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Toward Integrating Climate Change Externalities in Bank Sector Work

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Introduction

Global climate change is becoming increasingly important as a policy issue for World Bank client countries. While the Framework Convention on Climate Change (FCCC) is unlikely to impose legally binding limits on developing countries in the near future, it does require countries to "formulate, implement, publish and regularly update national and, where appropriate, regional programs containing measures to mitigate climate change." These communication requirements will in turn lead to a large number of climate-change related studies, including greenhouse gas (GHG) mitigation studies, which analyze and evaluate abatement costs of measures and policies that reduce GHG emissions.

The World Bank hopes to play a significant role in this effort through an analytical tool, the Global Overlay, which extends economic and sector work (ESW) in relevant sectors such as energy, transport, and forestry to include climate change externalities, i.e. GHG emissions. This extension program is being spearheaded by the Climate Change Unit of the World Bank's Global Environment Division (ENVGC). Global Overlays are undertaken as a modest extension of regular Bank ESW and do not require any changes in the operational responsibilities for the sector work.

Three Global Overlays have already been completed by the regions in collaboration with Bank clients (Argentina Carbon Sequestration, Ukraine Energy Options Global Environmental Analysis, and Mexico Greenhouse Gas Assessment). An initial study on the Mekong Power Integration Scheme has been completed, which may develop into a full Global Overlay. A Phase 1 Global Overlay for the Russia Oil Sector has also been completed. The U.K., in cooperation with the Bank, is funding a study on Greenhouse Gas Emissions from the India Power sector in two provinces, which is nearing completion. A study on Greenhouse Gas emissions in the urban transport sectors of Mexico City and Santiago, examining how control cost curves for local pollution reduction are altered by the presence of a globally motivated agent (e.g., the Global Carbon Initiative [GCI]), is also nearing completion.

This paper examines the methodological groundwork for Global Overlays in the climate change area. Chapter 1 describes the communication requirements of the FCCC for Bank client countries and the implications these may have for Bank Country Assistance Strategies (CAS). It also describes the Global Overlays concept and outlines recent changes in the Bank's Operational Policy regarding the specification of global externalities. Chapter 2 lays out some of the conceptual and methodological problems behind GHG abatement costing. It describes objectives, scope and limitations of the two main conceptual approaches and the methodological components of previous mitigation studies. Chapter 3 reviews the two most comprehensive mitigation studies completed so far and analyzes their strengths and limitations. Chapter 4 summarizes the findings from previous chapters and suggests building blocks and a four-step analytical structure for Global Overlays.

1 Policy Framework

FCCC Requirements for GHG Mitigation Studies

Since the mid 1980s, climate change has evolved from an issue of scientific inquiry to a global policy concern. The Framework Convention on Climate Change (FCCC) that was signed at the Rio Summit in June 1992 entered into force in March 1994, and in the meantime has been ratified by more than 150 countries. While the FCCC does not impose any legally binding targets on emissions of greenhouse gases (GHG) on any of its contracting parties and any emission constraints on most developing countries are unlikely in the near future, the Convention does have immediate effects through its communication requirements. These will contribute to a large number of climate-change related studies, including GHG inventories, vulnerability assessments and GHG mitigation studies.

In its Art. 4 (b), the FCCC requires countries to "formulate, implement, publish and regularly update national and, where appropriate, regional programs containing measures to mitigate climate change". According to Art. 12.1., all ratifiers shall communicate these programs, together with an inventory of greenhouse gas sources and sinks, to the interim secretariat. Developed countries and others listed in Annex I, which includes most economies in transition[1], also have to present a detailed description of the policies adopted to stabilize emission by 2000 at 1990 levels. Their first communication was due in September 1995[2].

Countries not listed in Annex I, i.e. most developing nations, have not been given a deadline for submission of national communications. These national communications will likely be informed by preceding GHG country studies. It should also be noted that, under Art. 4.3 of the FCCC, developed countries committed themselves to meeting the full costs of such studies.

Previous GHG Mitigation Work

GHG mitigation studies are a subset of abatement cost studies for greenhouse gas reduction which identify and evaluate different technological measures and policy options to reduce GHG emissions in the context of the FCCC (see Chapter 2)[3]. Such studies are carried out under different auspices. One of the first and largest GHG mitigation studies was coordinated by the United Nations Environment Programme (UNEP) Collaborating Centre on Energy and the Environment in Denmark (see Chapter 3.1) and completed in May 1994. The Global Environment Facility (GEF) financed an extensive study on "Issues and Options in Greenhouse Gas Emissions Control in China" that was jointly implemented by World Bank staff and two high-ranking Chinese ministries, under the administrative guidance of the United Nations Development Programme (UNDP) (see Chapter 3.2). This project was completed in December 1994. An analysis of energy mitigation options in Ukraine prepared for the Kiev resident mission of the World Bank by RCG/Hagler Bailly was completed in December 1994 (RCG/Hagler Bailly 1994). The GEF financed a study on Greenhouse Gas Emissions and Mitigation Strategies in Mexico in collaboration with the Universidad Nacional Autonoma de Mexico. A regional study called "Climate Change in Asia", written by the Climate Change Institute and financed by the Asian Development Bank, also contains some estimates of abatement costs. An earlier intercountry comparison was undertaken by the Lawrence Berkeley Laboratories in 1991.

More extensive attempts are currently underway, financed by the GEF or bilateral donors. A US$9.5m GEF-financed project designed to evaluate the costs and effectiveness of GHG mitigation measures in 12 Asian countries started in mid-1994. In addition, bilateral donors are also financing mitigation studies. The most extensive program is the U.S. Country Studies Initiative, which is guided by an interdepartmental working group and comprises mitigation components for over 50 countries. Technical advice for its mitigation work is coordinated by Lawrence Berkeley Laboratory. The U.K., in co-operation with the Bank, is funding a study on Greenhouse Gas Emissions from the India Power sector in two states, which is nearing completion. The Norwegin, Danish, German and Dutch governments have also been active in funding GHG mitigation studies and projects.

Global Overlays

Bank experience and resources warrants significant involvement in the rapidly evolving field of GHG mitigation work. For example, the Bank's economic and sector work deals with many of the same sectors, e.g. energy, forestry and transport, that are analyzed in GHG mitigation studies. Extending this work to cover climate change externalities offers the prospect of capturing analytical economies of scale and scope as well as enhancing consistency between sectoral development strategies and global environmental protection. Such an extension has been spearheaded by the Global Environment Division (ENVGC) under the "Global Overlay" program[4].

Similar to a graphic overlay, which attaches a new layer to an already existing surface, a global overlay adds a global dimension to the sector studies that the Bank undertakes on a regular basis for its client countries. An overlay for the climate change area is likely to consist of two components:

- it uses an existing sector development strategy for sectors with significant greenhouse gas (GHG) emissions such as energy, transport, forestry and agriculture and calculates the emissions associated with this strategy, and
- it outlines cost-effective sectoral mitigation options available to the country if it seeks to limit its GHG emissions in that sector.

Overlay analyses for climate change quantify only climate change externalities, i.e. the emission or sequestration of greenhouse gases associated with a particular sector development strategy. Sectoral analyses for other focal areas (such as biodiversity losses or impacts on international waters) are being implemented separately.

It should be noted that an extension of Bank sector work is already called for by recent changes in its operational policy. Specification of global environmental externalities is called for by Bank Operational Policy (OP) 10.04 (September 1994). The document notes that global externalities are "normally identified in the Bank's sector work or in its environmental assessment process". Hence, Bank sector studies should now specify the global environmental implications of proposed sectoral development plans. OP 10.04 requires that "global externalities [...] are considered in the economic analysis when (a) payments related to the project are made under an international agreement, or (b) project and project components are financed by the Global Environment Facility. Otherwise, global externalities are fully assessed (to the extent tools are available) as part of the environment assessment process and taken into account in project design and selection".

Sector work is generally a precursor for identification of projects. Overlays may be used for identification of both regular Bank and bilateral lending and GEF investment operations. For the GEF and similarly motivated donors, Global Overlays are an investment screening tool that allow reliable identification of cost-effective mitigation options or important investments in climate change mitigation, in addition to biodiversity conservation or the protection of international waters that are eligible for GEF funding.

