ESMAP
Energy Sector Management Assistance Program

# Low Carbon Growth Country Studies—Getting Started

## Experience from Six Countries

LOW CARBON GROWTH COUNTRY STUDIES PROGRAM

MITIGATING CLIMATE CHANGE THROUGH DEVELOPMENT

CARBON FINANCE ASSIST

LOW CARBON GROWTH COUNTRY STUDIES PROGRAM

# Getting Started: Experience from Six Countries

## FOCUSING ON LOW CARBON DEVELOPMENT

Six emerging economies—Brazil, China, India, Indonesia, Mexico, and South Africa[1]—are proactively seeking to identify opportunities and related financial, technical, and policy requirements to move towards a low carbon growth path. With the help of the Energy Sector Management Assistance Program (ESMAP), the governments of these countries have initiated country-specific studies to assess their development goals and priorities, in conjunction with greenhouse gas (GHG) mitigation opportunities, and examine the additional costs and benefits of lower carbon growth. Mitigation actions today are expected to reduce future expenditure on adaptation. These actions can help attract international concessional funding to cofinance programs in energy, industry, transport, and natural resource management, which have carbon reduction implications.

Together, the experiences from these six developing countries demonstrate the benefit of a structured engagement across a country's economy on growth and GHG mitigation. The result is a framework for policy, planning, and decision making that can:

- Support strategic, sustainable, and cost-effective low carbon growth
- Limit climate impacts and associated management costs
- Help harness climate finance opportunities and implementation support
- Increase national competitiveness in the face of a green revolution
- Build dialogue, local capacity, and know how

Collectively, these studies identify some broad messages (i.e., the need for renewable energy (RE) and energy efficiency (EE) support) and some surprises (i.e., low cost transport options and untapped cogeneration investments), generating a wealth of knowledge that provides a global public good. The goal is to use this knowledge to create low carbon pathways and to identify GHG reduction investments beyond these countries. For instance,

- In **Brazil,** impacts are already evident. Detailed sector methodologies are in use and technical results are emerging. There is improved information

[1] A study has recently been initiated in Poland (2009).

sharing across sectors and within the public sphere together with stronger linkages between technical research groups and corresponding government ministries and agencies.

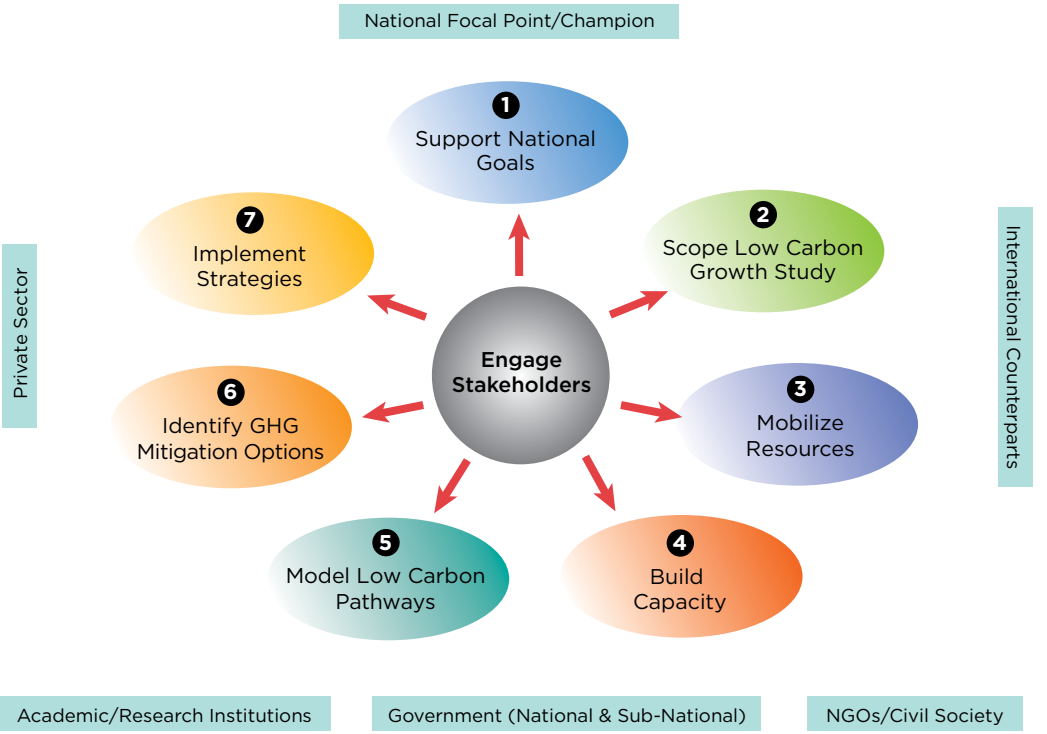
- **China's** study provides policy support to better understand RE and EE targets and low carbon growth.
- **India's** relatively low carbon economy reflects energy intensity 20 percent below world averages and per capita emissions among the lowest worldwide. However, curbing transmission and distribution losses, rehabilitating or closing lowest efficiency coal plants, and adopting mandatory energy efficiency standards for household appliances provide significant emission reduction opportunities. Further gains have been identified in the transport sector (e.g., improved vehicle fuel efficiency, reduced reliance on private transport).
- The **Indonesian** study provides insight into fiscal and financial policy instruments and tax and spending policies to promote movement towards a lower carbon economy. Strategic investment approaches and financing sources, as well as improved fiscal incentives in forestry, are also considered.
- **Mexico's** study provides a body of knowledge about prospective low carbon "wedges," specific low carbon projects, and the continuing policy reform agenda. Main energy savings arise from cogeneration and EE improvements in industry, while the forestry sector has untapped mitigation potential.
- **South Africa's** study is helping to create an enabling environment and to provide support for national and private sector organizations to undertake EE and demand-side management (DSM) measures identified as priorities in the government's Long Term Mitigation Scenario.

