Win-Win Climate Negotiations

Robert Repetto

Crucial but difficult international negotiations, culminating in the December 2009 meeting in Copenhagen of the Parties to the United Nations Framework Convention on Climate Change, will establish the framework for the period following the expiration of the Kyoto Protocol in 2012. It is vital that all major emitting countries negotiate and implement firm agreements to reduce global greenhouse gas emissions.

The expectations for the developed (Annex I) countries are clear – they need to strengthen the binding emissions caps established at Kyoto and bring in the United States to set a trajectory toward a reduction of 80 percent by 2050. Yet developing countries also have a stake in the game. Even though they have less historical responsibility for climate change, its effects will fall unequally on them. What can they do to make a deal that will reduce their climate risk even as it allows their economies to grow?

For these non-Annex I countries, the negotiating strategy for the post-Kyoto period should focus on "win-win" mitigating policies and measures that would reduce greenhouse gas emissions while promoting, not limiting, their economic growth. Limiting their commitments in this way would enable them to participate in stabilizing global concentrations, while satisfying demands from Annex I countries that they make significant commitments. Fortunately, such "win-win" opportunities are ample.

In return for commitments on policies and measures by non-Annex I countries, the Annex I countries could offer a variety of inducements. These might include, for example,

- More ambitious targets and timetables for their own mitigation trajectories. If fears of leakage of emissions to developing countries are assuaged, Annex I countries could reasonably become more ambitious.

- Less restricted access to their permit markets for CDM projects. The European Union has restricted and draft U.S. legislation has refused the purchase of offset credits from other jurisdictions, partly from reluctance to accept a "business as usual" baseline that would force Annex I countries to bear the cost of all mitigation actions in non-Annex I countries. This reluctance could be overcome if the latter countries committed to significant policies and measures.

- Greater cooperation on technology sharing and adaptation financing, which are both of high priority in some

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non-Annex I countries, especially those with lowest incomes and greatest vulnerabilities.

In these negotiations, non-Annex I countries could table offers of specific policies and measures they would be willing to adopt, together with timetables for implementation. Countries would accompany their offers of specific policies and measures with estimates of their probable efficacy, in terms of greenhouse gas mitigation. Negotiations would center on finding an equitable balance of commitments among participating countries. In this approach, an international secretariat would provide a negotiating venue; keep track of countries' offers; provide independent resources for estimating the efficacy of particular measures; record and document agreements; monitor and report on implementation; and provide a forum for amending agreements and settling disputes. These functions are analogous to those undertaken by the World Trade Organization in the context of international trade negotiations.

Despite the very difficult economic circumstances in which international climate negotiations will take place in 2009, successful outcomes are more urgently needed now than when the Kyoto Protocol was concluded. Focusing negotiations on implementation of "win-win" opportunities to reduce emissions in non-Annex I countries can be successful in producing agreements that will be implemented and will result in significant reductions, and is one of the few imaginable approaches with that potential.

What are "win-win" mitigation measures and what is their potential scope for emission reductions? In fact, their scope is sufficiently broad that such commitments in the next negotiating round can make a major contribution. By a narrow definition, a win-win measure is one that offers a favorable economic benefit-to-cost ratio or favorable financial return on investment when considered apart from any value ascribed to the reduction in greenhouse gas emissions it brings about. For example, an energy efficiency investment that offers a two-year payback period, implying a rate of return around 50 percent, and at the same time reduces electricity consumption and carbon dioxide emissions is a win-win measure.

A broader definition would extend the economic benefit-to-cost criterion to include important non-market benefits and costs, such as environmental damages unrelated to greenhouse gas emissions. For example, an investment in rehabilitating a coal-fired power plant to improve its heat rate would reduce carbon dioxide emissions[1] because it would consume less coal per kilowatt hour produced, but would also reduce other damaging emissions of particulates, sulfur and nitrogen oxides, mercury and other air quality pollutants. The resulting improvements in mortality and morbidity, as well as the savings in health care costs, would be important economic benefits, even if they were not reflected in the financial costs and returns of the individual power plant. This broader definition of "win-win" measures extends their potential scope considerably.

The United Nations Foundation and others have called on governments to

[1] Assuming that its load factor remained the same.

double the rate of national energy efficiency improvements in their countries over the next decade. Not only is this achievable, it can be done at a significant savings in energy costs and with attractive rates of return on the needed investments. Many studies have documented the impressive potential for "win-win" mitigation measures, both in the Non-Annex I countries and in Annex I countries, emphasizing the abundant opportunities for improvements in energy efficiency, using technologies and approaches already tested and available.

For example, a recent study by McKinsey & Co. and the Conference Board estimated that about 20 percent of current U.S. emissions could be eliminated at a profit.[2] A broader study for all the G8 countries estimated that the rate of improvement in energy efficiency could be doubled with incremental investments of $400 billion, which would make a substantial contribution to overall mitigation goals. These profitable investments would result in annual energy savings increasing to $500 billion by 2030, with an average internal rate of return on investment of 20 to 30 percent.[3]

The potential for cost-saving energy efficiency gains is even larger in important non-Annex I countries such as India and China, where competitive market forces were weaker in past decades and energy prices were controlled. A recent report by the McKinsey Global Institute estimated that developing countries could reduce their growth in energy consumption from 3.4 percent per year to 1.4 percent – almost a 60 percent reduction – just by adopting existing energy-efficient methods and technologies that are cost-saving and pay for themselves. By 2020 their energy use would then be 22 percent below projected levels.[4] The Asian Development Bank has estimated that almost a quarter of India's energy use could be eliminated through profitable energy efficiency improvements.[5] These opportunities include more efficient household lighting, fans, appliances, building shells and windows; and similarly, more efficient industrial motors, furnaces, boilers, HVAC systems and other stationary and mobile equipment. Energy efficiency throughout the electricity supply system can also be significantly improved by improving the quality of coal supply, rehabilitating low-efficiency power plants, upgrading the transmission network, and reducing distribution losses.

Even if commitments are made, however, realizing this potential for efficiency gains will require enactment of specific measures to reduce market, institutional, financial and regulatory barriers and to correct misalignments of financial incentives. It cannot be assumed that cost-effective investments and market decisions will simply happen, especially not at the pace that is

[2] McKinsey & Co., "Reducing U.S. Greenhouse Gas Emissions: How Much and at What Cost?", December 2007.

[3] Expert Group on Energy Efficiency, "Realizing the Potential of Energy Efficiency: Targets, Policies and Measures for G8 Countries," United Nations Foundation, Washington, DC, 2007.

[4] McKinsey Global Institute, "Fueling Sustainable Development: The Energy Productivity Solution," October 2008.

[5] Asian Development Bank, Technical Assistance Report, "India: Facilitating the Operation of the Energy Conservation Fund 'Energy Smart' in Madhya Pradesh," Manila, Philippines, October 2008.

needed. Forward-looking policies and measures are needed.

These include up-to-date energy efficiency standards for all important energy-using residential and industrial equipment and for motor vehicles as well. National energy conservation building codes should be enacted and enforced. Electric utilities will need incentives and mandates to implement aggressive demand-side-management (DSM) programs and to put energy savings on a par with capacity expansion in resource planning. Large investments are needed to rehabilitate or replace old, inefficient power plants, to upgrade transmission and distribution networks, to install or replace electricity meters, and to improve electricity sector regulations and management. For example, in many countries regulatory changes are needed in order to realize the substantial potential for co-generation and combined heat and power plants.

These investments in energy efficiency improvements by no means exhaust the potential for "win-win" greenhouse gas mitigation, either in Annex I or non-Annex I countries. In both regions, direct and implicit subsidies to energy industries grossly distort demand and supply patterns, leading to inefficient production and excessive energy use. In India, for example, energy subsidies to agricultural and household electricity users, and to kerosene and liquefied petroleum gas have imposed a fiscal burden exceeding one percent of GDP in recent years. These subsidies cannot be justified on poverty grounds, since by far the greater part of the benefits go to those who are not poor.[6]

Fertilizer and other agricultural subsidies are another example common to developed and developing countries. In the United States and Europe, farm subsidies lead to excessive and inefficient fertilizer use, resulting in greater greenhouse gas emissions and significant deterioration in water quality because of runoff and eutrophication. In India, these subsidies impose a heavy fiscal burden, distort both fertilizer production and use, and lead to significant increases in greenhouse gas emissions of nitrous oxides.

The forestry sector also offers other significant opportunities. In such countries as India and China, where forests are depleted in many regions, investment in reforestation is economically justified in order to provide fuelwood and building materials and to stabilize soils, aside from the benefits of carbon sequestration. In heavily forested countries such as Indonesia, where a large fraction of carbon emissions arise from forest fires and deforestation, forest policy reforms would greatly improve the sustainable returns from forest resources while reducing carbon emissions and increasing sequestration.

Negotiating on policies and measures (PAMs) is an approach that has been well explored in past years. Although the Kyoto Protocol adopted national targets and timetables, supported by cap-and-trade programs, as the dominant approach among Annex I countries, a focus on policies and measures

[6] Ministry of Finance, "Central Government Subsidies in India," New Delhi, December 2004.

nonetheless retains considerable support in Europe, Japan and elsewhere. The International Energy Agency and other bodies have compiled lengthy inventories of policies and measures that have been, or could be, adopted. There is also considerable experience and information on the efficacy of many such measures.

The many advantages of a focus on policies and measures have been identified. Among them:

- Commitments on policies and measures are consistent with "the common but differentiated" responsibilities that countries agreed to in the Framework Convention.

- They offer flexibility for countries to choose the measures that make most sense in their particular situations, which differ greatly among countries.

- They can be consistent with sectoral approaches favored by some countries, including Japan.

- Unlike national or sectoral targets and timetables, however, which require further implementing policy decisions, commitments on PAMs go directly to the actions that will be taken.

- Implementation of commitments on policies and measures is comparatively easy to monitor.