To date, the World Bank has been actively involved in the China GHG Emissions Control Study. In addition, three Global Overlays have already been completed by the regions in collaboration with Bank clients (Argentina Carbon Sequestration, Ukraine Energy Options Global Environmental Analysis, and Mexico Greenhouse Gas Assessment). An initial study on the Mekong Power Integration Scheme has been completed, which may develop into a full Global Overlay. A Phase 1 Global Overlay for the Russia Oil Sector has also been completed. A study on Greenhouse Gas emissions in the urban transport sectors of Mexico City and Santiago, examining how control cost curves for local pollution reduction are altered by the presence of a globally motivated agent (e.g., the Global Carbon Initiative [GCI]), is also nearing completion. A study on GHG-friendly alternatives to 2-stroke engines in South Asia has just commenced.

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1 Art. 4.6 grants economies in transition "a certain degree of flexibility" in meeting their requirements.

2 At this writing, five Bank client countries, Poland, Hungary, the Czech Republic, the Slovak Republic, Estonia, and Latvia, have presented their national communications to the interim secretariat. The Environment Department commissioned an external study to evaluate the consistency of Bank operations in the Czech Republic, Poland, and Hungary with the plans and measures outlined in the communications. The final report is available from ENVGC.

3 The expressions *abatement* and *mitigation* are often used interchangeably. Since *mitigation* is the term favored by the FCCC, *mitigation studies* is used here to denote efforts developed in relation to the FCCC process that are designed to inform national policymakers about different GHG reduction options. The cost imposed by implementing these options is termed *abatement cost* in line with the conventional use of the term in economic parlance.

4 Guidelines for Climate Change Global Overlays have now been developed, and are available from ENVGC. Overlays are not restricted to climate change externalities. Similar work has been developed for the biodiversity conservation area, and has been planned for international waters focal areas.

2 Typology of GHG Abatement Cost Studies

Top-down vs. Bottom-up

GHG mitigation studies form a particular class of abatement cost studies for GHG emissions reduction[5]. The latter come in different types, shapes and sizes. They are also designed to serve various and often very different objectives. For example, some studies are used to evaluate the effects of a carbon tax on various sectors and quite often the entire economy, while others attempt to evaluate the cost-effectiveness of different technologies on a sectoral level. GHG abatement cost studies differ with respect to the geographical and sectoral scope they cover, the timescale, the level of disaggregation and the modeling techniques. Perhaps the most important distinction is between two different professional and methodological approaches, which are aptly called top-down and bottom-up[6].

The top-down approach comprises short-run macroeconomic and long-run general equilibrium models. Both model types look at the overall impact of changes in climate policy on the economy— particularly changes effected by the introduction of a carbon tax. In these models, energy is treated as an input for the production of a representative good. Since production is assumed to be efficient, any restriction of energy consumption is viewed as a cost.

Important distinctions within the top-down models relates to their time horizon (long run vs. short run) and their geographical scope (global vs. national). Short-run models such as DRI for the USA (Brinner et al. 1991) or MDM (Barker et al. 1993) usually focus on the transitional effects of policy changes on the economy, often based on a Keynesian framework.

Intermediate and long-term top-down models are intertemporal general equilibrium models of various degrees of complexity. Global models such as the Second Generation Model (Edmonds et al. 1992) or GREEN (Burniaux et al 1992) focus on the broad impacts that different policy options would have on world regions and have limited sectoral or regional detail. National models such as Jorgenson/Wilcoxen (1992) and Goulder (1993) for the US or Blitzer et al. (1993) for Egypt generally offer much more sectoral detail. For example, Jorgenson/ Wilcoxen predict impacts of carbon taxes on the output of 35 industries and the supply prices of their products. Following from their objective to ascertain the impact of climate policy choices, top-down models concentrate on capturing the links and feedbacks between the energy sector and the rest of the economy, with less emphasis on the dynamics of the energy sector itself.

A study taking a somewhat different approach was completed in 1995, examining the macroeconomic impacts of direct subsidy elimination in the United States. The Jorgenson-Wilcoxen-Slesnick model, developed by Dale Jorgenson Associates for the U.S. Environmental Protection Agency, and reported in Shelby, et al. (1995), applies a computable general equilibrium model of the U.S. economy to a policy entailing the elimination of US$15.4 billion in direct energy subsidies (about 3% of total energy expenditures), including subsidies to non-carbon energy sources. Carbon emissions drop by 4% annually over the base case for the period 1990-2050. Removing the subsidies contributes 30% of the total reduction in emissions required to achieve stabilization of emissions from the U.S. overall. If the revenues are recycled via a decrease in capital income taxes, Gross National Product will improve by 0.2% over the base case due to the favorable impacts of increased investment on the economy. If recycling occurs through a reduction in marginal labor taxes, growth increases, but only gradually to 0.1%, as the opportunity cost of consuming leisure increases, causing workers to supply more labor and produce more output. Finally, a change in the average tax rate only results in an increase in consumption, and no increase in labor supplied, resulting in a -0.3% change in growth. The model is not capable of analyzing the impacts of a change in the budget deficit as a result of the decrease in subsidies, so no "worst case scenario" is available.[6]

In summary, top-down models have some limitations when applied to modeling greenhouse gas abatement costs. First, most models do not have enough technological detail to model energy sector options very carefully. One reason for this is that they tend to focus on the effects of price changes rather than sector-specific investments. Second, the assumption of efficient production may lead to an overstatement of GHG abatement costs for the given structure of the energy system. Inefficient use of energy may be due to a combination of market, policy and information failures. Often cited examples are (i) high transaction and information costs relative to energy saving, (ii) unfavorable institutional arrangements (e.g. landlord/ tenant) and (iii) regulatory imperfections. To the extent that inefficiencies persist, energy efficiency improvements - and associated GHG emission reductions - could be achieved at a cost lower than the gain from efficiency improvements. This is known as a 'negative' cost abatement option, and results in a net gain to society.

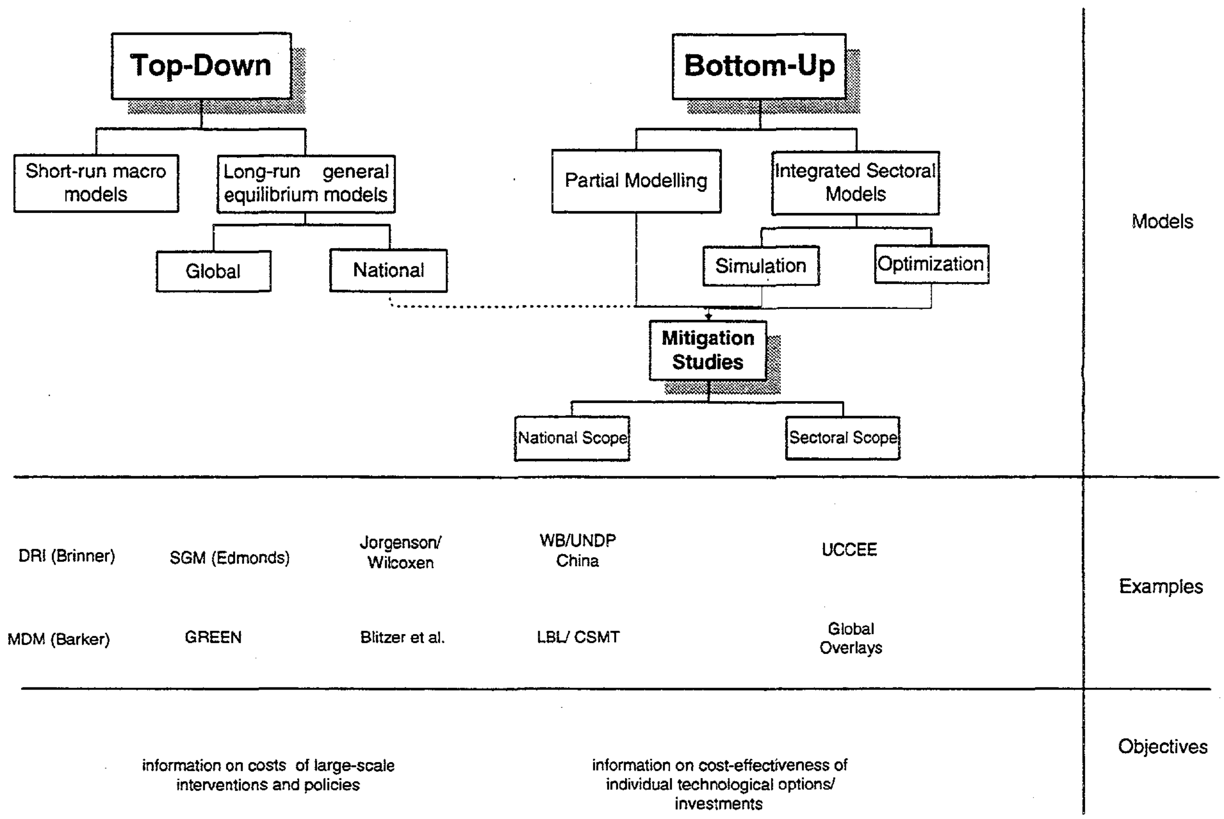
Many top-down modelers acknowledge that such opportunities may exist, but are generally less sanguine about their size. In addition, they argue that such efficiency improvements should be included in the baseline as well as in any abatement scenario. To a large measure, then, the divergence in results between top-down and bottom-up studies can be traced to different assumptions about the baseline rather than differences in methodology[7].