Among other things, the studies have engendered in-country ownership of mitigation strategies and have already provided two valuable outputs:

(i) A successful process for establishing low carbon pathways; and
(ii) A growing, useful knowledge and data set that can be used to both help other countries reduce their GHG emissions and help decrease the cost of mitigation.

The following pages will focus on the first of these outputs—the Low Carbon Growth Country Studies Process. The framework for this process is based on experiences over the past two years from ESMAP-supported studies in these six countries. Figure 1 illustrates the framework and the steps to perform a comprehensive assessment of GHG mitigation options, highlighting the central importance of sustained communication with stakeholders in the study process. Separate publications will describe emerging results from these studies.

**Figure 1: Low Carbon Growth Country Studies Process Framework**




## ESTABLISHING A LOW CARBON GROWTH COUNTRY STUDY: Step by Step

### STEP 1. Support National Goals

A Low Carbon Growth Country Study is a process of engagement that builds consensus among policymakers and other stakeholders on lower carbon development paths. National priorities and goals for economic development determine whether the study targets all major emitting sectors or just specific areas of interest. The study typically identifies emission mitigation opportunities and their associated costs and benefits, informs sector planning, and characterizes appropriate policy support. It lays a foundation for nationally appropriate mitigation actions (NAMAs) and provides a framework for measurement, reporting, and verification. The study helps attract new resources to address the incremental costs of low carbon growth through technology, financing, and capacity building.

All six countries were engaged in the international dialogue on climate change at the outset (2006–07). However, national policies, growth challenges, and greenhouse gas (GHG) mitigation activities varied widely, influencing the scope and breadth of each study. Each study is determined by the country—government and local stakeholders—and tailored to the country's economic circumstances. A preview of some emerging results indicates the different starting points and sector analyses undertaken in each country (Table 1).