Negotiations with non-Annex I countries on policies and measures can complement the Clean Development Mechanism, the principal means devised in the Kyoto Protocol for non-Annex I countries to cooperate in mitigation activities. The CDM is essentially a mechanism designed for project-level activities. Despite efforts to develop programmatic CDM activities, the CDM is not easily extended to policy changes or for broader programs. These are extremely important mitigation options and much more easily covered by direct negotiations on policies and measures.

Moreover, in order to combat the perverse incentives inherent in the Clean Development Mechanism, elaborate safeguards have been necessary to ensure "additionality" and to construct realistic hypothetical baselines describing what might have happened in the absence of the project to be credited. Nonetheless, there is considerable skepticism in policy circles in Europe and Washington that CDM projects have all resulted in real and additional emission reductions.

This process has created its own dilemma: ensuring adequate safeguards has raised transaction costs and delayed project approval, but in the absence of such safeguards, incentives for participants in the CDM to increase "deal flow" leads to projects of dubious merit. The need for a great deal of external oversight and evaluation limits the expansion of the Clean Development Mechanism to the scale needed to accomplish even a stabilization of emissions in non-Annex I countries. These difficulties are absent from commitments on policies and measures, which can be evaluated simply on the

basis of their potential efficacy and can be of significant scale.

E.U. and U.S policy is adding to uncertainty about the future role of the CDM. To pressure major polluters from the developing world to adopt binding emission reductions, E.U. regulators have threatened to ban the import of certified CDM credits from large non-Annex I countries into the European Union's own Emission Trading Scheme, by far the world's largest cap-and-trade program and the main market for CDM credits. In Washington, there is reluctance to adopt a system that transfers a great deal of wealth from the struggling U.S. economy to China and other economic competitors.

The "additionality" requirement in the CDM also prescribes an economically irrational requirement that direct negotiations on policies and measures avoid. Under CDM rules, "win-win" projects and programs are inherently ineligible for credit, because if they are financially and economically rewarding without such credits, it is assumed that they would be implemented through normal market processes, unless the proponent can establish that sufficient barriers exist to prevent implementation. This additionality requirement rules out those activities and projects that can reduce emissions at the least cost or the greatest gain, which are precisely the ones that developing countries should first carry out. Commitments on policies and measures can remove this irrationality and can be a useful complement to the Clean Development Mechanism.

The approach to negotiations advocated here has an important analogy in trade negotiations under the WTO and the GATT. Over many negotiating rounds, those negotiations have significantly reduced tariffs and other trade barriers, contributing significantly to an expansion of trade and increases in world incomes. Trade negotiations do not deal with targets and timetables for trade expansion, with few exceptions. Instead, they deal with measures, such as tariff reductions, that countries are willing to take in exchange for reciprocal measures by other countries. Monitoring and dispute resolution procedures focus on countries' implementation of such measures and adherence to them. Moreover, trade negotiations are well suited to "win-win" negotiations. It is well established in economics that trade barriers injure the national economies of those countries that impose them, as well as the economies of their trading partners. Countries would benefit even if they lowered their trade barriers unilaterally, with no reciprocity from other countries, and many countries have actually done so. In trade negotiations, countries are committing only to do what is in their economic self-interest, which is the main reason why these negotiations have succeeded. If climate negotiations adopt the analogous approach, they too can succeed.

Annexes to this paper identify and describe an extensive list of specific policies and measures needed in major countries to achieve potential gains in energy efficiency, rationalize energy production and consumption, and to reduce carbon emissions from other sectors, including agriculture and transportation. There is ample scope for international negotiations covering the immediate post-Kyoto period on "win-win" policies and measures that, if

adopted, would bring about significant progress between now and 2020 in mitigating greenhouse gas emissions.

If this approach were to be adopted for the immediate post-Kyoto period, it is legitimate to ask what the next phase could be, after all the "low-hanging fruit" of cost-saving mitigation measures were harvested. Fortunately, one of the best characteristics of low-hanging fruit is that it grows back. After another decade there will be other attractive investment opportunities and cost-saving measures. Rapid technological progress and innovation, spurred by the flow of investment and entrepreneurial talent into technologies that reduce carbon emissions, will continue to lower mitigation costs, as has happened in past decades. Renewable energy technologies that are now more expensive in financial terms may attain the cross-over point of competitiveness with conventional fossil fuel energy sources. There will be other win-win opportunities. By that time, if Annex I countries make good on their post-Kyoto commitments, developing countries may also be willing to accept more far-reaching responsibilities. An opportunity to achieve meaningful cooperation on climate protection now should not be discarded.

Negotiations that center on "win-win" policies and measures can overcome the obstacles to reaching an effective post-Kyoto agreement on climate stabilization. If negotiations are based on actions that are in countries' economic self-interest, there is little reason for governments to free-ride, even when the world economy is in a severe slump, when unemployment is rising, businesses are failing, trade is shrinking and credit is contracting in all the world's major economic regions. In China and elsewhere in Asia, tens of millions of workers formerly employed in export industries have lost their jobs, leading to fears of widespread social unrest. Developing countries will not accept commitments that imply significant restrictions on their economic growth. Policy makers and politicians are rightly afraid of placing additional burdens on consumers or producers in the form of higher energy prices. Therefore, in these negotiations developing countries are highly unlikely to accept binding restrictions or national caps on greenhouse gas emissions comparable to those in the Kyoto Protocol for Annex I countries. Only "win-win" measures have potential appeal.

At the same time, the Annex I countries will not accept that the world's other major emitters continue with "business as usual" as the underlying principle. This would risk substantial leakage of emissions to the developing world and a flight of industrial investment and jobs to emerging industrial powers in the developing world. China, India, Brazil and other such countries are much stronger industrial competitors now than 12 years ago at Kyoto. A "business-as-usual" baseline would also imply major financial transfers from North to South, whether under the Clean Development Mechanism, a global emission trading system, or another cooperative arrangement. As the U.S. Senate made clear prior to Kyoto, it will not agree to significant mitigation costs unless the major developing countries agree to undertake significant actions as well. The very rapid economic growth in the developing world during the last decade

has raised its share of global emissions, underlining the futility of emissions reductions only among the Annex I countries.

Therefore, the feasible negotiating space is extremely constricted. Countries that undertake such agreements and actions must judge them to be in their national interests. Moreover, to be sustainable, agreements must continue to be consistent with national self-interest not only when they are ratified but also in future years, or else countries will desist in their implementation efforts, as several countries have done during the Kyoto Protocol period. The basic approach outlined above, requiring large non-Annex I countries to commit only to significant “win-win” policies and measures, can uniquely succeed within these constraints.

Annex A
Win-Win Options in India

This section of the report surveys a range of significant win-win options available in India to reduce greenhouse gas emissions while saving money or providing an attractive return on investment. The survey is by no means exhaustive but supports the hypothesis that there is much that India can do in the near future to lower emissions while strengthening its economic growth prospects. Most of these options are undoubtedly well known to Indian government officials and build on efforts already underway. Undoubtedly, experts in India will be aware of other options not mentioned here, which will serve only to support the basic hypothesis of the report.

Background

In order to support a continuing rapid rate of 8 % annual economic growth, the Government of India's Planning Commission projects a five-fold rise in electricity generation and a 3 or 4-fold increase in primary fuel use by 2031, including a rise in coal burning to 2 billion tons per year. This expansion would remedy today's severe electricity shortages, amounting to nearly 10% in total demand and 17% in peak demand, which arose in part because India constructed less than half of planned capacity additions over the past 15 years. The expansion would also provide power to the roughly 40 percent of Indian households, mostly in rural areas, that now lack access.

These growth plans imply a rapid increase in carbon emissions – more than a doubling in two decades. The electricity sector is already responsible for about half of India's total 1.25 billion tons of annual emissions of carbon dioxide.

These expansion plans also imply a heavy economic burden. Annual investments have been averaging about $10-15 billion per year, but from 2008-2013 estimates place investment needs just for generation at $25 billion per year, and $45 billion per year for the power sector as a whole. Since the return on these investments has been low and in many states negative, the ability of the sector to finance its own expansion is very limited, as is its attraction to foreign investors.

Energy shortages are not confined to electricity. The rapid increase in vehicle ownership and the difficulty in finding and developing new oilfields has raised India's oil import dependence above 75% of total consumption. Even though natural gas reserves are less scarce, the lack of delivery infrastructure has limited consumption growth to only 2% per year in the past decade.

The Potential for End Use Efficiency

Investments in end-use energy efficiency are highly cost-effective from a system-wide perspective. Because the supply of electricity is very inefficient, each kW saved at the end-use side is equivalent to almost 1.8 kW at the generation side, once auxiliary consumption at the power plant and T&D losses are taken into account. For example, it is estimated that the

deployment of energy-efficient lighting, more efficient refrigerators in households, and more efficient motors in industry could save as much as 10 percent of total national power generation. The Working Group for the 11th Plan (2008-2013) has suggested an outlay of about $1.4 billion for energy conservation measures over five years, but this is very modest in relation to the budget for other elements of the power sector and could be enhanced.

The potential for savings is vast. End-use energy efficiency improvements alone could create nearly 25,000 megawatts (MW) of capacity, according to government estimates. Energy conservation potential for the economy as a whole has been assessed at 23% of the energy generation, with industry and agriculture showing the most potential. The government acknowledges the need for energy conservation and efficiency, and enacted the Energy Conservation Act (ECA) in 2001 to tap the potential of energy conservation and efficiency benefits.

Nationwide, a 2001 study found that better end-use energy efficiency could profitably reduce electricity demand by 32 percent and greenhouse gas emissions by 45%, relative to a business-as-usual scenario. These are "win-win" opportunities. For example, initial assessments by the Asian Development Bank in Madhya Pradesh found that energy efficiency investments could save US $185 million a year and reduce demand for new generation by more than 1,150 MW. Energy efficiency can be improved at a cost estimated at $200,000 to $500,000 per MW, compared to $800,000 per MW to add fresh generation capacity, and an additional $200-300,000 per MW for transmission and distribution.

