms drawn from the National Special Energy Account.

- The Petroleum Development Corporation (PEDCO) is active in the upstream oil sector and handles Korea's emergency oil stockpiles.

- The Korea Gas Corporation (KGC) is the monopoly gas importer and distributor. The Dai Han Coal Corporation (DHCC) and the Korea Mining Promotion Corporation (KMPC) are responsible for implementation of rational policy in the coal and mineral resources area.

F.3.2 Reducing Energy Subsidies

Energy subsidies in Korea are of two types: production subsidies and consumption subsidies. Korea has favored the former over the last 30 years, providing support to the coal and nuclear power industries. Large subsidies have been provided for nuclear power development, including R&D on the nuclear fuel cycle process as well as for the design of a Korean standard nuclear reactor. In the case of coal, subsidies have been mainly in the form of compensation for losses in coal production (see below).

Recently the Korean government has set up modest programs to promote alternative energy sources. This support has been focused on R & D. As well, subsidies in the form of low interest loans have been created for the construction of small hydroelectric facilities.[13] Low interest loans are also available for installation of alternative energy facilities using photovoltaic, solar thermal and wind power.[14]

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[13] Construction of a small scale hydroelectric plant needs a permit first from the municipal government and agreement given by KEPCO to purchase the electricity produced. In addition a permit must be obtained from the Ministry of Environment. The rate paid by KEPCO for the electricity it purchases from private power producers is unilaterally set by KEPCO. (*Energy Policies of ROK.* 1995. International Energy Agency.)

[14] An important financial source for subsidies to alternative energy producers has been a government surcharge (currently, $1.70 per barrel) on imported crude oil and petroleum products. This surcharge has been used

Consumption subsidies have been given to industry, farmers, and low-income users through government control of prices for coal, electricity, and some petroleum products. Energy prices in industry have been set lower than those in other sectors to promote industrial competitiveness in export markets. But this energy policy has produced adverse effects on energy conservation and the environment. The 1993 Economic Five Year Plan called for reforms that would lead gradually to domestic energy prices that more accurately reflect supply and demand conditions.[15]

During the 1960s and 1970s, domestic coal (anthracite) was a major household fuel and was also used for power generation in Korea. A portion of the Petroleum Business Fund was given to operators of coal fired power plants to offset the difference between domestic coal and imported coal prices.[16] This practice had continued until 1989 when the Coal Business Act was enacted to facilitate the closure of the uneconomic coal mines. Between 1989 and 1996, the government spent $520 million to compensate coal mine owners and laid-off workers. During this period, the number of coal mines was reduced from about 347 to 11.[17]

F.3.3 Modifying the Industrial Base and the Energy Sector

With its industrial structure primarily oriented toward energy-intensive heavy and chemical industries, Korea has been vulnerable to fluctuations in energy prices and supply disruptions. In addition to energy security problems, Korea has suffered significant environmental problems because of its reliance on energy-intensive industries. For these reasons, the government initiated restructuring programs throughout the 1990s that promoted the development of less energy-intensive industries. It is still too soon to measure the effects of these programs. However, the share of petrochemical and heavy industry's products in total exports decreased from 11.4% in 1990 to 11.1% in 1996, while electronic products increased to 18.8% in 1996, up from 15.7 % in 1990.[18]

National economic policy also promoted the use of LNG in order to reduce electricity generation and residential heating costs. LNG was introduced in 1986 in Korea and imports have steadily increased from 68,000 TOE in that year to 7.6million TOE in 1994. LNG demand is expected to continue to grow in the next decade. Along with the successful introduction of LNG, there has been a series of nationwide protests against further nuclear power development. As a result, the

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to create a Petroleum Business Fund which can be used to support alternative energy projects.

[15] *Energy Policies of ROK.* 1995. International Energy Agency.

[16] See footnote 14

[17] *Korea's Energy Policy to Mitigate Climate Change.* 1997. The Ministry of Commerce, Industry and Energy.

[18] *Major Statistics of the Korean Economy.* March 1998. National Statistical Office, Republic of Korea.

share of nuclear power in total primary energy consumption has decreased from 14% in 1990 to 11% in 1995.[19]

F.3.4 Deregulating the Energy Sector

Market deregulation of the Korean economy generally, and its energy sectors specifically, has been explored by the government since 1992. Efforts have also been made to reduce subsidies to heavy industry.

Deregulation of the energy industry began with the petroleum industry in the late 1980s. Until that time, prices and production of most petroleum products had been set by the government. Along with deregulation, a variety of restrictions on market entry to the petroleum sector were likewise abolished.

Recent deregulation efforts have been focused on the electricity industry. The first step was to deregulate power plant licensing. A second step was to open the electricity market to cogeneration. Privatization of electricity generation is now being seriously considered, as is privatization of other state-owned energy corporations. Privatization and deregulation are the main political tasks of the new national administration in the wake of foreign debt problems stemming from the devaluation of the Korean won.

F.3.5 Reforming Tax Policy

Tax policy has been an important tool in Korea's initiatives to reduce energy consumption. Various tax incentives have been introduced to encourage investments in energy-saving equipment and new and renewable energy technologies. Tax incentives such as a 10% investment credit and a 5% tax deduction have been in place since early 1980s for the following: 1) replacement of inefficient industrial furnaces, kilns and boilers; 2) installation of combined heat and power systems; 3) installation of alternative fuel-using facilities, including solar water heating systems; 4) other installations that promise energy savings of 10% or more.

F.3.6 Market Liberalization Policy

Market liberalization, including trade, started in the first half of the 1980s to advance the goal of internationalization of the Korean economy. From the mid-1980s, the government undertook far-reaching measures in support of its market liberalization aims. Selective export promotion and measures were abolished, and a new system aimed at relying on open market mechanisms to determine prices and products was established. As a result, most non-tariff barriers to Korean markets were eliminated. A program of gradual tariff reduction was launched in 1992 when a

[19] *Yearbook of Energy Statistics. 1997.* Korea Energy Economics Institute.

democratic government took over. The liberalization of Korea's import markets and capital sector are now being actively undertaken to help internationalize domestic markets and business development.

F.4 SECTOR-SPECIFIC ACTIONS AFFECTING GHG SOURCES AND SINKS

Korea is striving to transform the country into a low energy consuming society by aggressively promoting energy conservation and efficiency in the industry, buildings, transportation, and electricity generation sectors.

F.4.1 Reducing Energy Use in Industry

The industrial sector accounted for 51% of Korea's total energy consumption and 39% of its total CO_2 emissions in 1992.[20] The programs for energy conservation and efficiency improvement initiated in the industrial sector include: (1) establishment of energy efficiency targets by product; (2) improved energy management of energy-intensive companies (including the preparation of energy management guidelines); (3) an energy audit program for industry; (4) dissemination of energy efficient technologies for improving industrial equipment efficiency; (5) cogeneration facilities; (6) financial assistance for energy conservation investments; and (7) a voluntary program for industry to reduce CO_2 emissions.

Energy Efficiency Targets by Product

The Korean government has established energy efficiency targets for major products and has encouraged energy-intensive industries to achieve these targets. Prepared in 1991, the government's "5-Year Energy Conservation Plan" for energy-intensive industries specifies annual energy efficiency targets to be achieved for 161 energy-intensive products from 1992 to 1996. The program has resulted in annual energy savings of nearly a million TOE and a yearly reduction in the energy intensity of the industrial sector by over 2% (see Exhibit F-5).