The bottom-up approach is based on engineering estimates of costs for individual measures or combinations of measures, primarily within the energy sector. These models are generally based on the least-cost planning approach that integrates the traditional supply perspective of energy planning with demand side management measures in a consistent framework. Consistent with their use for energy planning, bottom-up analyses are used to evaluate individual mitigation options in the energy sector.

There are two subgroups within the engineering/ bottom-up approaches, i.e. (i) partial models and (ii) full energy system representations which can be subdivided in (a) integrated simulation models, and (b) optimization models, mostly based on linear programming. In partial models, abatement options are analyzed separately and usually ranked in technological cost curves in order of their cost-effectiveness. Such cost curves can provide a comparison of the direct costs associated with the implementation of individual measures, but such a separate analysis ignores interdependences between different options that are likely in a comprehensive mitigation scenario. Integrated energy system models can overcome this shortcoming.

Simulation models such as LEAP offer a large degree of flexibility in representing particular system characteristics and they also represent individual technologies and subsectors in much detail. The high degree of complexity has its drawbacks, however. It demands thorough knowledge of the model system by the individual user and the consistency of the system has to be monitored since there is no built-in optimization procedure. *Linear programming optimization models* minimize discounted cost over some period, subject to infrastructural and policy constraints. Frequently used models include WASP, EFOM and MARKAL. Such models have been found useful for designing optimal supply systems, but they also have certain disadvantages imposed by the mathematical framework.

Figure 2.1. Typology of Greenhouse Gas Abatement Cost Studies



There are general limitations of the bottom-up approach as well, as has been repeatedly pointed out. First, the feedbacks between the energy system and the rest of the economy are generally ignored. Since the energy sector may be of considerable significance for macroeconomic variables such as annual GDP growth, inflation, or the trade balance, this shortcoming is important, particularly for more aggressive mitigation scenarios. Second, hidden costs of abatement measures are often ignored. These are not only the more visible costs of information campaigns and program administration, but in a wider sense also intangible costs imposed by less than perfect substitution of energy-consuming devices or underestimated time requirements for the implementation of individual measures.

A Typology of GHG Abatement Cost Studies

Modeling approaches generally have to match the objective of the study as well as its proposed scope and the degree of disaggregation required. Figure 2.1. gives a broad overview of the types of studies (see also Grubb et al. 1993, UNEP 1992 for more detailed typologies).

Figure 2.1 shows that the difference in methodology and professional orientation between top-down and bottom-up approaches is matched by a difference in objectives. It also indicates that mitigation studies combine a bottom-up approach on a partial modeling basis or sectoral integration basis with a macroeconomic assessment component that is derived with a top-down approach. Examples for mitigation studies at the national level are the WB/UNDP study on China and work in the US country studies program on the basis of the Lawrence Berkeley/CSMT methodology. Sectoral level examples are global overlays (e.g., energy/forestry) and the UCCEE studies, even though some examples in the latter also include non-energy options.

5For a more comprehensive comparison of the two approaches see Grubb et al. 1993 and UNEP 1992.

6Shelby, M., R. Shackleton, M. Shealy, and A. Cristofaro. "The Climate Change Implications of Eliminating U.S. Energy (and Related) Subsidies." Paper presented at the *Evaluating Energy Subsidies* conference sponsored by the U.S. EPA, Sept. 6-7, 1995, Washington, DC. 1995.
See also:
Jorgenson, Dale W. and Peter J. Wilcoxen. "Reducing US Carbon Dioxide Emissions: An Assessment of Different Instruments." *Journal of Policy Modeling*, Volume 15, pp. 491-520, October-December 1993.
Bohringer, Christoph, "Fossil fuel subsidies and environmental constraints: a general equilibrium analysis of German coal subsidies and carbon emission restrictions, *Environmental and Resource Economics*, 8:141-55, September 1996.
Welsch, Heinz, "Recycling of carbon/energy taxes and the labor market: a general equilibrium analysis for the European Community", Environmental and Resource Economics, 8:141-55, September 1996.

7 The issue here is to what extent win-win options would be implemented in the absence of climate change concerns. If all profitable investment options are realized, these win-win options would become part of the baseline. Further reductions would then have positive costs. This is also called an *efficient baseline*. Conversely, if existing trends are simply projected into the future, the win-win potential in an abatement scenario often is considerable. This is called the *business-as-usual baseline*.

3 Review of Previous GHG Mitigation Studies in Developing Countries

While there are quite a few GHG abatement studies both for the global and the national level in developed countries, there is a paucity of such studies for developing countries and for economies in transition. Of this set, only a few are GHG mitigation studies – studies that analyze and evaluate individual mitigation measures and GHG reduction opportunities. Probably the most extensive mitigation studies are the UNEP Greenhouse Gas Abatement Costing Study Project that comprised 10 countries and the study entitled "Issues and Options in Greenhouse Gas Control in China", undertaken jointly by UNDP, the World Bank and two Chinese ministries. These two studies are reviewed below, with a focus on their methodological framework.

The UNEP Greenhouse Gas Abatement Costing Study Project

The UNEP GHG Abatement Costing Project that was guided by a team of researchers from the UNEP Collaborating Centre on Environment and Energy (UCCEE) at the RISO National Laboratories in Denmark is one of the pioneering efforts to undertake a thorough analysis of GHG mitigation options and their costs in developing countries. In its first two phases, the project has focused mainly on CO_2 emissions from the energy sector, but extensions to other sectors and gases are planned.

Phase Two encompasses 10 country studies, including developed countries such as Netherlands, France, Denmark and developing countries such as Brazil, Venezuela, Egypt, Senegal, Zimbabwe, Thailand and India. The results of these 10 studies are published separately[8], but summarized in one volume (UNEP 1994b) and accompanied by a main report that explains the methodology and compares the results (UNEP 1994a).

Methodological framework

The proposed UCCEE methodological framework consists of three elements: (i) a definition of key concepts, (ii) a set of common quantitative assumptions (international fuel prices, discount rates, reduction targets), and (iii) an analysis procedure with essentially four steps:

1) Definition of baseline or reference scenario;
2) Identification and ranking of mitigation options;
3) Construction of two abatement scenarios;
4) Macroeconomic assessment and subsequent political and social evaluation.

A graphical and more comprehensive representation of the analysis structure is displayed in Figure 3.1.

This procedure combines features from bottom-up and top-down approaches. Step (2) is equivalent to the partial modeling version of the bottom-up approach. It consists of separate evaluations of costs and emission reduction potentials for different mitigation options. The ensuing steps (3) and (4) correct some of the drawbacks associated with that method.