The end-use pattern of energy by sector in India differs from that in the OECD: 30% is used in agriculture and 36% in industry. Transportation and commercial sector uses are relatively small. In households, the biggest consumers (34%), followed by lighting (29%). According to the Planning Commission, greater end-use efficiency can make a substantial impact in mining, water pumping, industrial production processes, haulage, mass transport, building design, construction, heating, ventilation, air conditioning, lighting and household appliances.

In these important sectors, the major opportunities for cost-effective energy savings include the following:

- Buildings: better insulation, advanced windows, energy-efficient lighting, space conditioning, water heating, and refrigeration technologies.

- Industry: More efficient industrial processes and waste heat recovery, more cogeneration, preheating, more efficient motors, pumps, and compressors.

- Cities and Municipalities: Increase in district heating systems, combined heat and power, more efficient street lighting, more efficient water supply, pumping, and sewage removal systems.
- Agriculture: More efficient irrigation pumping and efficient water use, such as drip irrigation.

- Households: More efficient lights, fans, stoves, and appliances

- Transportation: More efficient gasoline and diesel engines, adoption of CNG and hybrid fleet vehicles; improvements in urban bus systems, modal shifts to inter-city rail for freight

The Government of India has recognized the important potential for end-use energy efficiency savings, partly by creating the Bureau of Energy Efficiency within the Ministry of Power and by enacting the Energy Conservation Act in 2001. The BEE was charged to develop and promulgate energy efficiency standards, including a minimum Energy Conservation Building Code (ECBC), which it did in 2007. The mandatory scope covers only new commercial buildings, but encompasses envelope, lighting, HVAC, electrical systems and solar devices. In initial case studies, compliance with code reduces energy use by 50%, raises initial cost by 10-15% with a payback of 5-7 years.

Six key industries – aluminum, cement, fertilizers, pulp and paper, petrochemicals and steel – account for about two-thirds of total industrial energy use. The energy intensity in these industries is higher than in developed countries, mainly due to obsolete and energy inefficient technologies. The Energy Conservation Act singled out these consuming sectors for special attention, including promulgating specific energy consumption norms, conducting regular energy audits, implementing technically and economically viable improvement measures, and establishing energy management systems.

Already, the central government's recent integrated energy policy assigns an important role to end-use energy efficiency. Among the specific policies recommended in the Integrated Energy Policy intended to improve energy efficiency are those to:

- Merge the Petroleum Conservation Research Association and the Bureau of Energy Efficiency (BEE) into an autonomous statutory body under the Energy Conservation Act, independent of other energy ministries and separately funded by the Government of India;
- Make the expanded BEE responsible for accelerating efficiency improvements in energy-using appliances, equipment and vehicles through mandates and incentives;
- Implement mandatory energy efficiency standards and labeling of energy-using equipment, including financial penalties if equipments fail to meet minimum energy performance standards;
- Establish benchmarks for energy consumption in energy intensive sectors;
- Promote urban mass transport, energy efficient vehicles, and freight movement by railways.

Another important government "mission," called the Bachat Lamp Yojana, aims to replace 400 million incandescent light bulbs with compact fluorescent bulbs by 2012. This public-private partnership between the Government of India, private sector

manufacturers and traders, project developers, and State Electricity Distribution Companies would distribute CFLs at about US 30 cents each to households throughout the country. Over the lifetime of each CFL, the benefit-to-cost ratio to the household is about 8:1 in saved electricity a longer lifetime. Bachat Lamp Yojana seeks to utilize the Clean Development Mechanism (CDM) of the Kyoto Protocol to bring-down the price of CFLs.

Obstacles to End-Use Energy Improvements

Electricity Pricing and Subsidies

Naturally, in India there are the usual barriers to end-use efficiency, such as lack of awareness, split incentives, and high implicit discount rates among energy consumers. However, in addition to these, one of the most significant obstacles has been the disarray that has long undermined the electricity supply sector. The power sector is the joint responsibility of the central government, which controls about two-thirds of generating assets, and state governments, where State Electricity Boards have had oversight authority. The SEBs were never free to operate on a commercial basis, but have been forced by state governments to pursue political and social objectives, subsidizing power for households and farmers. To attract rural voters and to support farmers, many states introduced flat-rate tariffs based on the horsepower of motors or electricity connections rather than metered usage; as a result, energy consumption is free at the margin, and receipts fell far below supply costs. With these implicit subsidies the putative agricultural share of electricity consumption rose from 9 % in 1970 to over 20% in 2000.

To try to make good their losses on subsidized power, SEBs set much higher tariffs for large industrial and commercial enterprises. Industrial tariffs have been about 15 times agricultural and twice residential rates, on average. As a result, many firms installed captive power plants or diesel generators and opted out of the grid, exacerbating the SEB's financial distress and lowering overall energy efficiency. Despite decades-long reform efforts, electricity pricing and revenue structures are still distorted. Overall, receipts average only about 70 percent of average supply costs. Consequently, most SEBs have lacked the financial resources to improve power quality or availability, and have had to depend on financial bailouts from state and central governments to stay afloat. These enormous annual subventions have run at about 1.5 percent of GDP in recent years.

Subsidies and political interference have also infused the power sector in many states with a variety of rent-seeking behaviors by providers and users. As a result, theft of power and non-payment of electricity bills, sometimes sustained by bribes to power sector staff, account for about another 15 percent of electricity consumptions. In most states, only about 55 percent of electricity consumption is billed and only about 40 percent of the billed amount is actually collected. Theft and pilferage is estimated at about $5 billion annually. Consequently, at least one-third of electricity users face a zero marginal cost for electricity. Incentives for improved end-use efficiency are

severely impeded when for a large percentage of users electricity use is free at the margin.

The central government and some state governments have been making strong efforts to address these problems, with support from the World Bank and other agencies. The national Electricity Act of 2003 required all SEBs to separate the regulatory and supply functions by creating independent State Electricity Regulatory Commissions and to unbundle generation, transmission, and distribution. It also created wider opportunities for private-sector participation in generation and distribution and introduced wholesale competition, trading and bilateral contracts. The Act envisioned a more market-driven framework where electricity would be generated, sold and traded in the market as determined by supply and demand.

Nonetheless, electricity rates are still highly controlled and distorted. Under utility regulation by the Central Energy Regulatory Commission, fixed charges are paid in proportion to generator's availability (ability to generate), regardless of actual energy generation. Energy charges, which can account for nearly 40-60% of total tariff, are calculated using fixed operational benchmarks, not actual operational data. The Act also requires independent power producers to pay a surcharge in order to sell to industrial consumers, in order to prevent a complete loss of industrial business from the SEBs.

The Accelerated Power Development and Reform Program (APDRP) is another effort to overcome supply difficulties. It provides incentives and investment support to upgrade transmission and distribution systems in states that enter a memorandum of understanding accepting a time-bound reform agenda. The agenda includes reorganization of the SEB, electricity rate reform, metering of low-voltage distribution lines and consumer connections, energy audits, and improved billing procedures. The basic objectives of the program are to reduce distribution losses from 30-40 percent to a more reasonable but still relatively high 15 percent and to improve supply conditions for consumers. Considerable progress has been made under the APDRP, but – as discussed below – much more could be done. It is ironic that Indian companies are world leaders in information technology, but India's crucial power grid is still deficient in its use.

In addition, the electricity supply system lacks the capacity and motivation for demand-side-management programs. In many states, utilities are struggling to overcome supply shortfalls to meet growing demands while engaging in the reforms and reorganizations that recent policies demand. Personnel are overwhelmingly supply-oriented with an engineering perspective. Relations with customers are often problematic, due to the poor quality of supply and billing irregularities. Little can realistically be expected of the SEBs with regard to DSM programs.

Examples of "Win-Win" Policies and Measures to Improve End-Use Efficiency

Nonetheless, there are many additional "win-win" policies and

measures that could be adopted to improve end-use efficiency. One of the simplest would be to divide India into different time zones, as Indian energy experts have recommended. That would help shave peak power demands, so that some of the least efficient power plants would not have to be dispatched as often. Other significant measures include:

- Completion of metering programs: Install smart meters on low-tension distribution lines and on household and agricultural connections, to reduce losses, theft, and unpriced electricity use;
- Completion of tariff reform: Eliminate cross-subsidies in electricity tariffs and adopt time-of-use pricing for major consumers. Rate reform would force users to consider actual power supply costs and, in particular, would encourage farmers to raise irrigation efficiency, with both water resource and energy benefits.
- Integrated Resource Planning: Require that SEBs invite bids from distribution companies, energy service companies (ESCOs) and other qualified bidders for end-use energy efficiency and reduced electricity losses on an equal footing with bids to expand generation capacity.
- Mandatory Energy Audits: Require that all large public and private sector consumers carry out energy audits to identify cost-effective energy saving opportunities;
- Support for ESCOs and Efficiency Investments: Expand existing programs of financial support through credit facilities in industrial banks and provide payment guarantees to ESCOs for contractual project work with SEBs and other public sector entities;
- Mandatory Energy-Efficiency Equipment Standards and Labeling: The Bureau of Energy Efficiency could phase in mandatory minimum efficiency standards for important types of equipment, including lighting, fans, motors, pumps, HVAC equipment, with expected benefit-to-cost ratios exceeding 5:1. Energy labeling could be made compulsory for equipment exceeding minimum standards.
- Mandatory Vehicle Fuel Efficiency Standards: Minimum fuel efficiency standards could be adopted and gradually increased.
- Mandatory Building Efficiency Standards: The BEE, in cooperation with state governments could phase in mandatory minimum building efficiency standards for buildings exceeding size thresholds, along with penalties and enforcement mechanisms. LEED-like certification programs for energy efficient buildings could also be promoted.
- Revision of Bachat Lamp Yojana: Rather than rely on funding from the Clean Development Mechanism, the initial cost barrier could be overcome by supplying CFLs to any consumer on presentation of a utility bill, allowing the initial

cost of the light to be recovered through electricity billing over the lifetime of the lamp. Since the change in bulbs is highly cost-effective and hence not "additional," CDM financing is not only slow but also inappropriate.