[20] *1998 Master plan for energy conservation,* prepared by the National Committee for Energy Conservation, 1998, p. 7

Exhibit F-5
Results of Energy Efficient Products Program in the Industrial Sector

	1984-90	1991	1992	1993	1994	1995	1996
Number of Companies	424	30	178	176	176	176	176
Number of Products	79	5	161	158	158	155	155
Energy Savings (1,000 TOE)	700	-	705	668	998	900	810
Rate of Improved Intensity (%)	6.6~8.8	-	2.2	1.9	2.7	2.4	2.0

Source: *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 50.

Improved Energy Management

The Korean government launched its "Five-Year Conservation Program" in 1992 especially for energy-intensive industries whose annual consumption rates are more than 20,000 TOE.[21] During the plan's first five-year period, the government invested 2,344 billion won ($2.6 billion)[22] and achieved a 14.8% reduction from 1991 energy consumption levels. The cumulative savings resulting from the first plan was 4.1 million TOE, exceeding by 40% the program savings target of 2.9 million TOE.

Exhibit F-6
Results of First Energy Conservation Plan for Energy-Intensive Industries

	1992	1993	1994	1995	1996	Total
Saving Rates (%)	2.6	2.4	3.6	3.3	2.9	14.8
Investment (100 million won)	7,538	5,519	3,606	3,395	3,382	23,440

Source: *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 51.

A second five-year plan was launched in 1997, targeting 190 companies that consume more than 30,000 TOE per year. The goal of the second plan is for these companies to save 10% of their energy consumption by the year 2001 (see Exhibit F-7). The government intends to invest 3,097.8 billion won ($3.4 billion) in the program. The principal means of achieving these targets include replacement or retrofitting of equipment, improvement of operation and process efficiency, waste heat recovery, and heat insulation.

[21] *Korea's Energy Policy to Mitigate Climate Change.* Ministry of Commerce, Industry and Energy, 1997, p. 8.

[22] Conversion from Korean won to US$ was based on the 1997 exchange rate of 900 won to 1 US$.

Companies will be evaluated and their performance classified as excellent, good, or unsatisfactory. Excellent performers will receive a 50% discount on energy audit costs and their energy management teams will be given overseas technical tours.

Exhibit F-7
Projected Energy Savings for Second Energy Conservation Plan

	1997	1998	1999	2000	2001	Total
Investment (100 million won)	3,374	2,699	15,305	5,928	3,672	30,978
Energy Savings (1000 TOE)	791	652	871	619	434	3,367
Saving Rates (%)	2.3	2.0	2.4	1.9	1.3	9.9

Source: *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 51.

Energy Audits

In addition to preparing and distributing energy management guidelines in accordance with Article 24 of the Rational Energy Utilization Act, the government has launched a program of audits and consultations designed mainly for small and medium size companies that have relatively poor energy management. One focus of the program is new and expanded facilities built by these enterprises. Companies making investments in plant and equipment that receive energy audits are required to submit energy utilization plans showing how they will make improvements.[23] Energy savings from this program have grown from 159,000 TOE in 1991 to 428,000 TOE in 1996 (see Exhibit F-8).

Exhibit F-8
Results of Energy Utilization Plans for Small and Medium Companies

	1991	1992	1993	1994	1995	1996
Plans Submitted	24	17	21	23	37	30
Energy Consumption (1,000 TOE/year)	2,300	7,520	1,273	1,135	5,794	5,075
Savings (1,000 TOE/year)	159	76	174	204	797	428

Source: *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 52.

[23] According to Article 11 of the Rational Energy Utilization Act, companies are required to prepare and submit energy utilization plans before the start of operations of new or expanded factories which consume more than 1,000 TOE or 40 GWh per year.

KEMCO has been conducting energy audits since 1980. KEMCO maintains six specialized audit teams for energy-intensive industries such as the chemical, metal, ceramic, textile, pulp and paper, and food industries. While audits are provided free of charge to small and medium companies, large companies are charged a fee. Audit teams perform cost-benefit analyses of equipment and management practices and recommend improvements. As shown in Exhibit F-9, KEMCO performed fee-based audits for 1,263 companies between 1980 and 1996, for a savings of 926,000 TOE. The free audit program had the participation of 7,396 companies and saved 576,000 TOE during this period. For 1996, KEMCO audited 61 large companies and 350 small and medium companies, recording energy savings of 125,000 TOE.

Exhibit F-9
Savings from Energy Audit Program

	Year (1980-1996)	Number of companies	Saving Rates (%)	Savings (1000 toe)	Saved Costs (billion won)	Investment (billion won)	Pay Back (years)
Fee-based Audit	'80~'96	1,263	8.9	926	1,446	2,658	1.8
Free Audit	'81~'96	7,396	7.9	576	966	1,212	1.3

Source: *Handbook of Energy Conservation*, KEMCO, 1997b, p. 136.

Industrial Equipment Efficiency

The Korean government is encouraging the replacement and retrofit of old and inefficient boilers, kilns, furnaces and motors. (see Exhibit F-10). Since 1980 the government has provided approximately 30 billion won per year for this purpose, in low interest loans and tax incentives. In addition, 5% of the total replacement and retrofit cost is deductible from corporate income taxes. The government has also initiated the development of high efficiency motors since 1993. It intends to replace all low efficiency motors with high efficiency ones by 2006. In addition to its industrial motors program, the government has ordered KEPCO to include high-efficiency motors in the utility's demand-side investment plans.[24]

[24] *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 54.

Exhibit F-10
Replacement of Inefficient Boilers, Kilns and Furnaces (1997)

Items	Results	
Equipment Survey	▸	6,628 companies
Technical Guidance	▸	boilers: 609 companies
	▸	kilns and furnaces: 95 companies
Financial Support	▸	60 Projects
	▸	630 million won
Actual Replacement	▸	for Industry: 297 boilers
	▸	for Buildings: 259 boilers

Source: *Annual Report.* KEMCO, 1997a, p. 10.

Cogeneration

Currently 14 cogeneration plants are providing heat and electricity at 12 industrial complexes. An additional 5 cogeneration plants are under construction. For all new industrial complexes, the government has required a mandatory review of the feasibility of constructing cogeneration plants. The government expects to build 33 cogeneration plants by the year 2001. While the cogeneration program is modest at this time (see Exhibit F-11), electricity restructuring plans in the wake of the financial crisis promise to accelerate the development of this option.

Exhibit F-11
Cogeneration Plants in Industrial Complexes (1996)

Number of Cogeneration Plants	Number of Companies Served	Generation Power	
		Heat (Gcal/h)	Electricity (MW)
14	474	4,320	1,047

Source: National Communication of the Republic of Korea. Republic of Korea, 1998, p. 54, and *Korea's Energy Policy to Mitigate Climate Change.* Ministry of Commerce, Industry and Energy, 1997, p. 9.

Financial Assistance

Through the Rational Energy Utilization Act, the government has provided financial assistance to industrial, building, transport, and residential sectors in order to promote energy conservation. Total funds disbursed by this program reached 2,780.9 billion won ($3.1 billion) in 1996. The fund is divided into three categories: facility funds, R&D funds, and operating funds. The funds are offered at annual interest of 5~10%.