**Table 1. Emerging Results from Six Low Carbon Growth Country Studies**

| COMMON THEME | EMERGING RESULTS |
|---|---|
| **Renewable Energy** | Across the program, RE resources—small-scale hydropower, wind, solar water heating, solar PV, and ethanol, etc.—are recognized as having untapped potential. **India** plans a major scale-up in solar energy though RE potential is small when compared to energy needs. **Mexico** has identified substantial low-cost emission reduction potential in the development of the wind power sector. **Brazil's** ethanol exports could support global emission reductions. **China** aims to scale up RE from 8–15% from 2008–20; small-scale hydropower is the most economic option and wind is also competitive. China also sees major RE export potential (i.e., wind, small hydropower, solar water heaters, and solar PV). **South Africa** aims to de-carbonize the power sector by 2050 and steps are being taken to scale up RE with government targets of 4% of electricity demand being met with RE resources by 2013. Eskom, South Africa's public electricity utility, plans to install solar water heating for 1 million households and businesses to reduce peak demand. Also, South Africa is supporting feed-in tariffs for RE. |
| **Energy Efficiency / Demand-Side Management** | There is substantial scope to improve the efficiency of energy supply and demand across the program and nearly all measures are cost effective. In **Mexico,** tackling energy efficiency is seen as a cheaper option than investing in new generation capacity, and potential net benefits exist in tackling residential and nonresidential demand. In **China,** improved power dispatching could reduce the need for small- and medium-scale thermal generation. There are also significant gains in addressing supply-side energy efficiency in **India** through reducing transmission and distribution losses. Mandatory energy standards could also bring substantial savings in the residential and nonresidential building sector. In contrast, **Indonesia** has identified energy savings potential in equipment used by small- and medium-sized enterprises and has examined the role that fiscal incentives could play to support a transition to more EE equipment in priority industries. |
| **Land Use, Land Use Change, and Forestry** | Measures to improve agricultural productivity and livestock management could help slow deforestation in **Brazil. Mexico's** forestry sector has untapped mitigation potential. Measures to reduce emissions from deforestation and degradation (REDD) are seen as an opportunity in **Indonesia,** providing an incentive to support sustainable forest practices and improve fiscal management in this sector. |
| **Transport** | Low-cost emission reduction opportunities are identified in the transport sector and can be harnessed through a variety of measures, such as improved transport planning and managed traffic demand (**Indonesia**), development and optimization of urban mass transport (**India, Mexico**), improvements in vehicle maintenance and/or fuel efficiency standards (**India, Indonesia**), as well as the introduction of targeted services, such as bus rapid transit (**Mexico**). |
| **Policy Implementation** | Analysis, identification, and development of policy measures to support implementation of a lower carbon development path are common themes across the study program. Support needs to be tailored to the local context and sector. **China** needs support to examine price, fiscal, and market mechanisms to foster innovation, production, and exports of new "green" technologies. **South Africa** needs implementation support to achieve its National Energy Efficiency Strategy. **Indonesia** needs assistance integrating climate change issues into national development planning and budgeting and to develop approaches to reduce emissions from manufacturing, as well as identifying price adjustments for electricity and fossil fuels. **Mexico** needs help enforcing energy efficiency standards and coordinating across the government to harness cross-sector efficiencies. |
| **Financing** | All countries face large challenges to finance investments and institute supportive policies and programs. Both public and private investment sources, including households, are important going forward. For example, financing **South Africa's** program to improve EE by 12% by 2015 is a major challenge and technical assistance was provided through the study to examine financing mechanisms for EE. In contrast, **Indonesia** sees REDD as a financial incentive and opportunity for lower carbon development in the forestry sector. |
| **Capacity and Knowledge** | Across the program, there has been significant demand for capacity building and knowledge transfer to support technical, cross-sector, and policy analyses, as well as policy implementation. Needs were broad, however. **India** needed support to develop a new bottom-up planning tool to assess mitigation potential on an ongoing basis. **South Africa** needed support to strengthen new and existing organizations tasked with implementing EE/DSM programs. **Indonesia** needed support for sustainable policy development that integrates environment and climate change issues into annual work plans, budgets, and medium-term development processes. |

## STEP 2. Scope Low Carbon Growth Study

Almost without exception, the following factors were considered critical to the success of the six studies:

- Study identified as a priority activity for the government
- Flexible approach to study design and implementation that responds to national priorities
- Transparent and objective analysis that *"tells the story the way it is"* without preconceived ideas
- Locally owned and collaborative study process

### Identify a Local Champion—an Organization, Committee, or Individual —with Convening Power

As the six countries embarked on a process to explore mitigation opportunities and related financial, technical, and policy requirements, the importance of working with a national coordinating body emerged as a key factor in study success. Representatives from the Planning Commission and Ministries of Finance, Environment, and Foreign Affairs, among others, are focal points for these studies and provide an interface with domestic climate change committees (Table 2). Some committees existed already, but others were created during the study; a number include interministerial representation.

### Align Study Scope and Objectives with National Climate Change Policies

The studies drew on available national policy paper(s) and goals for climate change, growth, and sector development to define study objectives and scope (Box 1). This opened a dialogue on low carbon growth that built on established lines of communication, national climate change discussions, and related sector activities. Cross-sector analysis—including the interfaces and trade-offs among agriculture, land use, energy supply, residential and industrial energy use, transport, and waste management, among others—while difficult, was critical for a comprehensive assessment of mitigation opportunities (Table 3).

**Table 2. Low Carbon Growth Country Study National Partnerships**

| COUNTRY | LEAD INSTITUTION/S | COORDINATING BODY |
|---|---|---|
| **Brazil** | Ministry of Foreign Affairs, Ministry of Environment, Ministry of Science and Technology | Inter-ministerial Committee on Climate Change (1999) |
| **China** | National Development and Reform Commission | National Development and Reform Commission |
| **India** | Planning Commission, Ministry of Environment and Forests, and Ministry of Power | Prime Minister's Council on Climate Change (2007) |
| **Indonesia** | Ministry of Finance, National Council on Climate Change | National Council on Climate Change (2008) |
| **Mexico** | Interministerial Committee: Energy, Environment and Finance | Inter-secretarial Commission on Climate Change (2005) |
| **South Africa** | Department of Environment and Tourism, Department of Energy, Eskom, National Energy Efficiency Agency | Department of Environment and Tourism |