- Public-sector life-cycle procurement: Public-sector entities consume one-fifth to one-fourth of all energy in India. Procurement based on minimum life-cycle costing rather than the minimum initial cost could be phased in and supported by manuals and training programs.
- Industrial Sector Benchmarking and Requirements: Energy-intensive sectors such as metals, fertilizers, cement, chemicals and paper could be benchmarked to international standards, and programs adopted to raise sectoral energy efficiencies to comparable levels. Programs could offer both "carrots" and "sticks," such as loan financing for equipment upgrades and increased internal and external competition to put pressure on the least efficient plants.
- Support for Industrial Cogeneration: Require the purchase of electricity at fixed prices from co-generators at time-differentiated avoided costs of the utility by the grid to encourage cogeneration. Relax licensing of off-grid power plants, with clear and straightforward inter-connection standards at reasonable fees and back-up charges. Expanding grid-connected co-generation will improve the reserve position of the grid, increasing reliability and allowing for better operation and maintenance.
- Support for District Heating: Provide financial support and incentives for municipalities and utilities to invest in district heating systems to make use of waste heat from electric power plant.
- Support for Public Transportation: Convert municipal bus, taxi and three-wheeler fleets to compressed natural gas or hybrid technologies, which is justified solely on the basis of air quality and health benefits.

The Potential for "Win-Win' Supply Side Efficiency Improvements

The Planning Commission has recognized in its integrated energy planning that improving efficiency in power generation, transmission and distribution can be a "no-regrets" step, in that it can realize large financial savings, allow for increased generation and better quality of electricity delivery, while reducing carbon dioxide emissions and local pollutants from the power sector. Carbon emissions per KWH are 0.94 kg, 50% higher than the world average because of the low efficiency of power production. The efficiency of existing sub-critical pulverized coal power plants has great potential for improvement. Their average net efficiency is only 29 percent, and that of the best 500MW units only 33 percent. This is well below international standards for similar existing plants. Nearly all could improve their efficiency by one to two percentage points, which would reduce national carbon dioxide emissions by 3 to 6

percent. Similarly, rehabilitation of hydro stations could yield much needed peak capacity at negligible cost.

Past experience with plant rehabilitation and modernization (R&M) has exposed several difficulties, including the prevailing energy shortages that make it difficult to take plants off-line; the financial difficulties of the SEBs; the prevalent cost-plus tariff approach and the historical lack of personnel capacity for designing and implementing these projects at the state generation plants. In addition, the primary criteria for R&M project design have been extending plant operating life and increasing the plant load factor. Any improvements in heat rate or other efficiency parameters have been incidental. Consequently, past R&M projects have shown insignificant improvement in energy efficiency parameters. Incorporating energy efficiency among the primary design criteria would involve higher capital cost and should lead to improved energy efficiency parameters. Estimates indicate that doing so would be financially attractive in many cases.

The Government of India has initiated a program called "Partnership for Excellence," supported by credits from the World Bank and the Global Environmental Facility (GEF). It involves improved operation and maintenance (O&M) at 10,000 MW of poorly performing coal-fired power stations with the lowest plant load factors, followed by development and execution of a rehabilitation and modernization (R&M) investment plan, of which 5,000 MW would be taken up in the period from 2008 to 2013. The program would definitely be cost-effective, in that capacity could be restored and plant life extended at a cost under US $300 per MW, much less than the cost of new capacity. An extended rehabilitation plan targeting plants with both availability and efficiency below design would restore both at a cost below $500 per MW and reduce carbon dioxide emissions by 25-50 million tons per year.

Retiring the least efficient plants with the lowest availability would also be a win-win measure. The Government of India plans to retire 5000 MW of the lowest performing units by 2013. The least efficient 20 percent of sub-critical coal-fired plants have carbon emissions 60 percent higher per kwh than the most efficient 20 percent, and an average efficiency almost 40 percent lower. Because the availability of these plants is so low, they could be replaced by one efficient 300 MW unit operating at a high load factor. Doing so would eliminate more than 300,000 metric tons of carbon dioxide emissions.

By 2018, the government proposes to retire or recondition an additional 10,000 MW. Serious consideration should be given to retiring or increasing the efficiency of at least 15,000 MW of the least efficient plants, rather than the 10,000 MW currently contemplated. The benefits in lower generating costs, increased service reliability, and reduced air pollution would justify the added investment, aside from the reduced carbon dioxide emissions.

One key technical factor limiting efficiency is the use of poor quality coal, which is particularly problematic in that it increases auxiliary energy

consumption, operation and maintenance costs while reducing overall efficiency. The use of better quality coals, including washed coals, would improve efficiency. Moreover, reducing the ash content of coals at the colliery would reduce rail transport costs, which can double or triple the pithead price at longer distances, since high-grade energy (electricity) is used to transport low-grade coal and ash. The government has enacted requirements for coal washing, but they need to be supported by pricing incentives, in the form of sharper price differentials for coal according to caloric value and ash content.

Coal pricing, like all energy pricing in India, is complicated. Coal production, rail transport, and electricity production are all dominated by public sector enterprises operating under administered pricing systems and monopoly or monopsony conditions. The government has recognized that the path toward rationalization lies in the introduction of greater market competition, both in electricity generation and in coal production. Consequently, entry conditions have been improved in both sectors.

Within the generating sector, however, pricing continues to be based largely on cost-plus formulas. The government has attempted to encourage efficiency by using performance benchmarks rather than actual costs for the energy cost component of the tariff. Power plants that outdo the benchmarks make additional profit, as their tariff for the energy cost is based on the norms, rather than the actual costs. Power plants that fall below the benchmarks face revenue loss because their actual energy costs are higher than the tariff allowed by the regulators. In theory, this system provides strong incentives for power plants to improve efficiency.

However, setting benchmarks has been handicapped by information asymmetries and political pressures. The utilities (particularly the central utilities) have withheld crucial information about heat rates, making it difficult for regulators to set appropriately tight benchmarks. The central utilities have resisted tightening performance norms and have resisted submitting data on actual recent performance. Nonetheless, in a recent tariff order for the period 2004-2009, the regulators tightened the benchmark for 500 MW units from 2500 to 2450 kcal/kWh. However, the benchmark for the 200, 210, and 250 MW units was maintained at the level of 2500 kcal/kWh, set as far back as 1992. It was also decided to apply the same benchmarks for both existing and new stations, a needlessly lax concession. These steps do not exert strong pressure for greater efficiency in new or existing units. To make the system more effective, all units could be required to submit timely performance data, and benchmarks could be put onto a regular announced schedule of improvement.

In planning for capacity expansions, a win-win criterion would demand that new plants should be efficient on a life-cycle basis. Super-critical pulverized coal technologies are well suited for the Indian coal power sector in the near term, as they are commercially viable with plenty of experience worldwide in installing and operating them. Such plants, including scrubbers for sulfur removal and particulate controls, would be at least 5 percent more efficient than the best 500

MW sub-critical units without flue gas desulfurization. The use of washed coal would increase efficiency by another 1 percent. It is doubtful that IGCC plants would be cost-effective in India at this time, apart from their potential for carbon capture and storage.

However, there are potential win-win opportunities for new investments in transmission and distribution, aside from the metering program discussed already. High T&D losses result from the following factors: inadequate grid interconnections; a poorly planned network with an excessive ratio of low- to high-voltage lines and inadequate sub-transmission and distribution systems; inadequate maintenance and equipment upgrades; and chronic overloads. Yet, despite the recognition of the importance of improving T&D performance, outlays for T&D in the period 2002-2007 were half those for generation, even though many experts advised that investments in T&D be comparable to those in generation. Efforts to upgrade the T&D system by modernizing the existing infrastructure and introducing new technologies could be accelerated through steps such as expanding high-voltage lines, improving integration among regional grids, and improving monitoring and metering of distribution networks.

In contrast to administrative approaches to control of air pollutants from electric power plants, such as requirements that electrostatic precipitators and flue gas desulfurization be installed on exhaust stacks, cap-and-trade programs for pollution control are likely to be a win-win option. Experience has shown that pollution control costs have been reduced significantly under cap-and-trade programs, even when monitoring costs are included, because emission controls are carried out where and how they are most cost-effective. At the same time, cap-and-trade programs provide greater incentives for efficiency gains and carbon dioxide mitigation, since pollutants can be controlled through improved heat rates and the use of better quality coal, not just through end-of-pipe equipment that requires an energy penalty.

Policies and Measures for Supply-Side Energy Efficiency Improvements

- Plant Rehabilitation: Accelerate the schedule for rehabilitation and modernization of existing plants, with greater attention to potential energy efficiency improvements. Include hydroelectric plants in the accelerated schedule.
- Plant Retirement and Replacement: Accelerate the schedule for retirement and replacement of the least efficient and least available coal-fired power plants.
- Capacity Additions: Establish and enforce efficiency standards for all capacity additions.
- International Cooperation: Expand cooperative agreements with Nepal for imports of hydroelectric power.
- Transmission Investments: Increase investments in transmission and distribution infrastructure to lower technical losses below 10 percent, with a yield equivalent to at least 10,000 MW of new generating capacity.

- Distribution System Investments: Accelerate investments in better insulated conductors, capacitors, efficient and low-loss transformers, rationalized distribution networks and improved metering systems and instrumentation.
- Expand Wholesale Competition: Require utilities to consider bids from independent power producers as well as energy service companies in adding capacity;
- Measure and Monitor Performance: Require all power plants to measure efficiencies routinely, carry out energy audits to assess their efficiency levels, and submit timely performance data to regulators.
- Tighten Performance Incentives: Ensure that the regulatory benchmarks on power plant efficiency are sufficiently stringent and provide strong and consistent incentives for efficiency improvements.
- Improve Coal Quality: In addition to existing mandates, provide better incentives for the production and use of higher-quality coals by restructuring the coal grading and pricing scheme.
- Initiate Cap-and-Trade Programs: Introduce regional cap-and-trade programs for control of particulates and sulfur oxide emissions from major power plants.