Voluntary Program to Reduce CO2 Emissions

The Korean government introduced a voluntary program in 1998 for energy-intensive industries to reduce CO_2 emissions by lowering their energy consumption. Under this program, companies establish voluntary energy conservation targets and prepare an agreement with the government to meet these targets. In turn, the government pledges to support the companies through incentives of various kinds.[25]

F.4.2 Reducing Energy Use in Buildings

Insulation

In an effort to minimize heat loss in residential, commercial and public buildings, the government established a regulation in 1979 which requires all new buildings to be built with heat-insulation systems.[26] It has also provided funds to renovate existing buildings that lack such insulation. During 1984~1996, the government provided 71.1 billion won ($79 million) for 24,265 households for insulation retrofits (see Exhibit F-12).

Exhibit F-12
Financial Support for Housing Insulation

	Financial Assistance (billion Won)	Number of Households	Financial Assistance per household (million Won)	(000 1997 US$)
1984-1990	53.4	19,685	2.71	3.01
91	5.0	1,606	3.11	3.46
92	3.0	903	3.32	3.69
93	2.4	615	3.90	4.34
94	2.7	628	4.30	4.78
95	2.0	414	4.83	5.37
96	2.6	414	6.28	6.98
Total	**71.1**	**24,265**	**3.10***	**3.26***

* The weighted average financial assistance per household.
Source: Last two columns were calculated from *National Communication of the Republic of Korea. Republic of Korea, 1998, p. 55.*

[25] *1998 Master plan for energy conservation,* prepared by the National Committee for Energy Conservation, 1998, p. 12.

[26] *Korea's Energy Policy to Mitigate Climate Change.* Ministry of Commerce, Industry and Energy, 1997, p. 9.

Energy Audits

Since 1990, large buildings which use more than 4 GWh per year have been designated for intensive audits and efficiency improvements. The government has created a program for these large buildings in which those units that reduce their electricity use by 10 percent from the previous year would be rewarded with 20 percent of the savings through reduced electricity charges. Between 1986 and 1996, KEMCO conducted in-depth fee-based audits of 149 large buildings. This initiative has led to an estimated fuel savings of 4,078 TOE per year and electricity savings of 21,571 MWh per year.[27]

Between 1996 and 1997, KEPCO also conducted special energy audits of an additional 407 buildings which use more than 4 GWh. The potential savings from this audit program are estimated to be 6,604 TOE.[28]

Energy Efficient Design

Design guidelines have been introduced to ensure that structures such as large office buildings, hotels, hospitals, indoor swimming pools and large-scale community facilities adopt energy-conservation standards. Since 1985, the government has requested that building permit applications for large buildings be accompanied by an energy efficiency plan. This program is intended to encourage builders to go beyond the prescribed minimum energy efficiency standards. New buildings with an area greater than 10,000 m^2 have been mandated to submit energy efficiency plans since 1992.[29]

Management of Inefficient Buildings

Since 1995 the government has monitored energy-intensive buildings consuming more than 4 million kWh. The most energy-intensive buildings which annually consume more than 10 million kWh must submit a five-year energy saving plan. Recently 85 buildings were classified as the most energy-intensive ones. Together, these buildings account for 53% of total energy consumption of energy-intensive buildings. Electricity-intensive buildings receive a 10% discount on their electricity bills if they reduce electricity consumption 10% from the previous year.

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[27] *Handbook of Energy Conservation.* KEMCO. 1997, pp. 155-157.
[28] *Electric Audit and DSM Potential Survey of Large Buildings.* KEPCO, 1997. Pp. i-xii.
[29] *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 56.

Equipment Standards and Labeling

To raise consumers' awareness about energy efficiency, an energy efficiency labeling and standard measures program was introduced for six products: refrigerators, air conditioners, fluorescent lamps, electric ballasts, incandescent lighting and passenger cars. The government is considering ways of indicating energy costs on labels, so that consumers can compare the energy costs of different products. Since 1994, the government has established minimum efficiency standards for refrigerators, air-conditioners, fluorescent lamps, electronic ballasts, and incandescent bulbs. In 1997, the government began a program to make public announcement of products which fail to achieve the minimum efficiency standards.

In 1998, in an effort to strengthen the enforcement of minimum efficiency standards, the government has authorized MOCIE to ban production and sales of appliances and equipment that fall below the minimum energy efficiency standards.[30] It has also required the installation of high energy efficiency equipment in new public buildings and retrofits of existing public buildings to meet minimum efficiency requirements.[31]

The government plans to expand the list of equipment expected to meet minimum efficiency levels to include washers, microwaves, and electronic rice cookers.[32] It intends to update its equipment list for appliances that can be shown to have large potential energy savings.

Energy Service Companies

The government has encouraged the formation of energy service companies (ESCOs) to systemize the development of energy savings as a business activity. ESCOs invest in and promote energy conservation and efficiency improvements in facilities and buildings, recovering their investment costs through savings from reduced energy consumption. Enhancing the role of ESCOs in the energy conservation market has been identified as a high national priority. As of 1997, 12 ESCOs had been registered. In order to further boost ESCO activities, the government has provided soft loans and tax incentives. Government funds for ESCOs increased nearly six-fold between 1994-1997 (see Exhibit F-13).

In 1996, the "Energy Saving Mart" was inaugurated to provide a venue for ESCOs to develop service contracts with major energy consumers with high energy savings potential. Encouraged by the success of this program, the government now is planning to hold the event every year.

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[30] *Ibid., p. 57.*

[31] *1998 Master plan for energy conservation,* prepared by the National Committee for Energy Conservation, 1998, p. 30.

[32] Ibid., p. 23.

Exhibit F-13
Financial Assistance to Energy Service Companies
(in billion won)

	1994	1995	1996	1997	Total
Financial Assistance	4.3 ($4.8 million)	2.8 ($3.1 million)	5.7 ($6.3 million)	23.0 ($25.6 million)	35.8 ($39.8 million)

Source: *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 57.

Another major program undertaken in 1996 was Energy Saving Performance Contracting. Under this program, energy efficiency investments are made by ESCOs and the resulting savings are divided among participants. As a starting point, the government is initiating an ESCO public project, intended for energy-intensive public buildings which can have significant demonstration effects on the private buildings sector.

District Heating

The government is expanding district heating because of its contributions to the goals of energy saving and reduced environmental pollution. The Integrated Energy Supply Act in 1991 has paved the way to nationwide expansion of the district heating system. As of 1996, 62,7000 households in the Seoul metropolitan area were supplied by district heating. That is equivalent to 6 percent of the residential market. In 1997, the amount of fuel saved due to district heating is expected to be 1.9% of the combined total of residential and commercial energy consumption. By the year 2001, district heating will be supplied to 1.8 million households, which will account for 15 percent of the residential market.

Exhibit F-14
Current District Heating Projects (1997)

	# of District	# of Household (thousand)	Investment (billion Won)	Maximum Heat Load (Gcal/h)	Total Energy Supply	
					Heat (Gcal/h)	Electricity Generation (MW)
Under Operation	12	918	12,398 ($14 billion)	5,771	6,058.5	3,020.7
Under Construction	4	159	3,930 ($4 billion)	993	1,078	95
Total	**16**	**1,077**	**16,328**	**6,764**	**7,136.5**	**3,115.7**

Source: *Handbook of Energy Conservation,* KEMCO, 1997b, p. 121.