**Table 3. Low Carbon Growth Country Studies: Starting point, scope, and highlights**

| | NATIONAL POLICY PAPER(S) | SCOPE OF LOW CARBON GROWTH COUNTRY STUDY | STUDY HIGHLIGHT |
|---|---|---|---|
| **Brazil** | National Plan on Climate Change (2008) | Assess potential to lower carbon content of development | Land use and land use change model |
| **China** | National Climate Change Programme (2007); 11th Five-year Plan (2006–10) | Support policy/strategy development to reduce energy intensity | RE and EE |
| **India** | Integrated Energy Policy (2006); 11th Five-year Plan (2007–12); National Action Plan on Climate Change (2008) | Articulate cost-effective strategy to lower carbon intensity and enhance economic growth | Bottom-up modeling of specific sectors and capacity building |
| **Indonesia** | National Action Plan on Climate Change (2007) | Address macroeconomic questions of costs and effects of low carbon development on economic growth | Strategic options for development |
| **Mexico** | National Climate Change Strategy (2007) | Identify and analyze low carbon options, policies, and strategies | Comprehensive low carbon program |
| **South Africa** | National Climate Response Strategy (2004); Long-Term Mitigation Scenario (2007) | Review Long-Term Mitigation Scenarios and develop implementation strategies in key sectors | Implementation support for energy efficiency |

### Engage With Key Stakeholders Early in the Planning Process

The study brings together a broad range of stakeholders. Government stakeholders include front-line government ministries, such as energy, environment, industry, and finance, plus the other ministries and agencies representing GHG-emitting sectors included in the study. Public and private institutions, civil society leaders, and groups positioned to catalyze action across multiple sectors of the economy often are included in the process (Box 2). Nongovernmental organizations (NGOs) and representatives of labor, women, minorities, and rural interests support an integrated response to climate change while media involvement supports information flow and broad ownership of results.

Early stakeholder engagement is important for agreement on the following issues:

- Objectives, goals, and success criteria for the study
- Available national expertise and necessary international input to achieve study objectives
- Time horizon for analysis, including key assumptions and study boundaries
- Baseline and reference development scenarios and underlying assumptions
- Target sectors for analysis (typically spanning some or all sectors of energy, transport, industry, forestry, land use, and households)
- Human, financial, and technical resource needs

Engagement builds ownership and consensus and establishes working arrangements for the studies. Thereafter, regular meetings with government counterparts and stakeholders are held to maintain communication, present preliminary results, and solicit feedback.

**BOX 1.**

### China and India: Low Carbon Studies Facilitate National Plans

Low carbon growth studies respond to a country's policy environment. **China's** 11th Five-Year Plan set a target of 20% reduction in energy intensity by 2011. The study supports the National Climate Change Programme's emphasis on energy intensity by focusing on evaluation, improvement, and policy development in three specific areas: re-evaluation of renewable energy targets, growth paths and related policy issues, and improving the efficiency of power dispatch and cement production.

In **India,** a World Bank paper prepared for the UNFCCC Conference of Parties in Bali (2007) compared India's GHG emissions profile to that of other countries and received favorable notice from the Ministry of External Affairs. The Indian Planning Commission later requested support for a low carbon growth study and collaborated with the study team to align this work with the Integrated Energy Policy (2006) and the 11th Five-year Plan (2007–12). The study subsequently gained traction among other ministries as initial results began to emerge.

**BOX 2.**

### Brazil: Collaboration in the Public Sphere

Initial stakeholder engagement included a series of consultations and three organizational meetings.

***Series of consultations: February–May 2007.*** Intensive discussions were held with about 60 people from government, private, academic, and NGO communities to explain, test, and adjust the study concept. Stakeholder committees were formed to map out the study process, including identification of state-of-the-art technical information and tools, preparation of an inventory of current local knowledge, setting priorities for investment of resources, and mapping human resources (both national and within the development community). Relevant official government plans were also identified together with areas for significant mitigation potential (axis for study and project boundary) and where additional study was required in light of currently available information (incremental information).

***First meeting: September 2007.*** This meeting developed the foundation for the study. The meeting took place over three days and involved about 60–70 people, including NGOs, 10 government ministries, and academia. It built government ownership of the study; strengthened partnerships with the Ministries of Foreign Affairs, Science and Technology, and Environment; and helped to establish the study as an interactive process taking place in Brazil's public sphere. Local experts presented their views on the study design at the meeting.

***Second meeting: April 2008.*** A presentation was made to the special committee tasked with preparing a national climate change plan in a one-day event that involved key local experts. Important feedback was gleaned at this meeting that also discussed inclusion of a legality scenario: What are climate mitigation gains if all relevant laws are enforced? The team was tasked with delivering early results to the committee for their feedback.

***Third meeting: March 2009.*** A presentation was made of the emerging results to representatives of 10 ministries.

## STEP 3. Mobilize Resources

### Determine Resource Needs

The participatory nature of the process brings significant gains—local ownership, study relevance, sustainability beyond the study itself, and development of human capacity—but takes a toll in terms of time and cost. Study costs have varied (US$0.5-$1.5+ million) and have taken about 30 months to implement. This has allowed time for meaningful stakeholder participation, a transparent and sustainable study process, and local capacity building. For instance, the first year of the Mexico study was spent agreeing to the objectives and scope of the study and engaging team members, while the second year was devoted to analysis and delivery of results. In the cases of Brazil and India significant effort was devoted to developing analytic models for land use and energy planning, respectively, that were not available when the studies started. In a number of studies, additional time was required to manage multiple funding streams that complicated study administration, reporting, and delivery.