Potential Win-Win Opportunities in Renewable Energy

The Government of India has been active for some time in promoting renewable energy and has set ambitious targets for its growth. There is a Ministry of New and Renewable Energy, which has developed significant incentives and national programs for renewable energy. The current Renewable Energy Plan envisages that it will provide at least 10 percent of grid-connected capacity additions through 2012 and beyond, as well as the installation of millions of solar water heaters, solar lanterns, small biogas plants, and small village mini-grids.

The Electricity Acts of 2003 and 2005 encouraged the growth of renewable energy by requiring grid connectivity and authorizing state governments to adopt Renewable Portfolio Standards requiring a minimum percentage of power generation from renewable sources. The Ministry of New and Renewable Energy has introduced output-based incentives for renewable energy (starting initially with grid-connected solar energy) and also plans to issue guidelines for tradable renewable energy certificates for states that have adopted a RPS. Some states have introduced renewable energy-based surcharge funds or have issued competitive bidding for renewable energy sources. In addition, renewable energy benefits from income tax holidays, accelerated depreciation, duty-free equipment import privileges, concessionary financing, a production incentive and other tax exemptions.

With these subsidies, renewable energy is competitive with conventional energy in many settings. Yet it is unclear that extensive “win-win” investment or policy opportunities can be found for renewable energy that are cost-effective without subsidy or consideration of the carbon mitigation benefits. Wind and

solar power are not yet competitive on an unsubsidized basis with coal-fired power except in areas that are not grid-connected or where transmission and distribution costs are relatively high and renewable energy can compete with retail power costs.

Moreover, the history of success of large-scale government programs to promote decentralized renewable energy has been spotty. There have been national campaigns to promote biogas plants utilizing agricultural and household wastes, to promote local social forestry activities to increase the sustainable supply of fuel wood, to develop and distribute improved stoves for household use, and to promote the cultivation of jatropha and other biofuel resources, but their success has been very dependent on local conditions and not very impressive overall.

More attention in recent years has gone to creating an enabling and encouraging environment for private-sector and non-profit sector initiatives, and to consider how successful models operating at local levels can be scaled up. One project provides credit lines to private companies to finance biomass power generation, cogeneration at sugar refineries, small hydropower, windmill power, solar PV power, and solar thermal projects. Also, a study by the World Bank Group and the government is assessing potentially viable business models whereby renewable energy companies might supply rural franchise regions, investigating what institutional and financial support would be needed and how it could best be arranged.

None of this implies that plans and incentives to increase the contribution of renewable energy should be considered inappropriate. Climate change concerns should be a significant driver of energy planning, and the potential damages from climate change should obviously be reflected in incentive and pricing policies. Moreover, some of these renewable energy efforts have important ancillary benefits, such as the health benefits from cleaner household cooking fuels and improved stoves, or the soil and water protection from reforestation of watersheds and waste lands. Rather, it seems difficult to identify policies and measures to promote renewable energy, other than some hydroelectric investments, that would unambiguously be considered "win-win" – i.e., justified on economic grounds alone.

Potential Win-Win Options for Policy and Subsidy Reform

Energy prices in India are generally controlled or heavily influenced by subsidies and cross-subsidies motivated by political and social objectives. Consequently, they do not closely reflect marginal supply costs. In many cases, they encourage economically inefficient energy uses, which yield benefits below real economic costs. Subsidies have also drifted away from intended target populations and have become difficult to justify on equity or other social grounds.

Electricity subsidies were discussed above. They are obviously regressive in equity terms, because about 45 percent of the population, predominantly the rural poor, still lacks electricity connections and receives no benefit from the subsidy. In fact, the resulting financial burden on the SEBs

impedes progress in rural electrification. Medium and large farmers gain most from the subsidy for agricultural uses. They are more likely to have tubewell irrigation and to operate pump sets and other electric equipment, while small poor farmers lack connections and may even purchase well water for irrigation from wealthier neighbors.

The rapid growth in electricity and other forms of energy consumption is mainly the result of the improving living standards of middle- and higher-income households in towns and cities. The disparity in energy use among income groups has widened along with the distribution of income itself. According to a 2007 report, the highest income group is now responsible for carbon emissions of 4.97 tons per capita, only slightly less than the world average of 5.03, and the wealthiest income group's per capita emissions are 3.5 times that of the lower 75 percent. In international negotiations, the Government of India has maintained that equal per-capita carbon emissions represent the only ethically defensible norm for international cooperation, but within India energy use and emissions are becoming more unequal.

Other energy prices are also affected by subsidies. Liquefied petroleum gas has been subsidized as a clean fuel substitute for biomass burning in rural areas, but studies have shown that most of the subsidy actually benefits urban families, while most rural households continue to rely on wood, dung, and other biomass fuels for cooking. Subsidized kerosene is used for lighting in rural areas, but is also widely used to adulterate diesel fuel for generators and motors. The benefits go primarily to non-poor households. Targeting of subsidies through household "Below Poverty Line" cards and certificates has proven ineffective because such cards are now possessed by a large percentage of households who are above the poverty line.

Phasing out these subsidies would be a "win-win" opportunity. Inefficient energy uses would be discouraged, and a heavy fiscal burden would be relieved, freeing resources for more effective anti-poverty programs.

The subsidy on nitrogenous fertilizers such as urea also provides a win-win opportunity for emission reduction, since nitrous oxide is a greenhouse gas 300 times as powerful as carbon dioxide and is generated when urea volatilizes in the field. Fertilizer subsidies were introduced more than 40 years ago to support the Green Revolution introduction of high-yielding fertilizer-responsive seed varieties. Now, however, the use of high-yielding varieties and chemical fertilizers is well established among large and small farmers alike throughout India. The distribution of the subsidy among farmers reflects the unequal distribution of land holdings, larger farmers benefiting disproportionately. Moreover, between one-third and one-half of the fertilizer doesn't reach farmers at all, but protects inefficient segments of the domestic fertilizer industry that cannot meet world prices because of inefficient plants and obsolete technology. Phasing out the subsidy would promote greater efficiency in the industry and among farmers.

Controlled pricing of coal and hydrocarbons presents difficult problems

of rationalization. Though the principle behind pricing of hydrocarbons has been parity with import prices, in practice the government has been reluctant to allow rising international prices to pass through to consumers. Adjustments have lagged, sometimes rather badly. Among the implications are an implicit subsidy to the rapidly growing fleet of personal and commercial motor vehicles. This growth is responsible for increasing congestion on urban roads, extremely poor urban air quality that has severe health impacts, modal shifts away from more energy-efficient bus and rail transport, and the need for rapidly rising expenditures on urban highways.

The Government of India has also controlled natural gas prices and allocated available supplies among priority sectors, such as petrochemicals, fertilizers, and electric power. Pricing has attempted to provide a fair return to producers while keeping costs down to major users and supporting the administered allocation priorities – a difficult task in the absence of market signals and adjustments. The current position is evidently that price decontrol must await a better balance of supply and demand, but that is exactly the balance that price decontrol would bring about.

Potential Policies and Measures for Energy Pricing and Subsidy Reform

These measures carry with them a political cost, since the dominant beneficiaries of energy subsidies tend to be politically active and influential, which is partly responsible for their persistence in the face of longstanding criticisms of their efficiency, efficacy and equity. Nonetheless, in the context of international negotiations in which other countries might offer comparable subsidy reforms and India might have much to gain, pricing and subsidy reform could be part of the bargain.

- Reform of Electricity Tariffs: Phase out cross-subsidies, introduce energy charges for all users, competitive bidding at wholesale level, distribution rates incorporating effective and improving efficiency standards;
- Phase-out of Subsidies for Kerosene and LPG: Eliminate these subsidies and reallocate the fiscal savings to other, more effective anti-poverty programs;
- Full Import-Parity Pricing of Petroleum Products: Fully pass through of import-parity prices for petroleum products to final consumers, excepting products with minor export markets.
- Elimination of Fertilizer Subsidies: Phase out producer and consumer subsidies for nitrogenous fertilizers.
- Decontrol of Natural Gas Prices: Allow prices to find competitive levels, relax administrative allocations, and allow pass-through of fuel and feedstock cost increases in product prices.

Conclusion

The purpose of this report has been to survey the range and scope of policies and measures available in India that would reduce greenhouse gas emissions and simultaneously strengthen India's economic growth – saving money, providing attractive returns on investments, or lowering fiscal burdens And freeing up resources that can be

better allocated to other development purposes. Though experts in India could undoubtedly carry out a more accurate and comprehensive survey, the findings of this report surely support the conclusion that if India carried out its available “win-win” opportunities, it could significantly reduce greenhouse emissions over the next decade.

Annex B
Win-Win Opportunities in China

To an extent little known elsewhere, China has already grasped a wide range of cost-effective opportunities to mitigate carbon emissions and has determined to carry out even more far-reaching initiatives. During the post-Kyoto period, it will be possible for China to make very significant emissions reductions below its baseline trajectory through policies and measures that also contribute to its economic, environmental and energy objectives.

What "win-win" means for China

By the narrower measure, a win-win mitigation opportunity is a measure that reduces greenhouse gas emissions while saving money on a life-cycle basis or offering a superior rate of return on the investment. China has many potential energy efficiency investments that would be win-win under this definition, as other countries do. A recent study by the McKinsey Global Institute, "China's Green Revolution," estimates adopting proven cost-effective energy efficiency technologies and other profitable mitigation investments would reduce emissions 37 percent below the baseline trajectory by 2030. This would amount to a 17-18 percent decrease in energy intensity in each 5-year period.