F.4.3 Reducing Fossil Fuel Use in Transportation

The number of passenger cars in Korea has soared from 127,000 in 1970 to 9.5 million in 1996. Energy consumption in the transportation sector reflects the dramatic growth in automobile ownership. In 1980 energy consumption by cars was only 4.905 million TOE; this figure increased to 14,173 million TOE in 1990 and to 29,792 million TOE in 1996 (2.1 times the 1990 level).[33] Thus, the share of transport sector energy use in final energy consumption rose from 13.0% in 1980 to 17.6% in 1990 and to 22.6% in 1996. The dominant energy source of the transportation sector is petroleum (99.5%).[34]

CO_2 emissions attributable to the transportation sector amounted to 18% of total energy-related CO_2 emissions in 1990 and 22 % in 1995. The annual growth rate of CO_2 emissions during 1990-95 was 13.9% in the transportation sector.[35]

The Korean government has supported seven policies to encourage energy efficiency and conservation in the transportation sector:

Fuel Economy Rating and Labeling Program for Automobiles

The fuel economy rating and labeling program has been applied to 267 models of passenger vehicles and jeeps fueled by gasoline, LPG, and diesel to provide consumers with better information on relative fuel efficiency. This program will soon be extended to buses.

Fuel Economy Targets

The government has established fuel economy targets to encourage vehicle manufacturers to produce and market energy-efficient vehicles. The goal is to improve fuel economy for all classes of vehicles by 5 percent in 1996 and 10 percent by 2000 over the 1991 base year (see Exhibit F-15).

[33] *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 27.

[34] *Yearbook of Energy Statistics.* Ministry of Commerce, Industry and Energy, 1996.

[35] *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 35.

Exhibit F-15
Fuel Economy Targets in Passenger Cars

(Unit : Km/ℓ)

Engine Size (cc)	1996	2000
Less than 800	23.4	24.6
800-1,100	20.3	21.3
1,101-1,400	17.3	18.1
1,401-1,700	15.4	16.1
1,701-2,000	11.4	12.0
2,501-3000	8.5	8.9

Source: *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 58.

Passenger Vehicle Use Management System

The dramatic increase in the number of cars since the mid-1980s has resulted in heavy traffic, especially in Korea's large cities. To cope with congestion and pollution accompanying Korea's high-volume urban traffic patterns, public employees have participated in a voluntary passenger vehicle use management system to encourage those with private vehicles to leave their cars at home every 10th day and to use public transit or ride to work with a colleague instead.[36] This program has also been promoted in large companies and is encouraged through a variety of public information campaigns. The government is considering an incentive program involving toll-charge discounts for car pool participants. Currently, taxis and passenger vehicles with three or more riders do not pay tolls through the many car tunnels in Seoul and other large cities.

Light-Weight, Fuel-Efficient Vehicle Ownership

To decrease energy consumption in the transportation sector, the government encourages the purchase of smaller and more fuel-efficient cars. The government is providing several incentives including reduced registration and license fees for small and fuel-efficient car owners. Others include reductions on automobile taxes, integrated insurance premiums, discounts on highway tolls and parking charges, and exemptions from the special surcharges on a second family car.

[36] Under the program, when the last digit of a vehicle's license plate is the same as the last digit of a calendar day, the owner should not drive his car on that day. Thus, a public employee whose car license plate ends with a "2" should not drive his car on the 2nd, 12th, or 22nd day of each month.

Progressive Emissions Tax

The government has imposed a progressive emissions tax to reduce the demand for motor vehicles and control the demand for large cars. The emissions tax on private cars with engine sizes above 3,000 cc is 370 won ($0.40)/cc, while that on private cars with engine size less than 800cc is 100 won ($0.1)/cc (see Exhibit F-16). Households with more than one car pay double the tax on the second car.

Exhibit F-16
Emissions Tax by Automobile Engine Size

(Unit: Won/cc)

Engine Size	Passenger Car	Jeep
Over 3,000cc	370	230
3,000-2,500cc	310	200
2,499-2,000cc	250	180
1,999-1,500cc	220	160
1,499-1,000cc	160	160
999cc-800cc	120	120
Under 800cc	100	120

Source: *National Communication of the Republic of Korea.* Republic of Korea, 1998, p. 60.

Construction of a National Oil Pipeline

The construction of a nationwide oil pipeline network is expected to reduce the numbers of oil tanker trucks on expressways, saving transportation costs as well as reducing air pollution. Pipelines between the southern and northern areas of the country and a storage facility in Taejon were completed in June 1995 and put in operation in the area south of Taejon. With the completion of the Sungnam storage facility in June 1997, the national pipeline grid is now operating in its entirety along a south-north line traversing Korea.

LPG as Automobile Fuel

The government aims to mitigate environmental pollution and diversify fuel sources by encouraging the use of LPG in automobiles. LPG emits less CO_2, SO_X and smoke than gasoline or diesel. According to a 1994 study of the TNO Road-Vehicle Research Institute, automobiles using LPG emit 13% less CO_2 than automobiles using gasoline. As shown in Exhibit F-17, LPG consumption as an automobile fuel has increased at annual growth rates of 10.0% from 1987 to 1990 and 7.2% from 1990 to 1996.

Exhibit F-17
LPG Consumption as Automobile Fuel in Korea

(Unit: 1,000 tons)

				Average Annual Growth Rate	
1987	1990	1993	1996	'87-'90	'90-'96
777	1,036	1,195	1,581	10.0	7.2

Source: *Korea's Energy Policy to Mitigate Climate Change.* Ministry of Commerce, Industry and Energy, 1997, p. 16.

The government will provide support for technology development (including the construction of basic infrastructure) and financial support to purchasers of compressed natural gas (CNG) and electric vehicles. Exhibit F-18 presents cost-effective GHG mitigation potentials for electric, CNG, and LPG vehicles report in the Korea portion of the Asia Least Cost Greenhouse Abatement Strategy (ALGAS) project.[37]

Exhibit F-18
GHG Mitigation Potential of Electric, CNG, and LPG Vehicles

Options	Introduction (year)	Estimated Reduction (1,000 Tons)
Electric vehicles	2005	0.38
CNG vehicles	1999	0.53
LPG vehicles	1998	0.58

Source: *Greenhouse Gas Mitigation Potentials and Costs for Korea.* Proceedings of 1998 Seoul Conference on Energy Use in Manufacturing: Energy Saving and CO_2 Mitigation Policy Analysis, pp. 23-24, May 19-20, 1998, Seoul, Korea.

F.4.4 Reducing Fossil Fuel Use in Power Production

Power generation in Korea has increased substantially over the past two decades: from 37,238 GWh in 1980 to 224,445 GWh in 1997. During that period, nuclear and LNG power generation surged, replacing oil-fired plants which had played a major role in the 1980s. As of 1997, the country's fuel mix for generation is: nuclear 34.4%, coal 29.9%, oil 19.1%, LNG 14.2%, and hydro 2.4%.[38]

[37] This project was funded by the Asia Development Bank and conducted by the Ministry of Commerce, Industry and Energy, Republic of Korea, during 1997-98.