### Build a Strong Team

Study teams gather data, conduct analysis, and work to maintain stakeholder engagement throughout the process and into implementation. Team composition is important and is a key discussion with government counterparts at the outset to reach agreement on desired local representation, as well as identify gaps in expertise and establish international support requirements. In India, the government sought international expertise to complement existing low carbon growth assessments. In Brazil, the government was explicit about using local experts (Box 3). Across the six countries, study teams mostly comprise local experts supported by technical assistance. Given the cross-sector nature of the work, multiple teams are engaged in each study, requiring coordination, integration of results, and scheduling of deliverables. Strong communication is essential for study efficiency.

**BOX 3.**

**Choosing the Low Carbon Growth Study Teams in Brazil**

In **Brazil,** the government was explicit at the scoping stage that the teams selected for each part of the study be identified through a stakeholder consultation process and chosen from a broad base of local experts. Local experts, therefore, were invited to make presentations at stakeholder meetings on their vision of how the work should progress. This led to the creation of 19 teams with the majority working on land use (7 teams) and energy (6 teams) issues. The remaining six teams worked on transport, waste, and cross-sector issues. Participants were drawn from government ministries and agencies, as well as from academic institutions, NGOs, and consulting firms. This mix of participants provided both local expertise and legitimacy in the public sphere.

## STEP 4. Build Capacity

### Build Capacity for Cross-Sector Engagement

In the six studies, government ministries along with public and private stakeholders sought assistance to build a technical and strategic capacity, for dialogue and thinking on low carbon policies and mitigation strategies across sectors and beyond traditional boundaries. Ministries of economy and finance, for example, needed to better understand their emitting sectors and their cross-sector interactions.

Capacity building is facilitated through structured, regularly scheduled interactions among team members, government ministries, experts, and stakeholders, as well as workshops and meetings that provide time and space for cross-sector discussions. By doing so, the low carbon growth studies bring the climate dialogue from the Ministry of Environment (historically responsible for international dialogue) to other parts of governments (national and subnational), particularly those ministries and agencies dealing with finance, and sectors having significant opportunities for carbon mitigation or sequestration. This cross-sector communication builds on existing expertise and knowledge in individual sectors, such as energy and transport, to support development of an integrated view of low carbon growth opportunities and priorities across the economy.

Regional and international meetings and conferences further enable national teams to learn and share actions plans with their neighbors and peers globally. This is supplemented by informal knowledge exchange across the six country studies. For instance, Brazil participated in the peer review of South Africa's Long-Term Mitigation Scenarios (LTMS) while Indonesia and Brazil are using India's transport planning model. Courses and technical collaboration are organized and funded through bilateral and multilateral institutions to provide focused educational opportunities. Box 4 outlines the capacity-building plan used in Indonesia and Box 5 recounts experiences across the low carbon program in sustaining stakeholder engagement.

**BOX 4.**

### Capacity Building in Indonesia's Low Carbon Development Options Study

**Indonesia** integrated specific capacity-building activities into the study process. Leading to and following up on the 2007 Conference of Parties in Bali, the government sought to strengthen its capacity on climate change issues and impacts. The Ministry of Finance collaborated with the study team on activities to develop knowledge and experience in national and international settings:

- ***Learning by doing***—Regular meetings with the working group to produce briefs resulted in rapid and focused knowledge building.
- ***Learning by engaging internationally***—In 2007 and 2008, key staff in the Ministry of Finance and working groups participated in global events, presenting and collaborating with international counterparts.
- ***Learning through technical collaborations***—In addition to collaboration on the low carbon growth study, interaction with donor-funded consultants and studies included UNDP, JICA, AUSAID, and DANIDA, among others.
- ***Learning through Environmental Economics Course***—Staff from the Ministry of Finance and the coordinating Ministry for Economic Affairs participated in an environmental economics course run jointly by the World Bank Institute and the Asian Development Bank.

Adapted from World Bank, "Low Carbon Development Options for Indonesia: Phase 1 Status Report and Findings," November 2008.