Step (3) sets up a consistent abatement scenario that integrates the technological options outlined in (2), but accounts for possible interdependencies between these options. For example, calculations of emission reductions from demand-side savings are calculated with current structures of the energy supply system, but they may be inaccurate if they are part of a

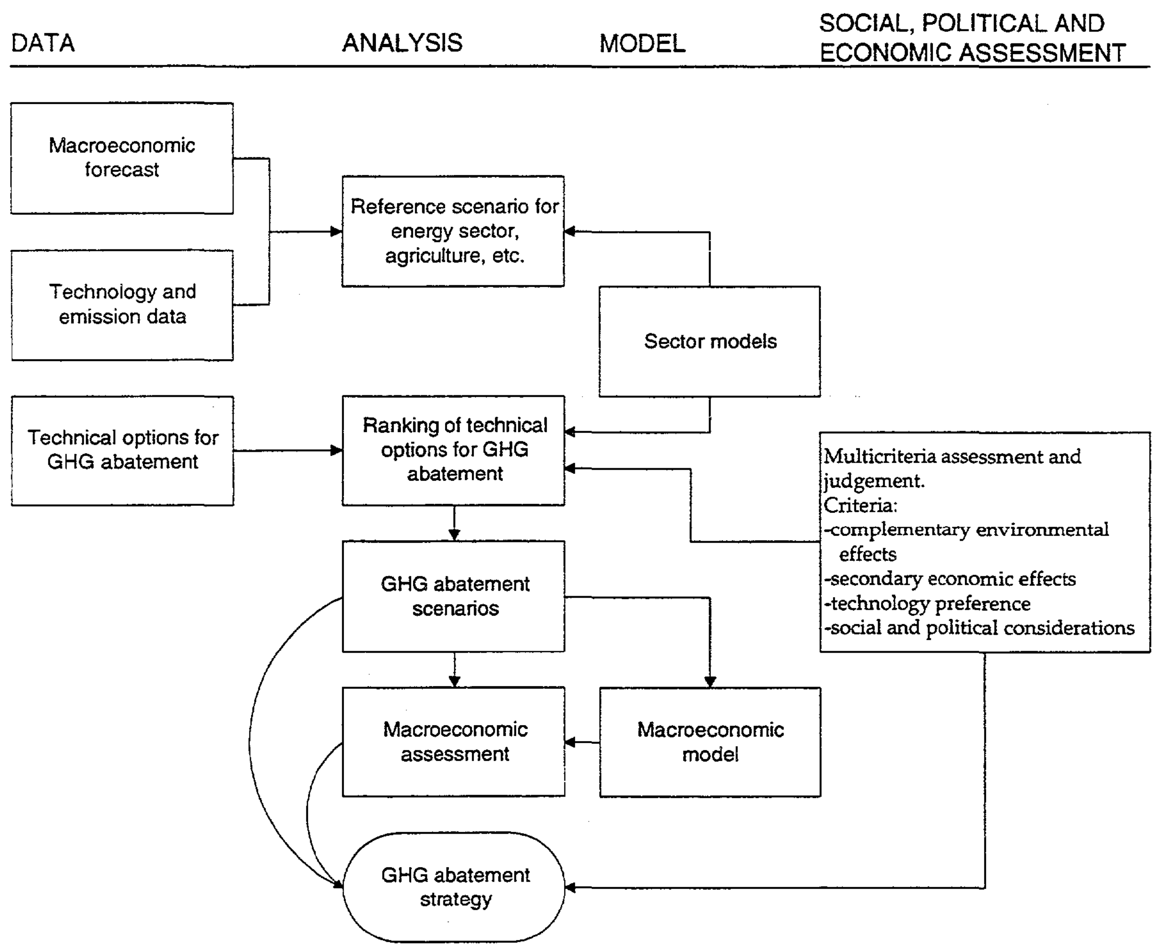


Figure 3.1 Structure of applied abatement analysis procedure

comprehensive GHG abatement program that would imply changes in the energy supply system.

Similarly, step (4) evaluates the feedback of sectoral changes on the economy in a macroeconomic assessment. The eventual GHG abatement strategy also has to undergo a social and political evaluation with multiple criteria, as commonly provided by political processes. These extensions seek to avoid the shortcomings of sectoral models with insufficient representation of the linkages to the general economy.

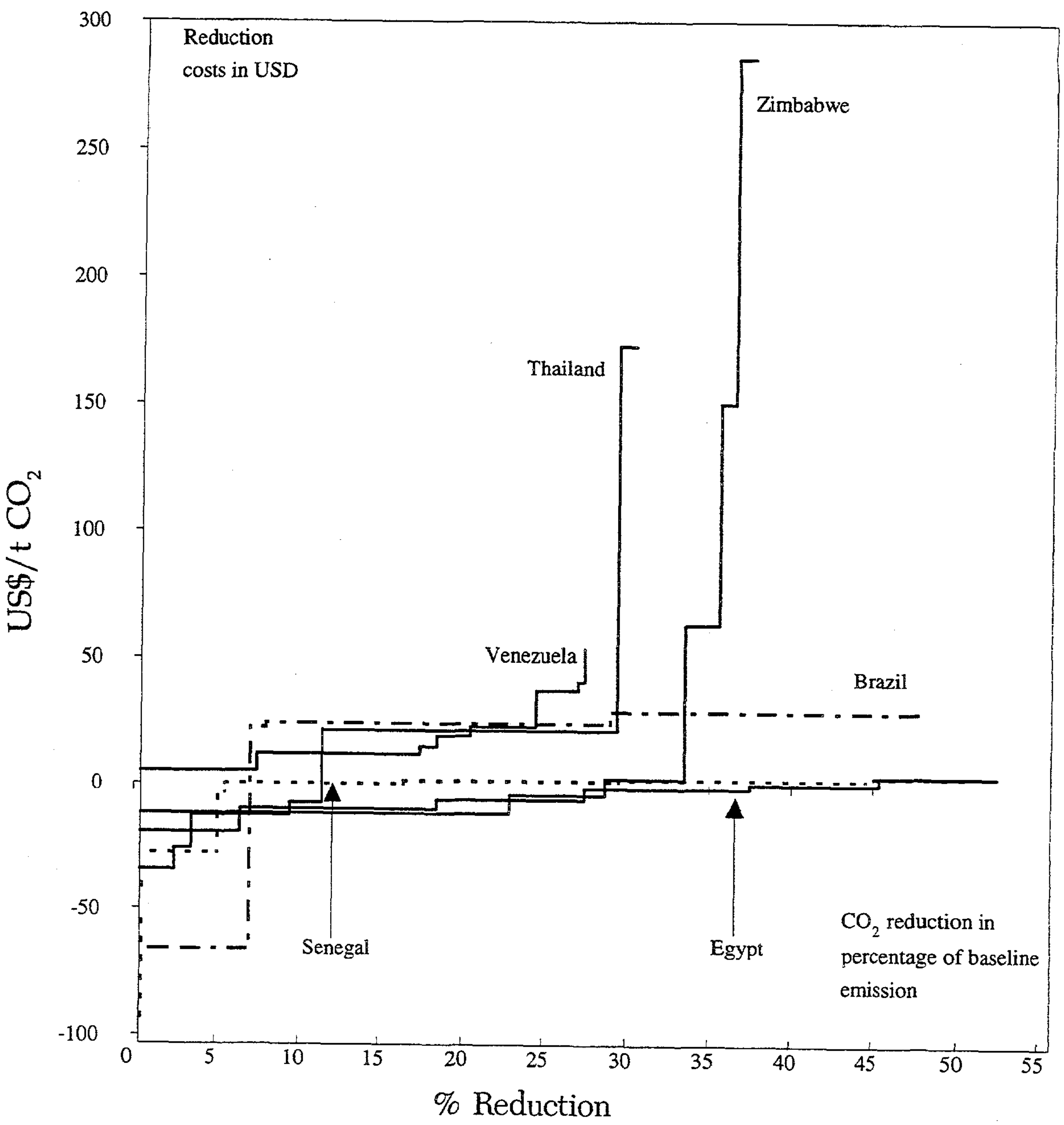
A very similar procedure was suggested by Lawrence Berkeley Laboratory and the US Country Studies Management Team (CSMT/LBL 1994).

Common Results

There are two scenarios in the UCCEE study—a 20% reduction relative to the baseline in the short term (2005/10) and a 50% reduction in the long run (2025/30). Figure 3.2 shows marginal abatement costs for six out of the ten countries in the study. On the x-axis are CO_2 emission reductions in the abatement scenario relative to the baseline. On the y-axis are marginal abatement costs in the target year.