[38] *KEPCO Annual Report,* KEPCO, 1997, p. 19.

Korea's electric sector accounts for 20 % of the country's total CO_2 emission (125.8 MT) as of 1996, but this percentage is projected to grow due to the increasing demand for electricity.[39] According to the 4th Long-Term Power Development Plan (1998), Korea will need 115 more power plants with a total capacity of 53,320 MW by 2015. MOCIE aims to stabilize CO_2 emission per kWh at the level of 0.11 kg-C by increasing the share of low-CO_2 emitting energy sources such as nuclear, hydro power, and LNG in the national generation mix.[40]

In order to curb rapidly increasing CO_2 emissions from power generation, the Korean government and KEPCO have recently begun to consider non-nuclear methods of meeting electricity demand through: 1) demand-side management (DSM); 2) increased use of LNG; and 3) new and renewable energy development. These measures are expected to contribute significantly to reducing fossil fuel uses in power production.

Demand Side Management

Under the 1995 revision of the Rational Energy Utilization Act, energy suppliers are required to develop and implement DSM investment. Accordingly, KEPCO has developed long- term plans for DSM since 1996 to improve efficiency and to lower peak loads. It has invested 58 billion Won (US$64 million) in such DSM programs as load management, time-of-use rates, discounts for voluntary curtailment, and rebates for efficient lighting equipment.[41]

In 1996 alone, these DSM programs contributed to reducing electricity demand by 1,818 MW. KEPCO has set a target of reducing the country's peak load in 2015 by 5,460 MW through DSM, which amounts to a 7.1% reduction in system peak load. In the long-term, it aims to maintain the growth rate of peak demand below the economic growth rate. To realize this goal, KEPCO plans to increase DSM investments from 58 billion won ($64 million) in 1998 to 280 billion won ($311 million) in 2015.[42]

[39] *Trend Analysis of the Framework Convention on Climate Change (FCCC) and Strategies for the Utility Sector,* kihoon Lee et al, KEEI, Seoul, 1998, p. 48.

[40] *The 4th Long-Term Power Development Plan (proposal),* MOCIE, 1998, p. 20.

[41] *National Communication of Republic of Korea,* Republic of Korea, 1998, p. 70.

[42] *The 4th Long-Term Power Development Plan (proposal),* MOCIE, 1998, p. 15.

Exhibit F-19
DSM Programs of KEPCO

Category	DSM programs
Efficiency Improvement	- Dissemination of High Efficiency Lighting Appliances - Rebate for Efficient Electronic Ballasts and Compact Fluorescent Lamps, Demand Controller, Inverter - Advertisements Promoting Electricity Conservation
Load Management	- Installation of Electronic Meters for Large Customers - Discount for Voluntary Demand Curtailment during Summer Peak - Discount for Requested Load Adjustments - Dissemination of Ice Storage Systems and Promotion of Fuel Transfer to Gas Coolers - Dissemination of Energy-efficient Vending Machines - Time-of-Use and Seasonal-Rate Pricing

Until recently, KEPCO's DSM activities had focused on load management rather than strategic efficiency improvement. However, GHG emissions reduction potentials for commercial lighting and industrial motor sectors are very high -- annually 7.1 MT and 14.3 MT, respectively, between 1998 and 2020 according to KEEI.[43] Research done by the Center for Energy and Environmental Policy (CEEP), University of Delaware, also concludes that 6.2 MT of GHG emissions can be avoided by 2030 in the commercial building sector alone, if high-efficiency options are provided.[44] In fact, KEMCO's analysis of the DSM potential in Korea shows that there are substantial room for electricity savings in the industry and building sectors (see Exhibit F-20). With the deregulation of the utility sector which has been underway since 1995, ESCOs will play more important roles in realizing the untapped energy saving potentials.

[43] *Greenhouse Gas Mitigation Potentials and Costs for Korea, Proceedings of 1998 Seoul conference on Energy Use in Manufacturing: Energy Savings and CO_2 Mitigation Policy Analysis*, organized by KEEI, 1998, p. 23.

[44] *CO_2 Mitigation Potential in the Commercial Buildings Sector of Korea: Lighting and Motor Efficiency Options.* John Byrne et al., CEEP, prepared for the Korea Energy Economics Institute, December 1995. "High efficiency" equipment is defined in this study as motor and lighting technology identified in the U.S. Office of Technology Assessment's 1991 study ("Changing by Design: Steps to Reduce Greenhouse Gases") as currently cost-effective (based on payback periods of less than five years).

Exhibit F-20
Electricity DSM projects of KEMCO

Electricity DSM projects		Yearly expected energy savings	Yearly expected demand reduction
Energy audit	6 large plants	34,294 MWh	10,211 kW
	14 large buildings	3,373,414 MWh	1,797 kW
	200 small&medium buildings	17,069 MWh	15,505 kW
Emergency power utilization	3,584 emergency generators		909,633 kW

Source: *KEMCO Annual Report*, KEMCO, 1997, p. 27.

The Green Energy Family Movement (GEFM)[45], jointly launched by KEMCO and several Korean NGOs, has shown how the government, industry, and NGOs can cooperate effectively to achieve an energy efficient economy. The GEFM's primary goals are to reduce electricity demand in the lighting and motor sectors through its Green Lights program and Green Motor program respectively which aims to promote the use of the most efficient equipments. During 1996-1997, 270 companies agreed to participate in the Green Lights program voluntarily. The expected result of the Green Lights program is shown in Exhibit F-21.

Exhibit F-21
Expected Result of Green Lights Program

Invested money	Expected saving of electricity	Peak reduction	Reduction of pollution	
			CO_2	SOx & NOx
36.1 bill.Won ($40 million)	3,700 MWh	63,117 KW	150,000 tons	1,159 tons

Source: *KEMCO Annual Report*, KEMCO, 1997, p. 37.

In order to promote DSM and energy conservation efforts, the Korean government is encouraging

[45] The Green Energy Family Movement aims to promote energy-efficient equipments and appliances through providing consumers with energy-related information and giving various incentives to the companies which voluntarily participate in its program. The "Family" in GEFM, therefore, is a broad concept including all sectors of our society.

KEPCO to further increase their DSM investments annually by 1% of total sales.[46] Moreover, DSM investments will be rate-based in an effort to promote DSM activities by the utility, and the weight given to DSM activities in overall management evaluation of state-owned corporations will be increased significantly. Also, the government is considering a gradual increase in electricity prices and reform of the existing rate structure to reflect the long-term marginal cost of power generation[47] and thus to facilitate energy conservation and improvement of energy efficiency.

Increased Use of LNG

The increased use of LNG-fired power plants has contributed to lower CO_2 emissions in Korea. While LNG-fired power generation was introduced in 1986, its share increased to 13.2% of total generation in just ten years. National fuel switching policy encouraged this shift to LNG in order to ease environmental problems. In fact, LNG plants in Korea emit just 549g of CO_2 per kWh, while coal plants emit 842~1,025g per kWh (see Exhibit F-22).