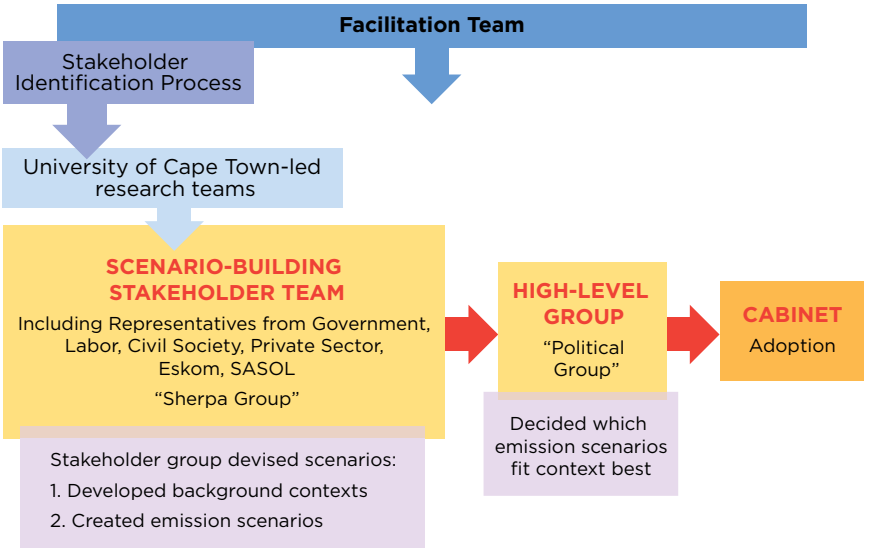
**BOX 5.**

### Sustaining Stakeholder Involvement: Examples from the Field

In **Mexico,** the low carbon growth study was readily accepted as a part of the government's ongoing national climate change strategy. Continued dialogue throughout the study process maintained a high level of interaction. Regular meetings were held with the Ministry of Finance and the interministerial committee, which allowed for conversation and feedback. Stakeholder workshops were a regular feature in the work plan and were an effective means to gather ideas and to verify GHG mitigation options with a wide range of interest groups.

In **India** and **Indonesia,** there was specific demand for stakeholder capacity building and a more structured approach to engagement was taken in collaboration with bilateral and multilateral organizations to convene targeted courses, workshops, conferences, or other technical knowledge transfer activities on climate change and development. In **South Africa,** the government integrated high levels of stakeholder involvement throughout the design and review stages for the Long-Term Mitigation Scenarios. South Africa's tool for national planning is illustrated below.

**South Africa's LTMS Process**




*Source:* World Bank, "Low Carbon Study: South Africa," Presentation, April 2009.

## STEP 5. Model Low Carbon Pathways

Four main methodological steps were employed in the more comprehensive low carbon growth studies to build a low carbon development and emission profile for the economy:

1. **Establish a baseline or reference scenario.** Estimate the future evolution of GHG emissions consistent with the national long-term development objectives and business-as-usual development.
2. **Identify and quantify low carbon options.** Use mitigation and sequestration options consistent with development objectives.
3. **Assess the associated costs of low carbon options.** Use applicable rates of return, cost benefit analysis, sensitivity analysis (particularly for capital-intensive investments), and other analytical tools.
4. **Build a low carbon emissions scenario(s).** Maintain consistency with the long-term national development objectives.

Underlying the four steps is a range of approaches and assumptions that reflect differences in study objectives, methodologies used for sector analysis or modeling, variations in the start and end dates for low carbon modeling (many working to 2030 consistent with the International Panel on Climate Change), and alternative approaches for defining baseline or business-as-usual scenarios. As an example, the Indonesian study does not use a discount rate to value GHG emissions. Mexico applies a fixed rate, of 10 percent while the India study applies a 12 percent discount rate declining over time to 10 percent. The Brazil study instead looks at real agents for implementation, the private sector, and their rates of return to assess a break-even price for carbon, an approach developed in cooperation with a local financial institution. These differences impact results—affecting estimates of incremental costs of GHG reduction, for example—and limit comparability between studies conducted in the same country by different bodies, as well as across countries. These issues can be further hampered by proprietary modeling concerns or data transparency issues.

Most studies develop their own reference and low carbon growth scenarios, choosing modeling tools with international validity that could best be adapted to sector needs and national objectives. Choice of model—macroeconomic, bottom-up, or financial—depends on the scope of the analysis, the sector studied, and the resources and data available locally (Table 4). The Indonesian study focused on macroeconomic modeling and scenario development using an existing Computable General Equilibrium (CGE) model to provide an overview of the implications of alternate low carbon paths (Box 9). In Mexico, the study used a bottom-up approach to assess and prioritize 40 low carbon options for 2007 to 2030 (Box 10).

In Brazil and India, new models were developed for land use, land use change, and forestry, and for energy planning, respectively, due to a lack of publicly available tools that met study objectives. This enabled thorough documentation of baseline conditions and incorporation of existing national plans in sector scenario modeling (Boxes 6 & 7); albeit at a cost in terms

**Table 4. Low Carbon Growth Country Study Models**

| COUNTRY | MODEL | ORIGIN | COMMENT |
|---|---|---|---|
| **Brazil** | Partial equilibrium and macroeconomic model specifically designed for the land use, land use change, and forestry sectors | Created by study team | Additional existing models used for energy, transport, and waste sectors |
| **India** | Bottom-up, user-friendly, Excel/ Visual Basic model | Created by study team | Designed for low-cost, ongoing use; easy to update and refine projections |
| **Indonesia** | Built on existing CGE modeling work | Used existing model | |
| **Mexico** | LEAP – an input/output, bottom-up model developed by the Stockholm Environment Institute for long-range energy alternatives planning | Used existing model | Incorporated outputs from LEAP in the CGE model for Mexico |
| **South Africa** | Based on Markal framework for national energy modeling | Existing model used by national research team for LTMS | Analyzed implications for national GHG emissions trajectories |

**BOX 6.**

### India's Low Carbon Growth Model

The Government of **India** worked with the study team to build a Low Carbon Growth (LCG) model that can be used as a planning tool to analyze key sectors and assess the impact of policy choices on GHG emission levels. It is a bottom-up, engineering model that is based on Excel/Visual Basic programs making it user-friendly, low-cost, and available for continuous use.