Figure 3.2. shows two similarities of the cost curves for developing countries. First, there is a considerable potential of abatement measures with 'negative' costs—or costs that are lower than the gain from efficiency improvements—which ranges from around 7% in Brazil and Senegal to 35% in Egypt. The only exception is

Figure 3.2 Marginal abatement cost in the long-term target year.



Venezuela, where the baseline scenario includes all efficient investments so there is no possibility of obtaining further gains in efficiency.

Second, there some similarities in the shape of the curves. Roughly, a steep part for the most cost-effective option(s) is followed by a flat part representing about 20% reduction potential, which is either slightly above or below zero abatement cost per tonne of CO_2. Further reductions are often fairly expensive, which makes the marginal cost curve rise steeply again from that point on.

In comparison, a win-win reduction potential of 10-35% in developing countries is comparable in magnitude to that estimated for developed countries, both within the UCCEE project and outside of it. In a thorough review

Table 3.1. Main categories of CO_2 reduction and related marginal abatement cost (MAC) in the participating developing countries for the long-term target.

Country	CO_2 reduction option	reduction (%)	MAC (US$)
Brazil	Electricity savings (industry, services and residential)	7	-66
	Solar uses in agriculture	1	22
	Fuelwood and charcoal for afforestation programmes	21	24
	Ethanol, bagasse and electricity generation from bagasse	19	29
	Total CO_2 reductions	**48**	
Egypt	Fuel switching in households	6	-21
	Efficient industrial equipment and maintenance	10	-12
	Transportation	2	-12
	Heat recovery and new industrial processes	9	-8
	New raw materials	5	-3
	Efficient household appliances	5	-3
	Electricity generation	8	-1
	Efficient stoves	7	2
	Total CO_2 reductions	**52**	
Senegal	Early hydropower implementation	0.1	-210
	Agriculture intensification	5	-28
	Energy conservation in industry	0.4	-4
	Dissemination of improved stoves	11	0
	Improve carbonisation efficiency	13	1
	LPG-charcoal substitution	15	2
	Biomass from afforestation	6	3
	Total CO_2 reductions	**50**	
Thailand	Efficient air conditioners	2	-36
	Electronic ballast	1	-27
	Compact fluorescent lamps (service sector)	6	-14
	Compact fluorescent lamps (residential sector)	2	-9
	Nuclear electricity	18	20
	Highly efficient gasoline cars	1	92
	Total CO_2 reductions	**30**	
Venezuela	Reduced flaring and leakage of methane	7	3
	Efficient boilers and kilns	10	10
	Freight transport	1	13
	Efficient electric motors in the industrial sector	2	17
	Passenger transport	4	21
	Electric sector	0.6	35
	Other energy savings in the industrial sector	2	39
	Efficient electrical appliances	0.4	52
	Total CO_2 reductions	**27**	
Zimbabwe	Efficient boilers	23	-9
	Energy savings in the industrial sector	4	-2
	Efficient motors and power factor correction	2	-2
	Increased hydropower	5	5

of abatement cost models, both of the top-down and the bottom-up variety, Grubb et al. (1993) estimated a reduction potential for developed countries of around 20% at very low or negative costs.

An issue slightly different from the overall cost of an abatement scenario are the individual mitigation options that comprise these scenarios. Table 3.1 summarizes the main CO^2 reduction options, their reduction potential and the respective (average) marginal abatement cost.

Table 3.1 shows some similarities across the developing countries in the study. The least expensive measures are usually energy end-use savings in households or industry. By comparison, electricity supply options tend to be much more expensive and tend to appear only at the high end of long-term abatement efforts.

Differences between studies

At the same time, there are significant differences between the country studies, with respect to their results and their assumptions and analysis structure. Some of these differences are unavoidable, such as time or resource constraints, expectations about the penetration of new technologies, or those distinctions introduced by differences in data availability and comprehensiveness. Some other, less inevitable differences are listed below.

Range of options considered: The mitigation options considered extend from less than 10 in the Brazil, Thailand and Senegal studies to 57 options in Egypt. Clearly, a larger range of options is likely to produce a smoother shape of the marginal cost curve. This might be most relevant for the intermediate cost range that is usually covered in less detail, while the ranking of the most cost-effective options may not be affected. Still, the unevenness of the coverage of technological options makes comparisons between countries even more uncertain.

Modeling tools: Studies also differed with respect to the modeling techniques they employed. All studies used some sectoral integration model to develop the abatement scenario, but as Table 3.2 shows, some teams use simulation models, while others preferred optimization models. Some country teams developed their own spreadsheet models, while others used internationally available products such as MARKAL or LEAP.

Output: There are considerable differences between the studies in content and presentation of results. For example, a macroeconomic assessment as proposed in the methodology was undertaken only by the France and Egypt country teams. While the Egypt study provided both macroeconomic assessments and the abatement cost for individual measures, the French country study reports only overall costs from different levels of carbon taxes, without explicitly listing the abatement costs of the chosen mitigation options. The India study also did not report abatement costs for individual options and due to a limited range of options considered, the maximum reduction their model could achieve was below 30%. As a consequence, the India study was not used at all and the France study was only marginally useful for international comparison, despite its

Table 3.2. Energy Sector Modeling Tools Used in UNEP Country Studies

	Simulation	**Optimization**
Brazil		MARKAL (dynamic)
Denmark	BRUS	
Egypt		ENPEP
France	NEXUS	
India		TEESE (static)
Netherlands		MARKAL (dynamic)
Senegal	LEAP	
Thailand	own spreadsheet model	
Venezuela	LEAP	
Zimbabwe	own spreadsheet model	

analytical sophistication. Similarly, the Thailand and the Venezuela studies did not exhaust all abatement options and, as in the case of the India study, did not reach the 50% reduction objective.

Baselines: The study teams varied considerably in their assumptions about the changes that would occur in the energy system without an explicit GHG abatement strategy[9]. For example, the Egypt team assumed that an adjustment program with energy price increases of 200-300% would be successfully implemented over a 5-10 year timeframe. As a response to these price changes, some efficiency improvements would be undertaken and are integrated into the baseline, but a lot of the present inefficiency is assumed to continue even in the long run, which opens up room for profitable and energy-saving investments resulting from a GHG abatement strategy. In contrast, the Venezuela team assumed similar price changes as a result of an adjustment program which the country has been undergoing, but the study assumes that all profitable efficiency improvements are realized under the baseline. Most other countries took a position somewhere in between.

Limitations

The UCCEE report lists three issues for further methodological improvement, namely (i) the development of baselines, (ii) the macroeconomic assessment and its link to the bottom-up study, and (iii) the issue of implementation costs.

Development of baselines. The UCCEE report lists in some detail the above-mentioned differences in baseline development across the country studies. It is less clear what lessons the team draws from these divergences and how they could be avoided.

One possibility would be to align baseline development more closely through collaboration between the Coordination Center and the national teams. Even though there are some guidelines for baseline construction, the report emphasizes that the decision rested with the national country teams. Closer coordination may allow consistent assumptions behind baseline development. A second and perhaps more promising option would be to develop multiple baselines. For example, the three options (efficient, most-likely, business-as-usual) could be developed separately. This would provide a range for the baseline, with a central estimate to be chosen by the research team. A somewhat simpler version would be to develop two baseline scenarios (high/low).

Independent of these options is the question of whether the focus on the 'degree of efficiency' of the baseline, i.e. to what extent profitable energy-saving investments should be assumed to be taken up without an abatement policy, is really adequate. As the WB/UNDP study on China study indicates, factors unrelated to investments in specific energy-saving technologies such as structural changes may be of considerable importance for energy consumption, particularly in rapidly growing economies. These aspects seemed to have received scant attention both from UCCEE and the country teams.

Macroeconomic Assessment. The UCCEE team acknowledges that their methodological design was over-ambitious regarding the linkage between bottom-up energy supply and top-down macroeconomic assessment. While all studies used macroeconomic projections to estimate energy demand, only France and Egypt had a formalized macro model they could use to assess macroeconomic effects of the abatement scenario. They note that "a more practical and helpful guideline for macroeconomic assessment would have been advice on the assessment of a few key macroeconomic indicators on the basis of available national economic statistics" (UNEP 1994a: 91).