In China, however, a broader definition of win-win that encompasses environmental protection and energy security motivates much of the national government's energy policy. China's rapid growth and relatively weak implementation of environmental standards have led to severe environmental problems. According to a recent international assessment, for example, 13 of the 20 cities in the world with the most polluted air quality are in China. Water quality has also suffered severe degradation throughout the densely populated parts of the country.

This environmental degradation has imposed significant economic costs in health impacts and lost productivity. Pollution at the local scale has also provoked social unrest. Consequently, the Chinese government weighs domestic environmental considerations heavily in formulating energy policy, alongside the goal of greenhouse gas mitigation.

This greatly expands the scope of win-win opportunities. Chinese, World Bank and other researchers have estimated the costs of resource degradation and environmental pollution to be in the range of 3-13 percent of GDP annually. A figure near the midpoint of this range implies that much or most of China's measured economic growth each year has been offset by damages to China's population and economic activities because of degradation of air, land and water.

The implications of adopting this broader win-win definition are consequential. For example, a recent estimate found that if the non-market environmental and health costs of coal production and use were factored into its price, the average coal price would be 23 percent higher, making more wind and nuclear energy investments and a

broader range of energy efficiency improvements economically competitive.

China's policy calculus also rightly places a strong emphasis on energy security. As vehicle ownership expands rapidly, China's limited domestic petroleum resources are being submerged under large and increasing oil imports. Nor is China self-sufficient in coal, despite becoming the world's largest producer. Producing 2 billion tons annually strains the transportation network and exacts a heavy toll in accidents, land degradation and pollution. Coal imports into the coastal provinces have increased rapidly despite large inland resources.

Despite the current world recession, it would clearly be unrealistic to assume that under a continuation of current growth patterns, fossil fuel prices would remain constant over the 20-30 year lifetime of current energy investments, during which time energy use would at least double. The estimation of win-win investments must be based on the presumption that under the business-as-usual alternative, fossil energy costs would increase substantially. This realization motivates the Chinese government's efforts to raise vehicular fuel efficiency, to promote hybrid and electric vehicles, to improve efficiency in the electric power sector and to push aggressively for end-use energy efficiency improvements. Much of China's past program to reduce carbon emissions has been motivated largely by the complementary goals of energy security and domestic environmental protection.

Nonetheless, there is also clear recognition in China's scientific and policy circles of the potential damages to China's water and land resources from future climate change. Water supplies are already severely strained in North China. Drought and desertification are severe in Northwest China. In alluvial and coastal areas of South China, flooding has traditionally taken a heavy toll. Three or four hundred million Chinese dependent on agriculture, away from the industrialized eastern regions, whose lagging incomes already constitute an economic, social and political problem, are increasingly at risk from climate change.

What China has already done

Few outsiders recognize or appreciate the far-reaching policies and measures that the Government of China has already adopted to mitigate greenhouse gas emissions. Much of the rhetoric to be heard in the United States about the competitive advantage China's industry would have and the "leakage" of emissions to China if the United States limits its carbon emissions reflects this lack of information and understanding.

Since 2005, large new coal-fired power plants constructed in China have used efficient super-critical technology almost exclusively. By 2007, Chinese companies had started constructing the even more advanced ultra supercritical power plants, which have become the new standard. In 2007, as part of an ongoing campaign, the Chinese government closed more than 500 older sub-100MW power plants with an aggregate capacity exceeding 14 GW, each of which can emit over 2000 grams

of CO2 per kWh (almost three times higher than best available technology) and plans to continue retirements at this pace. By such means the thermal conversion efficiency of the Chinese coal fleet has already been raised to over 30% – a level close to that in developed countries. Similar policies have recently been added to reduce the number of relatively inefficient plants with capacities under 300MW, which currently account for 30 percent of total capacity. The National Development and Reform Commission in China now requires that large power companies 'buy out' and close down inefficient generating plants equivalent to 60% of proposed construction capacity before projects will be approved.

An even more advanced coal-based thermal power technology is being introduced with strong support from the Chinese Government and investment from seven of China's major energy companies. The first stage will complete a 250MW integrated coal gasification combined cycle (IGCC) power plant in 2009, with potential for carbon capture and storage. The second and third stages are to add 400MW of IGCC capacity with commercial scale carbon capture and storage. Although Chinese and American companies are collaborating on these technologies, the trajectory is on a faster pace in China than in the United States. China has the capability and opportunity to leapfrog to the most up-to-date energy technologies because of the high rate of investment, and because it is much cheaper to adopt such technologies in new facilities than to retrofit old ones.

Despite its heavy reliance on coal, China has accelerated the growth of electricity production from alternative sources, including nuclear, hydro, biomass, wind and solar, in part through tax and other incentives. For instance, small hydropower enjoys a 6 percent value-added tax rate, as compared to a standard rate of 17 percent. For biogas utilization, a subsidy is provided to rural households for the construction of a biological digester. China's Renewable Energy Law, which came into effect in 2006, mandates that the power grid purchase renewable power, also giving subsidies for wind and bio-power projects. China has already adopted a national renewable energy portfolio standard calling for an increase to 3 percent of total generation by 2010 and 8 percent by 2020, with a goal of reducing dependence on coal-fired thermal plants from 80 to 65 percent by 2030. These measures imply ambitious growth targets in the context of China's rapidly increasing power consumption. In response, China has quickly become one of the world's largest producers of solar and wind generation equipment. China is a leading manufacturer of photovoltaic (solar) cells, second only to Japan, and is set to be the world's largest manufacturer of wind turbines by the end of 2009.

In the transportation sector, fuel economy standards were issued in 2005 that were much stricter than those in the United States. They have recently been tightened and remain stricter than the new American standards. In 2006 a heavy "gas-guzzler" excise tax based on engine displacement was adopted to discourage the use of large and inefficient vehicles. The tax rate currently varies from 1 percent for a fuel-efficient sub-compact car to 40 percent for a large SUV. China is also

heavily investing in hybrid electric and all-electric vehicles. A Chinese company may be first to introduce an all-electric vehicle to commercial mass markets, both domestic and export, as early as 2010. In the same vein, China is by far the world's largest producer and consumer of electric bicycles, the vehicle of choice for many lower-income households.

China has long recognized the importance of increasing end-use energy efficiency. Between 1980 and 2000, the government added 22 administrative measures, seven standards, eight plans and 14 policies designed to promote energy-saving technology, and recently released its first long-range program for efficiency improvement. A wide-ranging Energy Conservation Law was enacted in 1997.

Over this period, China has made great improvements in overall energy efficiency. Overall energy intensity relative to GDP has declined by 60 percent since 1980. The main driver has been economic restructuring and the declining economic weight of inefficient state enterprises. From 1995 to 2000, the rate of energy intensity reductions accelerated as inefficient energy-intensive state-owned enterprises were closed. Yet, in 2003 energy use per dollar equivalent of GDP was still 2.5 times the world average. China has been approaching but has still not attained the energy efficiency levels of other industrialized countries in key sectors. Moreover, the improving trend has been reversed between 2000 and 2005 because of the rapid growth of the more energy-intensive industries. By 2005, China's overall energy intensity was 43 percent higher than India's and 73 percent higher than in the U.S., based on purchasing power parity measures of gross domestic product.

In late 2004, the Ministry of Finance and National Development and Reform Council jointly issued an *Implementation Notion on Governmental Procurement for Energy-saving Products.* In order to make government a leader in energy efficiency and to stimulate market development of energy-saving products, it decreed that governmental bodies and agencies give preference in procurement decisions to energy-efficient products. As with other such mandates, however, implementation can be improved, since many agencies do not practice life-cycle costing. In addition, in the summer of 2007, the Government ruled that all government offices must keep temperatures no lower than 78°F in summer and no higher than 68°F in winter.

In the building sector, the *Design Standard for Energy Conservation in Residential Buildings* (i.e., the building code) went into effect in January 2006. China has a building stock of over 43 billion square meters, of which less than 5 percent meets these new energy efficiency standards. The majority of existing buildings, in fact, consume energy very wastefully. However, construction of new buildings in today's China is at an enormous scale. New buildings are required to use energy-efficient materials and insulation and adopt energy-saving technologies for heating, air conditioning, ventilation and lighting systems. The design standards require new buildings to lower in-use energy consumption per square meter at least to half the current Chinese average.

Even higher standards were adopted for richer cities, including Beijing and Shanghai. Again, implementing these standards also presents some problems, because of well-known split incentive problems. In 2005, the Ministry of Construction investigated energy conservation building code implementation and found that nationwide only 58 percent of building designs and only 23 percent of new buildings constructed from 2000 to 2004 followed codes.

Although solar water heaters have not been popular in most other countries, the market in China has grown rapidly and by 2006 amounted to about 90 million square meters, 60 percent of global installed capacity. Solar water heaters are now installed in 10 percent of all Chinese homes, and the market continues to grow at about 20 percent per year. The success of this simple technology is largely due to its low cost and environmental and safety advantages over gas or electricity. Typical units with an expected lifetime of 10-15 years cost as little as $180, compared to an annual running cost of US$120 to power an electric water heater. Many municipalities already require that solar water heaters must be installed on new residential buildings.

District heating, particularly in North China's cities, is more common than in most other countries but is inefficient and burdened by poor policies and management. In order to take better advantage of district heating's potential efficiencies, in 2008 the government borrowed almost $200 million from the World Bank to upgrade boilers and distribution systems, install meters, reform pricing, and strengthen management. In the cold climate regions of China, development of modern demand-driven district heating systems is another priority in the government's energy efficiency agenda.

Also in the building sector, the national government has adopted one of the world's most comprehensive mandatory energy efficiency testing and labeling standards for home appliances. Energy efficiency standards have also been adopted for lighting, heating and air conditioning and all major appliances.

The industrial sector generates an unusually high percentage of carbon emissions, more than 40 percent of the total, because of its large weight in China's economy and the legacy of inefficient state-owned heavy industries. Understandably, China has placed a great deal of emphasis on industrial energy efficiency improvement. China has aggressively participated in the Clean Development Mechanism to eliminate emissions of industrial greenhouse gases, some of which have a warming potential more than ten thousand times that of carbon dioxide.