The model considers five major sectors in the economy: electricity transmission, transportation, residential, nonresidential buildings, and industry, which together accounted for 60% of India's greenhouse gas emissions in 2004, and more than 400 possible interventions. These sectors are also considered the high growth sectors that will likely increase at a faster pace relative to the other sectors. The model enables planners to analyze future demand for emission-producing activities, estimate associated costs, and calculate GHG emissions under different development scenarios to 2030. The India LCG model builds energy demand from the bottom up and matches supply with demand. Demand in each sector is assessed from a simulation analysis of a number of variables, including Gross Domestic Product, population, age distribution, household size, income, and location (urban or rural).

The model has been used in India to generate various low carbon scenarios based on India's sector plans, the 11th and subsequent Five-Year Plans, and consultations with sector specialists. The annual growth of commercial energy demand for nonresidential buildings, industry, and agricultural sectors is assumed to be between 4.3–5.1% based on the projections contained in the 2006 Integrated Energy Policy. Various growth and population projections have also been captured. Going forward, the Government of India can refine the model, change assumptions, and update the data to continuously reflect the country's reality. The model will be transferred to the Planning Commission after study completion.

Adapted from "India: Strategies for Low Carbon Growth," Preliminary Report, World Bank, June 2009.

**BOX 7.**

### Modeling Future Land Use and Deforestation in Brazil

Exploring options for mitigating deforestation emissions requires projection of future deforestation. To simulate future land use and land use changes in **Brazil,** the Low Carbon Growth Study team integrated two models:

1. ***Economic model:*** The Brazil Land Use Model (BLUM), developed by the Institute for International Trade Negotiations (ICONE), is an economic modeling process that estimates the allocation of the country's area and measures land use change as a result of the dynamics of supply and demand for all of the main products competing for land, such as soy, corn, rice, beans, cotton, sugar cane, pastures, and production forests.
2. ***Geo-referenced spatialization model:*** Simulate Brazil (SIM Brazil), developed by the Remote Sensing Center of the Cartography Department of the University of Minas Gerais, enables future land use to be spatially projected over time for the whole country according to different scenarios.

Both models were developed to meet the needs of this study. SIM Brazil does not alter the data from the BLUM economic model for the projection of land use; rather, it finds a place for them, taking into account a variety of criteria, such as agricultural aptitude, distance to roads, urban attraction, the cost of transport to ports, declivity, and distance to a converted area. SIM Brazil works at a definition level of 1 $km^2$, allowing for the generation of very detailed, dynamic maps. The methodology can be described as follows:

**Step 1:** Identify the areas suitable for expansion.

**Step 2:** Build an economic model to project the amount of land use change within each activity (deforestation, livestock, and agriculture).

**Step 3:** Create a geographic model to distribute spatially the quantities of land required by each activity by year; hence, allocating where and how the land use changes take place.

**Step 4:** Calculate the emissions resulting from changes in carbon stocks through conversion of native vegetation and soils, as well as direct emissions from cattle and agriculture operations.

The calculations are done twice, first for the reference scenario and then for the low carbon scenario. Emission abatements achieved under the low carbon scenario can then be compared to the emissions projected under the reference scenario.

Adapted from World Bank, "Brazil Low Carbon Country Case Study," June 2009.

of time and resources to gather data, ensure its transparency, and allow easy access, understanding, and verification of information.

The South African study focused on peer review of the completed LTMS, as well as assistance to implement its recommendations (Box 8). The Mexico study also sought "outside" review of the analytic work for transport, energy, and oil and gas sectors through in-country, nongovernmental research organizations.

**BOX 8.**

### South Africa's Long-Term Mitigation Scenarios

**South Africa's** Department of Environment Affairs and Tourism requested support to complete a peer review of the Long Term Mitigation Scenarios (LTMS) for 2000–50. The LTMS was developed through a national research team at University of Cape Town and an extensive stakeholder consultation process with government agencies, business, and civil society. It comprises four parts:

1. Energy modeling and scenarios for power generation (alternative energy and clean coal technologies) and EE/DSM measures;
2. Nonenergy modeling, including industrial processes, transport, agriculture, and forestry sectors;
3. Macroeconomic modeling to estimate costs of climate change mitigation interventions and their impacts on economy and job creation; and
4. Impacts of climate change and adaptation.