Exhibit F-22
CO_2 Emissions by the Type of Power Plants (1996)

The type of power plant	Power generation (GWh)	CO_2 Emissions	
		Per kWh emission (g- CO_2/kWh)	Total emission (1,000 CO_2 tons)
Anthracite Coal	6,949	1,025	6,617 (7.3%)
Bituminous Coal	52,701	842	44,861 (49.4%)
Heavy-Oil	26,633	732	19,405 (21.4%)
LNG	30,944	549	16,799 (18.5%)
Combined Cycle	3,868	805	3,067 (3.4%)
Total	121,095	732	90,750 (100%)

Source: *Trend Analysis of Framework Convention on Climate Change (FCCC) and Strategies for the Utility Sector,* Kihoon Lee et al, KEEI, Seoul, 1998, p. 48.

[46] *The 4th Long-Term Power Development Plan (proposal),* MOCIE, 1998, p. 15.

[47] In spite of a 5.9% rate increase in 1997, KEEI estimates that the long-term marginal cost of electricity generation is 20% higher than the current rate. *Foreign Exchange Crisis and Energy Industry,* KEEI, 1997, p. 12.

Currently, KEPCO operates four LNG-powered combined cycle plants in four satellite cities to supply electricity and heat as part of the "Satellite Cities Development Plan" promoted by the Korean government. The Seoinchon combined cycle power plant, located 20 minutes from Seoul, achieved one of the highest thermal efficiency rates of 45.9% and lowest discharges of NOx (below 50 ppm) in the Korean electricity system. Such LNG-powered combined cycle plants emit as little as 0.108 kg-C/kWh, which is just 40% of the carbon emission rate from coal-fired power plants.[48]

According to the 4th Long-Term Power Development Plan, Korea will add 11 new 450MW LNG-powered combined-cycle power plants to its generation mix. Most of them are expected to be built by private companies.[49] To promote increased use of LNG, new terminals will be constructed along with an expansion of LNG distribution facilities. Korea will also diversify its LNG import sources and participate in overseas gas field developments in order to achieve a stable supply of LNG. [50]

F.4.5 New and Renewable Energy Development

In 1987, the Korean government enacted the New and Renewable Energy Development and Promotion Act to reduce Korea's high import dependence on fossil fuels and to minimize the environmental impact of energy consumption. An Alternative Energy Technology Development Plan was established based on this Act to develop and disseminate twelve major alternative energy technologies including solar thermal, photovoltaics, bioenergy, small hydro power, fuel cells, wind power, waste and geothermal energy.

Since 1988, the Korean government has invested 79.2 billion Won ($88 million) in photovoltaic power facilities, 33.9 billion Won ($38 million) in waste power facilities, and 5.7 billion Won ($6 million) in small hydro power facilities. As a result, the annual growth rate of new and renewable energy has been around 23% between 1991 and 1996.[51]

[48] *KEPCO Annual Report,* KEPCO, Seoul, 1997, p. 17.
[49] *The 4th Long-Term Power Development Plan (proposal),*MOIR, 1998, p. 52.
[50] *Korea's Energy Policy to Mitigate Climate Change,* MOIR, 1997, p. 15.
[51] *National Communication of Republic of Korea,* ROK, 1998, p. 63.

Exhibit F-23
New and Renewable Energy Consumption by Year

(Unit: 1,000 TOE)

	1991	1993	1995	1996	Annual Growth Rate
Total Energy Demand	103,622	126,879	150,437	165,209	9.6%
New and Renewable Energy	413	649	909	1,162	23.0%
Share (%)	0.4	0.5	0.6	0.7	-

The long-term goal of the Korean government is to realize 2% of energy demand through new and renewable sources by 2006.[52] About 110.7 billion Won (US $120 million) was invested for related R&D during 1988-96, with about half of the funds being provided as matching funds by private sector participants. Currently, Samsung Electronics and Samsung Heavy Industry, LG Refinery and LG Siltron, and Han-Kuk Fiber are the leading companies involved in new and renewable energy development, especially photovoltaics, wind power, and fuel cells.[53]

In order to induce more private investments in new and renewable energy projects, the Korean government has provided various financial incentives since 1980. For example, 5 % of the total investment in such projects is treated as tax credit. Loans are also provided at 5% interest on up to 80% of the total investment. Moreover, the government is considering a requirement that KEPCO must buy electricity generated by qualified alternative energy suppliers, especially suppliers of new and renewable energy sources.[54]

Exhibit F-24
Goals for Promoting New and Renewable Energy in 2006

(Unit: thousand TOE)

	1995 (actual)	2001	2006	Ratio of 2006 to 1995
Solar thermal	22.1	101.6	277.2	12 times
Bioenergy (Methane gas)	59.4	98.1	445.8	8 times
Waste energy	804.5	2,817	4,675.8	6 times

[52] *KEMCO Annual Report*, KEMCO, 1997, p. 31.

[53] 1997 Handbook on new and renewable energy, KEMCO, 1998, pp. 55-56.

[54] It is also considering a program to allow qualified electricity producers to sell electricity directly to consumers. *The 4th Long-Term Power Development Plan (proposal)*, MOCIE, 1998, p.19.

(Unit: thousand TOE)

	1995 (actual)	2001	2006	Ratio of 2006 to 1995
Photovoltaics	2.3	14.0	39.0	17 times
Wind power	0.1	7.9	32.8	--
Small hydro power	20.4	57.2	86.7	4 times
Fuel cells	0.3	13.6	132.0	--
Total	909.1	3,109.4	5,698.3	6 times

Source: *KEMCO Annual Report*, KEMCO, 1997, p. 31.

As shown in Exhibit F-24, waste energy, mainly derived from the burning of industrial wastes such as wood and pulp, makes up the primary contribution to the utilization of renewable energy, along with bioenergy. However, other advanced renewable technologies such as wind turbines, photovoltaics, and fuel cells are also expected to play important roles in reducing fossil fuel use in power generation in the future.

Wind power in Korea is now undergoing field testing with a 170 KW system installed at Moo-Ahn County in 1994. A feasibility study for a pilot-phase wind power generation plant on Cheju Island is also underway. Depending on the outcome of the study, the Korea government will decide whether to build the power plant using both photovoltaic and wind power on small Korean islands which do not have an access to the national electricity grid. In addition, the national government, along with the Cheju provincial government, is currently constructing a wind power plant with electricity generation capacity of 5,200 kWh as a pilot-phase local energy project.[55] KEPCO is also planning to build wind power plants with a total capacity of 14.8 MW by 2006 as part of its long-term power development plan.[56]

Commercial production of solar energy systems in Korea has improved in recent years. A photovoltaic production facility (for silicon technology) with the capacity to manufacture several kWs was constructed in 1992. A demonstration project for a 100 kW photovoltaic generation facility was installed on Hodo Island in 1993. Its operating field tests indicate that the technology meets international performance standards.[57]

Electricity generation costs of photovoltaic plants are similar to those of diesel power plants in Korea. Photovoltaic power plants, however, do not raise the noise problems or encounter fuel delivery problems (and costs) associated with diesel generators. Importantly, they also have much lower maintenance costs. Considering these facts, the Korean government has concluded that

[55] *National Communication of Republic of Korea.* Republic of Korea, 1998, p. 66.
[56] *The 4th Long-Term Power Development Plan,* MOCIE, 1998, p. 19.
[57] *Korea's Energy Policy to Mitigate Climate Change,* MOCIE, 1997, p. 17.

photovoltaic power plants would be the most appropriate power systems for small islands with less than 50 households. Beginning in 1998, the government plans to build such plants on 100 small, remote islands.[58]

Research jointly conducted by KIER and CEEP indicates that photovoltaics can also be cost-effectively used for grid-connected peak-shaving applications in Korea's urban areas. Case studies of photovoltaic peak-shaving application in Seoul and Taejon indicate that energy and demand savings generated by these systems are greater than their after-tax costs. [59] KEPCO and the UNESCO Commission of Korea are evaluating this technology for demonstration by 2000.