Implementation Costs. The implementation cost issue is raised most often with respect to energy-saving programs in the household and industrial sectors, where suspected high implementation or other transaction costs may prevent seemingly profitable projects from being implemented. While the report flags the development of a "formalized procedure for the assessment of implementation costs and barriers" (UNEP 1994a:124) as an area for further research, it is not clear how they could be measured on a sectoral basis. Similar issues are currently under study in the GEF's PRINCE program for the project level, and some indication could perhaps be taken from these results once they are available.

The World Bank/UNDP Study on China

This study is a comprehensive two-year analysis titled: "Issues and Options in Greenhouse Gas Control in China". It was funded by the GEF, administered by UNDP and executed by the Industry and Energy Division in the China and Mongolia Department at the World Bank in a joint effort with the Environmental Protection Agency and the State Planning Commission in China (National Environmental Protection Agency et al. 1994). The summary report came out in November 1994.

Its objectives included an inventory of GHG emissions and sinks, the estimation of future baseline emissions until 2020, as well as the identification and evaluation of emissions reduction options in four sectors: energy use, alternative energy supply, forestry and agriculture. Significantly, they also included the identification of potential barriers to the implementation of least-cost GHG reduction options and the steps that governments and international financing institutions could take to overcome these barriers, including recommendations for future GEF funding in China.

Methodological framework

In keeping with the various study objectives, the methodology employed by the joint study team consisted of different – though partly interconnected – components:

1) Estimation of two baseline scenarios (high/low growth);
2) Estimation of High Efficiency Abatement scenario;
3) Separate sectoral analyses for forestry, agriculture, alternative energy supply;
4) Identification and evaluation of energy use reduction options in various sectors;
5) Ranking of cost estimates from energy use case studies and sectoral analyses in order of cost-effectiveness.

This methodology blends elements from top-down and bottom-up approaches. Steps (1) and (2) represent top-down procedures, while steps (3) to (5) are based on a bottom-up partial modeling framework.

This study put particular emphasis on baseline development. Future emissions are calculated from an 18-sector energy demand model that allows fairly precise representation of expected technological developments in each sector. For the High Efficiency scenario, energy coefficients for sectoral production were taken from industrialized countries to simulate a transition to currently available technologies.

Steps (3) to (5) are based on a partial modeling framework. Abatement costs are calculated as direct costs from the investment, i.e. investment and operating costs, relative to the baseline. The evaluated measures for each sector are then aggregated for each sector. There is no integrated energy systems model, however, so that the alternative energy supply component cannot easily complement the High Efficiency scenario.

The case studies are geared more towards the identification of possible implementation barriers rather than the estimation of sectoral abatement costs. Since the cases under consideration had been proposed by an expert panel as the most promising ones and may therefore not be representative of the entire sector, the findings from the case studies were not sectorally aggregated. This affects the ranking of these measures: while individual mitigation options can be ordered regarding their cost-effectiveness, they cannot be aggregated into abatement cost curves since the quantitative dimension is missing.

Baseline Scenarios

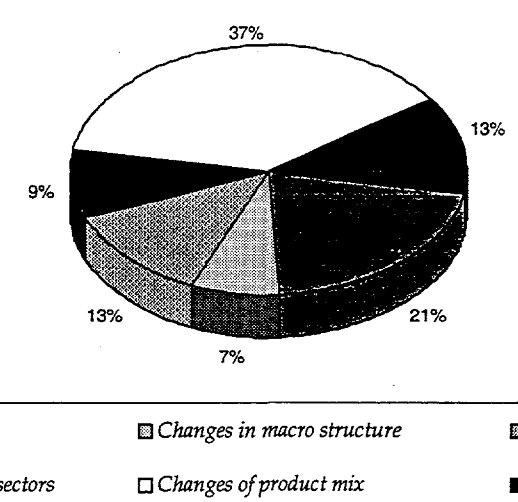
In order to provide a realistic estimate of the future path of GHG emissions in China and to identify the key factors affecting this path, the joint study team set up a GHG model that consisted of three components: (i) a macro-model to project final demand for goods and services; (ii) an 18 sector input-output table to represent the structure of the economy; the table includes energy coefficients to determine the energy inputs needed for the production of sectoral outputs; and (iii) an emission coefficient matrix to estimate the resulting emissions of GHGs as well as local pollutants.

The input-output coefficients were projected to the years 2000, 2010 and 2020 on the basis of historical data for China and under consideration of the I-O coefficients for industrialized countries in earlier decades. The energy coefficients are of particular importance for the resulting GHG emissions. Their projections were based on four factors: (a) expected economic growth, (b) scale of new plants relative to existing ones, (c) rate of adoption of new technologies, (d) increases in product diversity. These findings were corroborated by case study results.

The studies produced two baseline scenarios. A *High-Growth scenario* expects real economic growth to be 8% p.a. for the period 1990-2020. This scenario is not unrealistic given China's historical record and the experience of the East Asian economies. The *Slower-Growth* scenario expects 6.6% p.a. real growth. Under the High-Growth scenario, GHG emissions will rise to 2400 mtC equivalent by the year 2020, which is a threefold increase over 1990 levels. This baseline scenario already implies a considerable drop in China's energy intensity, which is one of the highest in the world. In the baseline energy demand scenario, Chinese energy intensity falls from 2.7 kilotonnes of coal equivalent per dollar in 1990 to 0.9 ktce/$ in 2020, in comparable prices. The main reason for this shift is structural change, as Figure 3.3. shows.

According to this estimate, only 21% of the total decline in energy intensity results from technical efficiency gains. The remainder is the consequence of structural change. The most important change is the shift in the product mix within subsectors, which contributes 37% of the total decline. This change represents the improvement in product quality and the shift into higher value added products, mainly in the chemical, machinery, building materials and light industry sectors. Saturation effects among residential consumers and the shift from direct coal use to electricity in this sector contribute 12% of the total, and structural changes between industry and other sectors as well as among industrial subsectors contribute 7% and 9%, respectively. These numbers indicate the enormous impacts that structural changes have on energy intensity. Thus macroeconomic and other policies that affect some of the structural

Figure 3.3. Sources of Projected Energy Intensity Decline in China, 1990-2020



Source: China: Issues and Options in GHG Emissions Control, December 1994 changes are likely to have a larger impact on energy demand and associated GHG emissions than many mitigation options considered in a mitigation analysis.

In the **High-Efficiency scenario**, the China GHG Model is used to estimate the potential for additional efficiency gains from technical improvements above baseline assumptions. The scenario involves a model re-run with lower sectoral energy coefficients. The coefficients are calculated on the basis of energy savings from the adoption of new technologies and processes. Table 3.3 compares unit energy consumption levels for baseline and high efficiency scenarios with 1980 Japanese levels.

Overall, the High-Efficiency scenario reduces primary energy consumption by 460 mtce or 14% and GHG emissions by 330 mtC or 13.75%. There are no cost estimates for this scenario, but the results from the case studies suggest that the direct net cost for such a scenario may well be negative. However, the case studies also point to significant implementation barriers and, in some cases, high information and transaction costs.

Sectoral Scenarios: Alternative Energy Supply, Forestry and Agriculture

The sectoral scenarios for agriculture, forestry and alternative energy supply are separate bottom-up analyses of the GHG mitigation options in these three sectors. For all three scenarios, energy savings and emission reductions were calculated relative to the baseline assumptions in the macro scenario.

The High Substitution scenario with a focus on *alternative energy supply* was based on the maximum amount of alternative (low carbon) energy sources that could be developed in China by the year 2020 under current development trends, given the long lead times for some of these energy sources. The scenario also includes direct substitution of coal by fuelwood and the use of coal-bed methane. Total GHG emission reduction from the High Substitution scenario relative to the baseline is 237 mtC or 10%. Table 3.4. compares the power supply results from this scenario with the baseline.