So far, the government has largely relied on administrative and regulatory tools to achieve the 20 percent reduction in energy intensity. The key administrative tools include: (i) administrative orders directing achievement of the target by the provinces and key state-owned enterprises; (ii) controlling the supply of land and capital, and tightening project approval to curb the expansion of capacity of energy-intensive industries like iron and steel, cement, aluminum, lead, paper, flat glass, chemicals, and

coke; (iii) ordering the closure of inefficient production capacity and setting energy efficiency standards for new production capacity in these sectors, with tighter conditions on new project finance.

In 2007, RMB 12 billion (~ US$1.6 billion) in fiscal support was also provided for industrial efficiency improvement, including RMB 7 billion in central government support for energy efficiency activities in the 10 Key Energy Conservation Projects, such as waste heat recovery, optimization of the energy metering system, rehabilitation of industrial boilers and kilns, and renovation of electric motor systems. RMB 2 billion in fiscal transfers was allocated to support the closure of inefficient production capacities. RMB 3 billion was provided for statistical work in the energy area, especially to monitor energy use. In addition to this grant financing, a government bond of RMB 5.4 billion was issued to finance business loans at subsidized interest rates to support energy efficiency and emission reduction projects. Furthermore, the government encouraged domestic banks to increase their lending for energy efficiency and emission reduction projects.

The Chinese government has drawn on international capital markets to supplement this domestic finance. A large Global Environment Facility project to introduce efficient coal-fired industrial boilers in China has led to an estimated 637 million metric tons of emission reductions at a cost of about US$ 0.03 per avoided ton of CO_2. Counting the reductions in domestic pollution would put this project clearly into the win-win category. The project did not seek simply to market and sell efficient boilers to China. Instead it transferred the knowledge, the intellectual property rights and the tools to allow the Chinese boiler industry to produce its own efficient boilers.

China also borrowed US$200 million from the World Bank in 2008 to increase financing for energy efficiency investments in China's medium-size and large industrial enterprises. The project is expected to leverage at least another US$200 million of funds for energy efficiency investment from participating domestic banks, as well as an additional US$170 million from beneficiary enterprises. These funds finance win-win energy efficiency projects offering above-market rates of return on investment.

Almost one-quarter of industrial emissions can be traced to production for export. To discourage these emissions, in November 2006, the Ministry of Finance added a 15 percent export tax on copper, nickel, aluminum and other metal products; a 10 percent tax on primary steel products; and a 5 percent tax on petroleum, coal and coke. Since then, the VAT rebate rate for export of steel products was adjusted four times and was eliminated for exports of more than 500 items of energy- or resource-intensive products, and an export tax was levied on more than 100 items of most energy-intensive products like steel and coke.

In 2008 the Government of China adopted a fiscal stimulus package to combat the global economic recession. Nearly 40 percent of China's proposed $586 billion stimulus plan—$221 billion over two years—is going

toward public investment in renewable energy, low-carbon vehicles, high-speed rail, an advanced electric grid, efficiency improvements, and other water-treatment and pollution controls. This percentage allocation is much larger than that in the comparable US stimulus package.

In the light of all these policies and measures that have already been adopted, there can be no doubt that the government of China is seriously committed to increased energy efficiency and a transition to a cleaner energy system.

What more China has already committed itself to do

The Government of China has declined to adopt specific international commitments for carbon reduction or absolute limits on future emissions, but it has adopted ambitious domestic goals for reduced energy intensity for the economy in the aggregate, a 20 percent reduction from 2005 by 2010 and continuing reductions thereafter.. In support of this goal, *China's National Climate Change Plan*, printed in English in June 2007, lays out a comprehensive and detailed agenda for mitigation across energy, industrial, transportation, agricultural, forestry and household sectors. Too extensive to recount in detail here, the Plan incorporates institutional, administrative, regulatory, technological, fiscal and market measures. Viewed objectively, it must be seen as one of the most ambitious mitigation policy frameworks so far adopted in any country, including countries in Annex I. The Plan is supported by laws on energy conservation, recycling, renewable energy, power generation and other relevant matters.

It entails continuing efficiency improvements in the coal-fired power fleet, including rapid introduction of advanced technologies, as well as maximum deployment of natural gas, nuclear, hydro, wind and solar power. It also includes dramatic improvements in transportation efficiency, based on strict fuel efficiency standards for gasoline engines and rapid penetration of hybrid and electric engines. It continues programs to improve energy efficiency in buildings and equipment.

In industry, the Plan calls for concerted efforts to reduce energy use further in key energy-intensive sectors such as iron and steel, non-ferrous metals, coal, electric power, chemical, and construction material, as well as in the transportation sector. The Plan also highlights the role of pricing in promoting energy conservation.

The central government has rolled out a series of policies to support its ambitious goals on energy efficiency. These include a work programming and accountability system under which responsibilities for delivery of energy savings are assigned to relevant agencies, top energy users, and provincial governments, with clear accountability for execution. A structural adjustment program for industries has been adopted, which is intended to control expansion of capacity in energy-intensive industries and to phase out existing inefficient capacity quickly. Also, the 1000 Large Industrial Enterprises Energy Conservation Action Plan is to develop and implement

specific energy conservation programs in the largest industrial energy consumers that account for fully 30 percent of total primary energy consumption in China. Each company will be required to sign onto an energy conservation plan, and its implementation of the plan will be monitored. Finally, the 10 Key Energy Conservation Projects will cover major energy efficiency technologies in manufacturing, transportation, commercial and residential buildings, and public facilities.

A few specific pricing measures were also adopted to reduce energy consumption and promote efficiency. The domestic prices of petroleum prices were adjusted upwards in 2007 to reflect the rise in world oil prices. Though not as high as in Europe or Japan, they are approximately at the levels of the United States and Canada. The National Development and Reform Commission (NDRC) has ordered that all preferential electricity prices offered by the local governments to energy-intensive industries be terminated. NDRC also ordered that the price of electricity for energy-intensive industries that are too small in scale and inefficient also be raised, to hasten their closure.

Electricity pricing in China still mainly follows the rate-of-return model: rates are set to reflect generating costs, although coal price changes are not fully passed through, and to afford plants a rate of return on investments. After many years of gradual adjustment, tariffs on average approximated long-run marginal costs by the early 2000s. Rate setting on this model implies problems similar to those in the United States and other countries: lack of incentive for utilities to pursue low-cost supply options, including demand-side management; lack of incentive for customers to shift loads to off-peak periods; and lack of incentive for development of co-generation opportunities, for example.

Nonetheless, the Government of China already has a strong policy commitment to demand-side management (DSM) in the power sector as a vehicle for energy efficiency improvement. National policies adopted at a high level in the early years of the decade ago require provincial and municipal authorities to facilitate DSM efforts. Utilities must conduct load management and expand the use of interruptible and direct load management. Utilities must integrate demand-side options into forward capacity planning. Policies on electricity rates prescribe greater use of time-of-use rates, off-peak differentials, and incentives for interruptible loads. Utilities are allowed to recover the costs of DSM education and information efforts in their management budget.

In August 2002, the State Council released “Recommendations on Expediting the Promotion of DSM.” Among the recommendations to power regulators:

- Develop detailed DSM regulations to clarify the roles of government agencies and power grid companies;
- Rationalize electricity rates, including time-of-use prices, peak and off-peak daily and seasonal rates, extending interruptible power rates and raising base electricity rates overall;

- Create system benefit charges and funds to support DSM;
- Develop mandatory efficiency standards for high power-using equipment to phase out outdated equipment and accelerate adoption of energy-efficient products and equipment.

Following these policy mandates, demand-side management programs are spreading through Chinese cities and provinces. As in other countries, China is finding these programs to be definitely win-win propositions. In Jiangsu and Shanghai, for example, DSM programs are under way that can reduce the need for gigawatts of new capacity and investments of hundreds of millions of dollars, at significant savings in overall energy costs.

Despite its unwillingness to commit to hard national carbon caps, China is clearly committed to strong policies and measures, in addition to those already taken, to improve efficiency and reduce its greenhouse gas emissions.

The potential for additional win-win reductions

There are substantial opportunities for further win-win mitigation measures that improve the existing fleet of coal-fired power plants, especially when the accompanying reductions in domestic pollution damages are taken into consideration. For example, coal washing and briquetting not only raises efficiencies but also reduces emissions of particulates, soot and dust. These are not only harmful local pollutants but also important contributors to global warming, because they absorb heat. In many plants, retrofits to improve boilers and combustion controls are also cost-effective, as is co-firing with agricultural and municipal wastes.

Despite substantial progress, the Chinese economy is still quite inefficient in energy use, both overall and in particular sectors and industries. Energy use per dollar of GDP is at least twice as high as in South Korea, another rapidly growing Asian economy. Energy use in heavy industries, such as steel, non-ferrous metals, petrochemicals, and cement, is also excessive. A ton of steel produced in China uses twice as much energy as a ton made in the U.S. and three times as much as in Japan. Many mills operate with outmoded technology and in a rapidly growing economy have allocated capital to expansion rather than to efficiency improvements.

A 2008 study from the McKinsey Global Institute estimated that even reflecting the measures that China has already put in place, emissions could be reduced by another 15 percent through win-win measures, disregarding other environmental benefits, and by twice as much if such co-benefits were factored in. However, delay of even 5 years would reduce the potential energy savings by 35 percent of those amounts because the buildings, power plants, factories and vehicles would already have been designed and built.

Win-win energy conservation opportunities available include: (a) adoption of energy-saving industrial technologies such as more efficient industrial boilers, kilns, and heat exchange systems; (b) recovery and utilization of by-product gas, waste heat and pressure; (c) installation of efficient

mechanical and electrical equipment, including motors, pumps, heating and ventilation equipments; and (d) industrial system optimization to reduce energy use.