F.4.6 Protecting Carbon Sinks

Korea's forests cover about 66% of the country's total land area. The net absorption of CO_2 by forests was estimated for 1990 at 26.2 MT, or 10% of total net CO_2 equivalent emissions in that year.[60] The government has implemented policies to protect existing forests and enhance the carbon pool. Included in these policies are forest planning, designation of reserve and protective forests, and control of forest fires, diseases and pests as laid out in the Forest Law. In an effort to expand the carbon pool, the government has been carrying out afforestation and reforestation programs.

Protection and Conservation of Existing Forests

Forest Planning. To achieve forest sustainability through efficient management, the Forest Law calls for a forest planning to promote reforestation, certain silvicultural and harvesting practices, and disease and pest control. Ten-year forest plans at the national, regional, and local levels are required. The preparation of private forest management plans by timber companies is required by the government and, in most cases, commissioned through Forestry Cooperatives, a specialized forest management organization. Government funding is provided for these private management plan, which play an an important role in sustainable management of Korea's carbon sink sources. Private forests managed under the forest plans take priority in governmental assistance through subsidies, loans, and various tax systems.

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[58] *National Communication of Republic of Korea,* Republic of Korea, 1998, p. 65.

[59] The Economic Viability of Dispatchable Peak Shaving PV Systems in Commercial Buildings of Korea, Proceedings of the International Solar Energy Society, 1997, Solar World Congress, Vol. 7 (August), pp. 94-103. The study employed load data for three Korean buildings -- the World Trade Center, Hyundai Department Store, and Lotte Hotel -- and used KEPCO electricity prices to conduct the analysis.

[60] *National Communication of the Republic of Korea.* Republic of Korea, 1998, pp. III and VIII.

Designation of Forest Reserves. In Korea, the forest reserve system was established to restrict conversion of forests to other land uses in order to maintain and enhance timber production and other public benefits. Forest reserves, which accounts for 77% (almost 5 million ha) of total forests in 1996, are essential for the conservation of carbon sinks.

Designation of Protected Forests. Protected forests are designated to conserve forest ecosystems and to enhance environmental benefits including recreation and watershed preservation. Timber harvesting is restricted to maintain maximum carbon sink capacity. Nature parks, protected forests for public benefit, wildlife habitats, and natural ecosystem reserves accounted for 23% (1.5 million ha) of all forest land in Korea in 1996.

Acid Rain Damage Control. To monitor forest degradation by acid rain, monitoring survey systems and survey procedures have been improved . To strengthen cooperation among countries in Northeast Asia for the control of acid rain damage, several joint research projects are being undertaken with China, Japan and Mongolia.

Prevention of Erosion and Rehabilitation of Deforested Lands. Preventive erosion control projects have been undertaken in areas which are vulnerable to landslides on a yearly basis. Since 1997, such projects have also emphasized landscape enhancement in communities in mountainous areas which are vulnerable to landslides. The development of a computer-aided erosion control plan and mechanized technology is also being emphasized. Forestry Cooperatives is initiating a specialized forest engineering group.

Regional and International Cooperation for the Conservation of Global Forests. Korea participates in regional and international sustainable forest management programs intended to promote better understanding of environmental value of forests including their critical role in conservation and biological diversity.

Policy Measures for Enhancing Carbon Pool

Afforestation. In Korea, the government encourages the conversion of abandoned crop land in rural areas to forests. When crop land is converted, subsidies are provided from 90% to 100% of the total conservation costs. Afforestation for pollution prevention and noise reduction are also encouraged in urban areas.

Reforestation. In Korea, reforestation has been actively undertaken converting natural forests that have been adversely affected by fire, disease, and pest infestation to plantation forests. Their activity is expanding the national carbon sink capacity. Ninety percent of total reforestation costs in private forests are subsidized by the government.

Policy Measures for Silvicultural Practices. To enhance biomass, various silvicultural practices such as removing shrubs and vines, and fertilization are actively pursued. Forests being managed

with advanced silvicultural techniques accounted for 4%of the forested area in Korea in 1996. In private forests, 80% of the costs of advanced for silvicultural management are subsidized by the government.

Improving Timber Utilization. Timber plays an important role in the carbon reservoir, but demand for timber is increasing continuously in Korea. To increase carbon storage capacity, new policies aimed at improved utilization of timber have been promulgated. These included: multi-use planning for small-size timber and timber treatment for increased longevity of wooden products.

Summary

To increase Korea's forest resources and to take advantage of their role as carbon sinks, development funds with loan rates of 3% (significantly lower than current bank rates) as well as tax exemptions and credits (for income and inheritance taxes) are provided.

Exhibit F-25 shows cost-effective GHG mitigation potentials from the establishment of urban forests, the enhanced regeneration to carbon-efficient species, and the improved management of natural forests.

Exhibit F-25
GHG Mitigation Potential of Option in the Forest Sector

	Estimated GHG Emissions Reduction (Ton of CO_2 equiv./yr)
Establishment of Urban Forestry	1097
Enhanced Regeneration to Pinus Koraiensis	312
Enhanced Regeneration to Larix leptolepis	451
Improved Management of Natural Forests	364

Source: *Greenhouse Gas Mitigation Potentials and Costs for Korea.* Proceedings of the 1998 Conference on Energy Use in Manufacturing: Energy Savings and CO_2 Mitigation Policy Analysis, pp. 23-24, May 19-20, 1998, Seoul, Korea.

F.5 ACTIONS THAT EXPLICITLY SUPPORT THE UNFCCC OR CONTROL GHG EMISSIONS

Korea's National Assembly ratified the UNFCCC in 1994. As a member of the UNFCCC, Korea has actively participated in Conference Of Parties meetings and is implementing a broad range of policies and measures to reduce GHGs. Since Korea joined the OECD in 1996, its role in

reduction of CO_2 emissions under the UNFCCC has been hotly debated at the COP meetings. In 1998, the Korean government announced that it has voluntarily decided to reduce its CO_2 emission from 2018. The country has made a strong commitment, within the limits of its economic and social capability to take action in concert with the UNFCCC signatories to combat the prospect of global warming. Listed below are specific actions taken to date to support UNFCCC objectives and control GHG emissions.

F.5.1 National Action Plans

In accordance with its UNFCCC responsibilities, Korea has undertaken the preparation of cost-effective GHG mitigation action plan to be completed by 1999. The action plan will identify appropriate policies and measures to mitigate climate change, which includes the enforcement of current policies described in Section III above, along with the introduction of new strategies.

During 1997, Korea's action plan activities focused on the refinement and expansion of national statistics on greenhouse gas emissions, the development and testing of a model for analyzing options for the reduction of greenhouse gases, establishment of a database of greenhouse gas reduction alternatives, and a review of developed countries' action plans.