Table 3.3. Comparison of selected unit energy consumption levels, baseline and high-efficiency (HE) scenarios, 1990-2020

		China			Japan
		1990	2020 (baseline)	2020 (HE)	1980
Steel[a]	(kgce/t)	1,610	1,284	857	—
Cement	(kgce/t)	208	196	135	135
Ammonia	(kgce/t)	2,066	1,665	1,258	1,000
Thermal power	(kgce/MWh)	427	348	345	338
Caustic soda	(kgce/t)	1,790	1,325	1,000	1,000
Ethylene	(kgce/t)	1,580	1,450	800	872
Industrial coal-fired boilers	(average efficiency, %)	60	70	73	73[b]
Electric motors	(average efficiency, mean size, %)	87	90	92	92[c]

[a]Comprehensive consumption (not directly comparable with international statistics).
[b]Average U.K. efficiency for comparable size ranges.
[c]Average efficiency for U.S. high-efficiency models.

Table 3.4. shows that fossil fuels, particularly coal, will dominate China's power supply even under an ambitious development and implementation scenario for alternative energy. All renewables together would supply 40% of China's electricity by 2020. Most of this maximum supply is expected to come from traditional sources such as hydro-electric and nuclear energy and only 5% of the total supply would come from a new generation of renewables such as wind and solar energy[10]. The incremental cost for implementing the High-Substitution scenario was estimated at US$159 billion in 1990 yuan at an exchange rate of 4.7 yuan/US$. This is equivalent to an average incremental cost of US$ 670 per tonne of carbon.

The *forestry sector* analysis showed that managed plantations and open forest management have considerable potential for carbon sequestration. A large-scale afforestation program that would include these components and also fuelwood plantations could sequester between 2.4 and 4.6 billion tonnes of carbon from 1990-2020. At the high estimate, an afforestation program could sequester 221 mtC in 2020, or 9.2% of baseline emissions in that year. A similar analysis for the *agricultural sector* concludes that a program consisting of improved cattle breeds and feed programs and modified rice cultivation practices could reduce GHG emissions from the agricultural sector by 15-20%. This represents only 0.8% of total GHG emissions in 2020, however.

Case Studies in Industrial Energy Efficiency

The study team analyzed 25 projects with potential for energy savings in 7 sectors. These projects were pre-selected by industry experts. All of them had rates of return, both financial and economic, above the social discount rate, ranging from 15% to 84%. The study team differentiated between three classes of projects: (i) industrial restructuring, (ii) energy conservation and (iii) high-efficiency equipment.

Industrial restructuring projects tend to have high investment costs and a high financial significance to the company. Energy savings are incidental to these projects and usually only one component of overall lower operating costs. The study findings suggest that implementation barriers to such projects are not based on a lack of incentive, but come mainly from financing constraints. Continued enterprise reform, particularly in the banking sector, would be essential to the success of restructuring projects.

Energy conservation investments tend to be much smaller in size. They typically focus on energy savings, often offering high financial rates of return (25-71% for the sample). Likely implementation constraints are a weak cost-consciousness, a lack of information and high transaction costs relative to the comparatively low NPV.

Table 3.4. Electricity supply scenarios, 2020 (TWh)

	1990		**Baseline**		**High-substitution**	
	(TWh)	%	(TWh)	%	(Twh)	%
Hydro	126	20	601	16	719	19
Nuclear	0	0	208	5	568	15
Other renewables	0	0	45	1	208	5
Fossil fuels	495	80	2,996	78	2,355	61
Total	621	100	3,850	100	3,850	100

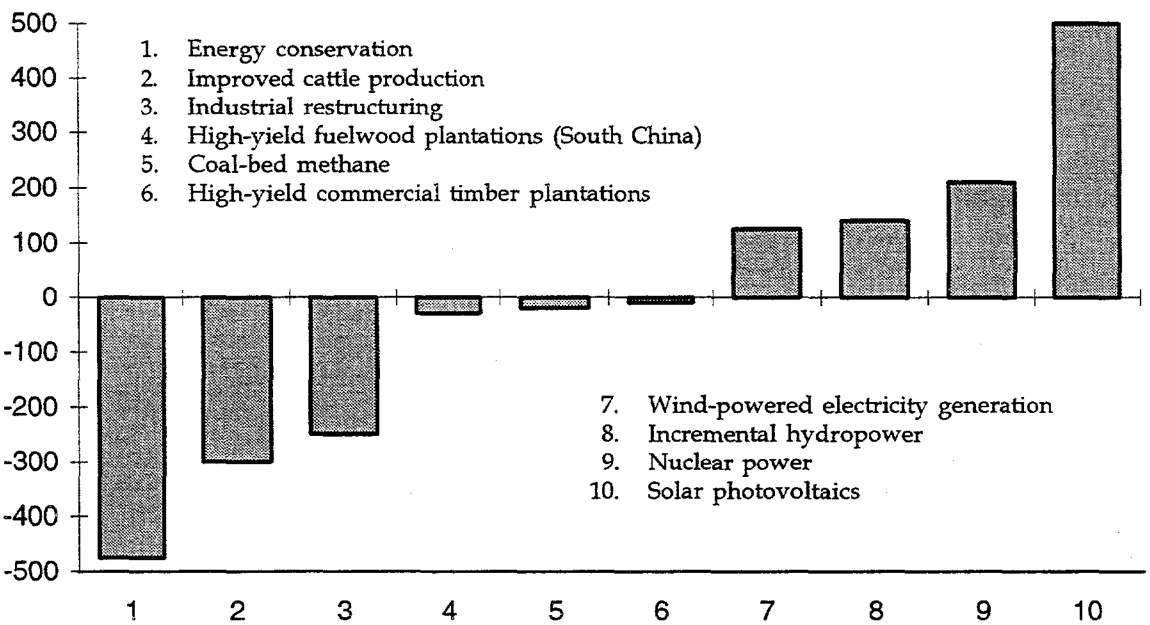
High-efficiency equipment. Two case studies for the manufacturing of variable-speed motors showed a potential for high rates of return under current product prices. Aside from uncertainty associated with product innovations, the study team also found additional constraints arising from the problems to license foreign technology. Adoption by users seems often bound by the same problems that afflict classic energy conservation projects.

Ranking

The study team selected ten mitigation options from the sectoral studies and the industrial energy efficiency case studies and ranked them according to net costs of reducing GHG emissions per tonne of carbon. Net costs are calculated by subtracting all classes of benefits, including local environmental benefits, from project costs. On the benefit side, the greenhouse gas reductions are discounted by the project discount rate[11]. The ranking according to this measure is shown in Figure 3.4. It should be noted that this is a partial ranking, which is not based on an integrated energy sector scenario.

The results emerging from Figure 3.4 have clear similarities to the UCCEE findings. In both cases energy efficiency investments emerge as least-cost GHG mitigation options with large

Figure 3.4. Estimated net cost of reducing GHG emissions in China with commercial technology (1990 Y/tC)



Notes and sources: Net costs of reducing GHG emissions have been calculated using extended cost-benefit analysis. **1. Energy conservation:** Average cost per ton reduction for the seven classic energy conservation projects evaluated. See *Energy Efficiency in China: Case Studies and Economic Analysis,* December 1994. **2. Improved cattle production:** Average cost per ton for improved cattle breeding and feed programs. See *Greenhouse Gas Control in the Agricultural Sector,* September 1994. **3. Industrial restructuring:** Average cost per ton reduction for the six industrial modernization projects evaluated. Ibid. **4. High-yield fuelwood plantations:** See *Greenhouse Gas Emissions Control in the Forestry Sector,* November 1994. **5. Coal-bed methane:** Calculated from economic cost-benefit analysis data provided by the GEF China coal-bed methane project. **6. High-yield commercial timber plantations:** Average cost per ton of intensive and extensive timber plantations. See *Greenhouse Gas Emissions Control in the Forestry Sector,* November 1994. **7. Wind-powered electricity generation:** See *Alternative Energy Supply Options to Substitute for Carbon-Intensive Fuels,* December 1994. **8. Incremental hydropower:** Hydroelectric capacity beyond levels currently part of China's power expansion plan. Ibid. **9. Nuclear power:** Ibid. **10. Solar photovoltaics:** Ibid.

negative net costs. In addition, forestry sector options such as fuelwood plantations and commercial timber plantations are also listed as low-cost options. By contrast, power supply mitigation options tend to be more expensive. For example, wind energy as the least expensive renewable energy technology costs on average around 120 yuan or US$25 per present tonne of carbon.