Electric motors driving all sorts of mechanical equipment consume 60 percent of all electricity. Yet, their overall efficiency is comparable to that of the developed countries during the 1960s. China's newer models approach current international standards, but their penetration so far has been small. Their widespread adoption along with better speed controls could reduce total national electricity demand by as much as 10 percent, with significant life-cycle cost savings.

Fans, pumps, and compressors alone account for 40 percent of industrial energy use and, on average, consume about three times as much power as would be efficient, because of poor design, irrational piping, poor operation and maintenance and other factors. If existing standards were always followed, their electricity load could fall by as much as 30 percent. Switching to variable speed drives alone would raise energy efficiency by 25 percent.

Comparable energy and cost savings are available in other important industrial energy uses: electric furnaces used for smelting and heat treatment; electrolysis and electroplating; electric welding; factory traction and locomotion, for example. In China's approximately 500 steel mills and 1000 rolling mills, cost-saving equipment upgrades would save 25 to 30 percent of energy used. Despite progress so far, the potential for further cost-effective energy savings in industry is enormous.

The Government of China has recently approved a World Bank/Global Environmental Facility project to finance industrial energy efficiency projects. As part of the loan appraisal process, a study reviewed 17 energy-saving technologies for the iron and steel industry, 30 technologies for the chemical and petrochemical industry, and 9 technologies for the cement industry, including further substitution of furnace ash and slag for clinker. The payback periods on money spent to install these technologies in existing facilities, calculated on very conservative assumptions, averaged 3.3 years. This corresponds to an internal rate of return on the investments of 26.5 percent. At the same time, these technologies would result in large percentage reductions in energy use and carbon emissions. Clearly, these are win-win opportunities.

The building sector is another major energy consumer, using the equivalent of 130 million tons of coal every year. As one might expect, the existing building stock is extremely inefficient. Most of it was built in the communist era by construction crews with no interest whatever in efficiency. Most of the energy used is wasted by losses through exterior walls and roofs, which average 4 times the losses in Canada or Japan. Chinese buildings use 50 to 100 percent more energy per cubic foot than buildings in other cold climates but are still more uncomfortable. Simple retrofits using sealants, insulation, and better doors and windows would save a great deal of energy and money.

In China, 90 percent of light bulbs in use are incandescent, and not very

inefficient ones at that. They use more than 10 percent of all electric power, two-thirds of which would be saved if they were replaced with compact fluorescents, with comparable life-cycle money savings. Moreover, as incomes rise for Chinese households and more of them live in cities, possession of such household appliances as refrigerators, fans, air conditioners, and electronic equipment has been expanding very rapidly. As elsewhere, purchasers tend to focus on initial rather than life-cycle costs, so strict enforcement of efficiency standards for lighting and appliances is a strong win-win opportunity. For example, the stand-by power requirements in typical Chinese appliances are often 10 times the amount necessary.

Examples of win-win policies and measures

As indicated above, the Government of China has already enacted an extensive portfolio of laws, regulations, policies and mandates to improve energy efficiency and to diversify energy sources. The first challenge, before adopting more policies and measures, is to ensure that these existing directives are appropriately implemented. Implementation has been somewhat problematical during the period of rapid economic expansion, for understandable reasons. New tools are needed if performance is to improve substantially.

China is a huge country and its economy has grown into a complex industrial powerhouse with enormous energy requirements. Governance of the energy sector is divided among many national bureaus, ministries and other influential bodies; many provincial and local government bodies; and many large and small state-owned and private sector enterprises. These vary widely not only in power and influence, but also in their interests and motivations. For example, the state-owned oil companies, which have descended from prior government ministries, each have hundreds of thousands of employees, ample financial and human resources, access to special knowledge and competencies, and consequently considerable influence over energy policy. They naturally tend to emphasize supply-side investments. Central coordination of energy policy among all these participants has been difficult, despite creation of high-level overarching policy-making bodies. Policy-making has tended to reflect the outcome of bargaining and negotiation within the central government, and there are pervasive principal-agent problems, since subsidiary bodies tend to put their own weights on competing policy objectives. So, for example, despite the policy emphasis on end-use energy efficiency, so far 20 times as much has been spent on supply-side expansion as on demand-side management.

Over the past several decades, China has been in transition from a state-dominated economy directed administratively from the top toward a much larger and more diversified market-based economy. It has consequently become increasingly difficult to implement policy through command-and-control approaches. If an appropriate balance between environmental and economic objectives or between expansion and efficiency is to be sustained, it is crucially important that conflicts between these objectives be reduced as far as possible by using

the national government's pricing and taxing powers. These powers can be used to make it more profitable to reduce pollution and to raise energy efficiency than not to do so. A corollary is the need for "hard budget constraints" in state-owned and other enterprises to ensure that economic signals have weight. Price reforms are called for, especially in the areas of energy and resources pricing and taxation.

In fact, China may be a good candidate for a "tax shift," raising fuel taxes and lowering value-added and business taxes in a revenue-neutral way. This would have the effect of stimulating domestic consumption and investment in the current economic slump, while supporting the goals of carbon mitigation, energy security and environmental protection.

That is not to underestimate the importance of strong, independent regulatory bodies and processes. Enforcement of existing codes and standards, strict and consistent permitting, and accountability of public and private bodies for implementation performance are equally important. Strengthening the institutional capacity and independence of relevant regulatory agencies, which are seriously understaffed and underfinanced in relation to the scale of energy and environmental challenges confronting China today, will remain a top priority.

Among the pricing and taxation measures that could be adopted in the power sector are those that would support renewable energy, demand-side initiatives and supply-side efficiency. The options in China at this point are similar to those available to other industrial economies. For example,

- By international comparisons, coal prices are low in China relative to petroleum and natural gas and do not fully reflect the environmental and safety impacts of the coal cycle. Although the industry has been moving toward a market-based system, remaining subsidies to coal producers could be removed, and a more comprehensive royalty or auction system for mining rights could be adopted. Higher environmental charges and better-enforced environmental and safety regulations would internalize the upstream costs of coal mining, and a higher pollution tax on coal would internalize environmental costs and encourage generators toward a least-cost dispatch order.
- Coal mines should be required to file closure and rehabilitation plans and put up financial assurances to back them.
- Simple housekeeping measures during coal transport, at power plants and at other end users would raise efficiency and reduce unnecessary emissions, especially of dust. This is an important short-term option because of the growing realization of the importance of black carbon in global warming.
- Capture and use of coal-bed methane is a strongly win-win option because of its implication in the mine explosions that contribute to the risks of coal mining in China. This is now being done as Clean Development Mechanism projects, but more could be done to capture methane rather than vent it.

- Similarly, the capture of methane from municipal solid waste and the construction of waste-to-energy plants could be expanded.
- China could consider adopting a national feed-in tariff to encourage grid-linked renewable energy options. It could incorporate an "adder" to regional thermal power prices reflecting the external costs of pollution. Wholesale rates could also include a performance incentive tied to demand and supply-side efficiency improvements.
- Adoption of time-of-use and interruptible power rates can be accelerated. Their benefits would be supported by investments in advanced metering for large customers.
- More ambitiously, the disincentive inhibiting power generators from undertaking DSM programs could be addressed by "decoupling" revenues from sales, using revenue caps, for example.
- China has begun to development the Energy Service Company (ESCO) industry, with international support. Financing and payment guarantees for work with public sector clients would help this industry expand.
- Pricing issues remain for petroleum fuels. The price increases of 2006-2007 were not fully passed along to end users by mid-2008, requiring the government to provide large subsidies to compensate the domestic oil companies. Full pass-through and higher fuel taxes would support efforts to promote fuel-efficient vehicles and alternative transport modes.
- Annual vehicle registration fees, insurance, and excise taxes could be calibrated to annual vehicle mileage to discourage driving.
- Many Chinese cities now suffer extreme traffic congestion, which imposes time and pollution costs. Road pricing schemes that charge for entry into downtown areas could be considered, where feasible.

In the regulatory domain, there are win-win opportunities to promote renewable energy and co-generation as well as efficiency. For example,

- Reducing barriers to grid connection for renewable energy projects and installing wholesale reserve and operating rules that do not unduly penalize intermittent energy sources would be useful.
- Generators should be required to use integrated resource planning that gives equal footing to demand-side options and combined heat and power.
- Adoption of cap-and-trade systems for conventional air pollutants would induce consideration of broader approaches than installation of end-of-pipe pollution controls, such as scrubbers. These alternatives would include burning of cleaner fuels and improvements in generating efficiency.
- In order to promote combined heat and power, power producers could be allowed to sell electricity directly to end users, not to the grid, paying only for the service of using the grid infrastructure.
- Heat is typically sold to buildings at flat rates, and buildings are not metered. The central government has adopted a policy framework that safeguards essential services for low-income households but allows

economically rational pricing. Implementation of this framework would rationalize district heating schemes and support combine heat and power investments.

- There is scope in China for expanded use of energy labeling programs that tell consumers the expected lifetime costs of energy-using equipment.
- There tends to be poor enforcement of building efficiency codes, vehicle inspections and all sorts of appliance and equipment efficiency standards. Enforcement approaches that strengthen independent monitoring and inspection and set penalties high enough for effective deterrence could be applied.

Conclusion

Despite declining to set binding national caps on emissions, which the Government fears would inhibit future economic growth, the Government of China has already put in place a wide-ranging program of greenhouse gas mitigation. This program is motivated not only by the perceived risks of climate change to water resources, agricultural production and coastal cities, but also by the closely linked problems of energy security and environmental degradation.

Despite all the policies and measures that the Government of China has enacted so far, there is considerable room for additional actions that would further reduce carbon emissions while strengthening, not inhibiting, the country's long-term development prospects. Many of these involve measures to implement fully the policy commitments already adopted, using market-based measures of pricing, taxing, and regulation to align incentives throughout the economy. In addition, there remain very significant opportunities to raise energy efficiency in buildings, households, and industry toward international standards, saving money and energy in the process.