In 1998, this research will concentrate on the following activities: preparation of a forecast of mid-and long-term emissions from greenhouse gases, an analysis of potential reductions, an analysis of joint implementation opportunities, and an analysis of legal and administration requirements to implement a national plan.

In 1999, the following will be the focus of planning efforts: establishment of reduction goals and additional technologies and policies to reduce GHG emission, determination of reduction priorities for initial action, and an analysis establishment of action plans by sector, promulgation of enforcement regulations, and an examination of international cooperation initiatives most suitable for Korea.

F.5.2 National Communications

The Korean government asked the Korea Energy Economics Institute (KEEI) to perform the national inventory survey of GHG emissions to meet the requirements of Articles 4 and 12 of UNFCCC in 1994. The research done by KEEI had four objectives: 1) prepare detailed national statistics on greenhouse gas emissions and absorption; 2) analyze potential influences of global warming on Korea; 3) research national policies for establishing a cost-effective plan to reduce greenhouse gases; and 4) establish a plan to minimize the economic burden of GHG emissions

reduction. Based on KEEI's 1995 report[61], Korea has submitted a national communication which takes into account UNFCCC guidelines for Annex I parties. Thus, while Korea is not an Annex I party, it has already taken steps to cooperate with UNFCCC goals that exceed its responsibilities as a developing country.

F.5.3 Global Environment Facility

Korea contributed US$ 5.6 million to the GEF in 1996-1997 to protect the global environment and will actively participate in the second cycle of GEF funds.[62] Korea will become a GEF board member in 1999.

F.5.4 Joint Implementation

Korea believes that Joint Implementation initiatives with North Korea will be beneficial for both parties, because North Korea's energy efficiency is low, and there is substantial potential to reduce GHG emissions for the peninsula as a whole through suit cooperation. Possible projects include retrofitting North Korea's old power plants with pollution-reducing and energy-saving technology, constructing new and high-efficiency plants and developing renewable-energy options. Also, Korea is exploring cooperation with China and southeast Asian countries in the fields of power generation, forest management, and soil conservation.[63]

F.5.5 National Policies Adopted to Reduce GHG Emissions[64]

The Korean government set a national goal of GHG emissions reduction by 2020 to 32 million TC over the BAU (14.2% reduction) through demand- and supply-side efficiency improvements, fuel substitution, and technological innovations, as shown in Exhibit F-26:

- Reduction of 15.6 million TC of GHG will be achieved through nationwide energy efficiency and conservation programs.

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[61] *A Study for Preparing Korean Country Report under the Framework Convention on Climate Change and Response Action Plan,* KEEI, 1995.

[62] *National Communication of Republic of Korea,* ROK, 1998, p. 139.

[63] *Trend Analysis of Framework Convention on Climate Change (FCCC) and Strategies for the Utility Sector,* Kihoon Lee et al, KEEI, Seoul, 1998, p. 197.

[64] This section is based on the executive summary of *GHG Reduction Plan in the Energy/Industry Sector* published in October 1998 by the Ministry of Commerce, Industry and Energy and the Korea Energy Economics Institute.

- 9.9 million TC of GHG will be reduced through fuel substitution in the power generation sector with nuclear and LNG and through expansion of town gas use in the residential and commercial sectors.

- Additional reduction of 6.2 million TC of GHG will be achieved through technological innovations.

Exhibit F-26
GHG Reduction Projection in the Energy/Industrial Sectors

(Unit: million TC)

Sector		BAU		Reduction Scenario		Reduction		Reduction %	
		2010	2020	2010	2020	2010	2020	2010	2020
Demand	Industry	92.8	114.7	88.0	106.9	4.7	7.8	5.1	6.8
	Transport	41.1	48.1	39.9	43.5	1.2	4.6	3.0	9.6
	Residential Commerce	47.2	60.5	45.1	57.3	2.1	3.2	4.4	5.3
Supply	Power					1.0	6.5		
	LNG					2.0	3.4		
Technology						2.8	6.2		
Total		181.	223.	173.	207.7	13.9	31.6	7.7	14.2

Source: *GHG Reduction Plan in the Energy/Industry Sector.* Ministry of Commerce, Industry and Energy and Korea Energy Economics Institute, 1998.

Sectoral Demand-Side Policy Measures

Rational energy pricing and tax reform will be pursued in combination with energy industry restructuring to allow for greater competition which will eventually lead to energy efficiency improvements and GHG emissions reduction. Legal provisions of energy pricing and tax reforms will be made.

Industrial Sector

- A voluntary agreement on GHG reduction will be pushed forward in the energy and GHG intensive industries such as steel, petrochemical, cement, and power generation. This voluntary agreement will be extended into other industries.

- Various incentives and technical and informational supports will be offered to promote the voluntary agreement.

- Industrial firms that install highly energy-efficient equipment will be eligible for financial supports.

Transportation Sector

- Highly efficient vehicles and compact cars will be promoted through a variety of incentives such as discounted parking fee and exemption from traffic jam fees.

- Corporate Average Fuel Efficiency (CAFE) will be introduced to meet the targeted fuel consumption.

- Transport modes through sea-bound and railroad freights will be encouraged to effectively reduce GHG emission.

Residential and Commercial Sector

- Installation of energy efficient equipment will be promoted through strengthening minimum efficiency standards as well as through active participation of ESCOs.

- Building design standards will be established to incorporate the energy efficiency concept in building design.

- Energy management system will be adopted to enhance building's energy efficiency.

- Expansion of district heating and small scale combined heat and power will be promoted.

Major Supply-Side Policy Measures

As part of clean energy supply policies, nuclear and LNG power generation will be expanded. Also, town gas will be expanded with the provision of natural gas supply infrastructure.

- Eighteen additional nuclear power plants (18,600MW) will be constructed between 1998 and 2015.

- Public acceptance program for national and local residents regarding the safety of nuclear power plants will be strengthened.

- Efficient and safe methods of nuclear wastes disposal and nuclear power plant decommissioning will be developed.

- New and highly efficient combined LNG power plants will be introduced.
- Participation in long-term northeastern Asian gas development projects and pipeline construction will be considered.
- Infrastructure for natural gas supply will be expanded through the construction of three additional port facilities and lengthening of the gas pipeline network.

New Technological Innovation Policies

Up until 2010:

- Application and dissemination of existing efficiency technologies
- Speed-up of the application of technologies under the 10-Year Energy Technology Development Program
- Search for future innovative technologies

After 2010:

- Upgrade and dissemination of technologies being developed under the 10-Year Energy Technology Development Program
- Development of decentralized energy technologies such as fuel cells, highly efficient solar thermal and photovoltaics, hydrogen, etc.
- Development of industrial processing technologies of carbon dioxide segregation and disposal.

Other GHG Emissions Reduction Policies

- From 1999, a demonstration project of emissions permits trading will be implemented among energy intensive industries such as steel, petrochemical, cement, and power plants whose annual energy consumption exceeds 10,000TOE
- After 2000, emissions permits trading will be expanded to those companies whose annual energy consumption is more than 5,000TOE. From 2010 to 2020, the trading will include companies which consume more than 2,000TOE annually.

- Joint implementation projects and Clean Development Mechanism will be explored and promoted for participation by Korean enterprises.

- Promotion of joint projects through the existing bilateral channel between developed and developing countries.