Limitations

Bottom-up analysis. While the individual mitigation options from different sectors were ranked according to their cost-effectiveness, the lack of a quantitative basis allows no judgment on the overall GHG reductions possible and their direct costs. In addition, the cost estimates for the energy sector are not developed from an integrated energy sector model and are thus not directly comparable because of their interdependence in a large abatement scenario.

The *link between the top-down and bottom-up* components is not well developed. Bottom-up data are used to confirm the detailed sectoral representation in the I-O table, but there seems no other link between the two components. This is particularly clear regarding the modeling of energy efficiency improvements. For example, it is not clear to what degree industrial restructuring or certain kinds of energy savings programs would contribute to the High Efficiency scenario outlined in the macroeconomic analysis.

Macroeconomic assessment. Despite the elaborate structure of the China GHG model, it was not used to model the abatement costs of GHG mitigation strategies, be they sectoral or cross-sectoral. In the High Efficiency scenario, lower energy coefficients show the potential for energy efficiency improvements, but the costs associated with such a strategy are not estimated. These issues may, however, be taken up in a follow-up study.

8Results from some of the studies are also published in the November 1994 issue of *Energy Policy*.

9See footnote 7.

10It should be noted that the supply constraint stems from long lead times and applies mainly to nuclear and hydro, but not to wind and solar. Modeling future costs for the latter is difficult since they are in an intermediate stage of technological development.

11Note that this procedure differs from the methodologies employed by UCCEE — where local environmental benefits are not taken into account at all — and the incremental cost concept used by the GEF (see GEF 1995 for details). A second difference is that both UCCEE and GEF do not discount GHG emission flows.

4 Toward Best Practice

The Framework Convention for Climate Change (FCCC) implies communication requirements for its more than 160 ratifiers, which will produce a large number of climate change-related studies in the coming years. One such product will be GHG mitigation studies, which analyze and evaluate the cost-effectiveness of various technological measures and policy options to reduce greenhouse gas emissions. The World Bank will play an increasingly important role in this effort through sectoral mitigation studies called Global Overlays. This paper outlines the methodological groundwork for Global Overlays in climate change by reviewing and analyzing results and methodologies from the most important previously undertaken mitigation work.

Mitigation studies are a class of abatement cost studies for GHG emission reduction. The latter differ in many respects, but the most important one is a conceptual and methodological divide between what has been called top-down and bottom-up approaches. The top-down approach is used by macroeconomic analyses which estimate economic costs and the emission reduction potential of large-scale policy changes such as the imposition of carbon taxes. The bottom-up approach is employed by engineering studies that compare costs of individual technological measures which would reduce net emissions of greenhouse gases, mostly within the energy sector. Mitigation studies to date have used a bottom-up methodology with some form of macroeconomic assessment component, reflecting their focus on an evaluation of individual measures and technological options to reduce GHG emissions.

Four Conclusions from Previous Studies

Four key experiences emerged from the review of the two most comprehensive mitigation studies:

1. The *bottom-up partial modeling methodology* employed in both studies reviewed here worked well, given its limitations. The UCCEE studies looked at a variety of options to mitigate GHG emissions, which differed considerably across countries. Overall, the estimates fall within a range that confirms earlier studies for developed countries. The UCCEE results suggest that the win-win potential in developing countries is at least as great as in the developed world.

The WB/UNDP study used bottom-up modeling successfully as a screening tool for potential GEF investments. Some of the opportunities identified in the study have been developed into project proposals now under consideration by the GEF.

2. The UCCEE studies succeeded in integrating these measures in two different consistent *abatement scenarios* for the short and the long run with the use of integrated energy models. This methodology seems well suited to the objective of GHG mitigation studies, i.e. the identification of the most cost-effective options for the reduction of GHG emissions, while avoiding shortcomings of a partial modeling framework.

3. *Baseline development* is done very carefully in the WB/UNDP study. Two aspects deserve particular attention. First, establishing two baselines with different economic growth

assumptions indicates very well the range of uncertainty associated with long-range macroeconomic predictions. Second, the study demonstrates the impact of structural and macroeconomic changes on energy demand along with the more sector-specific issues related to baseline efficiency. It should be added, however, that the China study required very extensive empirical work that may be difficult to match with the resource constraints of a sector study.

4. The *link between bottom-up cost estimates and top-down macroeconomic assessment* as proposed in the UCCEE methodology is promising, but turned out to be very difficult to operationalize. While such a link was included in its methodological guidelines, only two of the UCCEE country teams did in fact make such an assessment of the impacts of an abatement scenario on the general economy. The main challenge was the development of a formal macro model which could represent these impacts.

Careful analysis of macroeconomic impacts from an abatement scenario requires considerable macro modeling skills and extensive empirical research. Both aspects make it very difficult to develop within the budgetary confines of mitigation studies alone. These issues are perhaps better addressed in collaborative efforts with macroeconomists in research institutes, planning and statistics ministries. The significance of macroeconomic assessments depends also on the scope of the abatement scenario considered. For mitigation studies that look at small emission reductions, 'back-of-the-envelope' calculations should provide reasonably good estimates.

Building Blocks for Global Overlays

Together with the findings from earlier chapters, these conclusions suggest a few key elements that are essential for successful Global Overlay application.

Establish a link between objective and methodology.

Following from their objective to help client countries identify investment opportunities and policy priorities for reducing greenhouse gas emissions, Global Overlays should allow sufficient flexibility to focus either on an analysis of specific investment measures or on policy changes and their effects.

Identify win-win options at the macro and sectoral level.

Structural changes and other policy issues unrelated to energy sector-specific measures turned out to have a large impact on greenhouse gas emissions. A focus on macroeconomic policies that promote efficiency also reduces global externalities, a finding that reinforces a focus on overall efficiency improvements at the macro level. Similarly, mitigation studies confirmed the existence of a large potential for energy efficiency improvement measures at net gains to society. Concern about climate change thus provides additional arguments for tapping this potential for win-win projects and policies at the sectoral level.

Adopt a broad four-step analytical structure.

The analytical structure used by previous mitigation studies has proved fairly robust. It consists of four steps, adjusted for the purposes of extending regular sector work:

- *Establish one (or two if possible) sectoral reference scenario(s) and estimate associated GHG emissions.* The reference scenario is identical to the sector development scenario. Only the calculation of GHG emissions is truly additional.

- *Identify and evaluate mitigation options.* The number of options under the scope of study should be determined in discussions with sector economists.

- *Formulate abatement scenario.* The percentage reduction from the reference scenario to be achieved must be specified. Its timeframe should be guided by regular economic and sector work perspectives.

- *Estimate macroeconomic impacts from an abatement scenario.*

In addition, there should be common definitions of abatement costs and the discount rate applied to GHG emissions over time across studies.

Next Steps

This paper provides an overview of the analytical foundation for climate change Global Overlays. In addition to the Global Overlays already underway (and described in Chapter 1), the following steps are being taken to further develop the Global Overlay program as an integral part of ESW in the Bank.

- *Best practice guidelines* for climate change Global Overlays in the energy and forestry sector was published by ENVGC in February 1997.

- A *Handbook on Greenhouse Gas Assessment Methodologies* to be used by Bank project teams is expected to be completed in 1997.

- A *theme paper detailing the conceptual framework for climate change Global Overlays in the transport sector* has been commissioned, and will be completed in October 1997.

- A series of *consultations* with sector economists in the regional and central departments as well as with NGOs and other external constituencies is ongoing.

- Funding from the Danish and Norwegian Governments has been obtained, and is supporting methodology development and country applications. Additional financing for the overlay studies and the application of its results is being sought.

Acronyms

FCCC	Framework Convention on Climate Change
GHG	Greenhouse Gases
ENVGC	Global Environment Division, World Bank
ESW	Economic and Sector Work
UNEP	United Nations Environment Programme
GEF	Global Environment Facility
UNDP	United Nations Development Programme
GDP	Gross Domestic Product
UCCEE	UNEP Collaborating Centre on Energy and the Environment
MAC	Marginal Abatement Cost
PRINCE	Programme for Incremental Cost and the Environment

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