The peer review team comprised international and local experts and included participants from other developing countries working on similar studies, such as **Brazil.** The review team provided recommendations on implementation of the LTMS, including the need for policy and regulatory options, sector strategies, and RD&D for advanced technologies to achieve mitigation wedges. The review emphasized the importance of estimating total investment needs and international cooperation for financing and technology transfer.

Adapted from World Bank, "South Africa: Low Carbon Growth Strategy Concept Note," October 2007.

## STEP 6. Identify GHG Mitigation Options

Priority mitigation measures—that focus both on technological interventions, as well as supporting policy, regulatory, and institutional frameworks—are determined by drawing on modeling results and cost benefit/sensitivity analysis.

Varying approaches are used to prioritize interventions in terms of their $CO_2$ emission reduction potential and implementation cost. A marginal abatement cost curve, that maps $CO_2$ emission reduction potential against abatement costs (US$/ton $CO_2$) for a range of technologies, is used by most studies to help identify priority mitigation options (Figure 2); its main limitation being the sole focus on technology costs. Other costs of implementation, such as establishing policy and regulatory measures, addressing implementation barriers, and structuring incentives, are provided through supplementary analyses of market structure and policy frameworks.

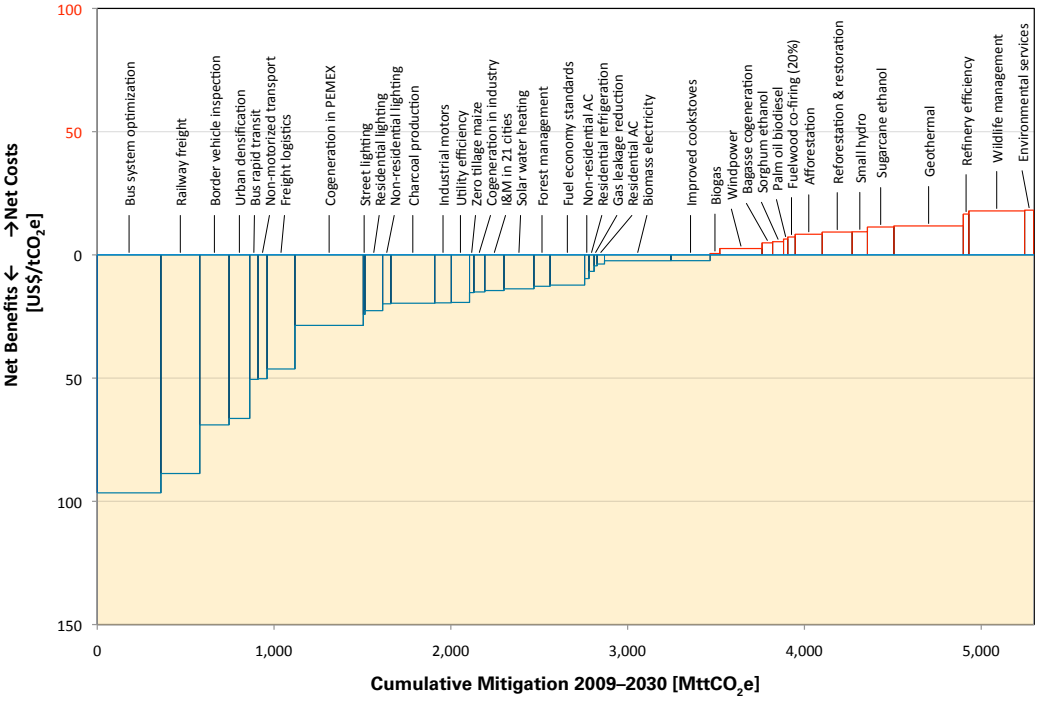
**BOX 9.**

### Indonesia's Economic Impact Analysis Framework

A bottom-up, inter-regional Computable General Equilibrium (CGE) model was developed based on **Indonesia's** 2005 input-output table to model trade, factor flows, and government transfers. The model was developed by the Commonwealth Scientific and Industrial Research Organization of Australia (CSIRO) and the Australian National University (ANU) with funding support from AusAID. A top-down, expenditure-based approach was taken for income distribution; fossil fuel-based consumption only is considered in modeling carbon emissions. The model is dynamic to 2050 and takes a look at various policy scenarios, such as reduced deforestation rates, carbon taxes, and redistribution of revenues to mitigate the downside, rising fuel prices and redistribution/compensation mechanisms, and implementation of industrial and sector energy efficiency measures. Overall, 35 sectors are captured and indicators are available for poverty, growth, GHG emissions, government revenue, gains, and losses.

*Source:* World Bank, "Low Carbon Development Options: Indonesia Country Study," Presentation, August 2009.

**Figure 2. Marginal Abatement Cost Curve from Mexico Low Carbon Growth Study**




*Source:* World Bank, "Low Carbon Development for Mexico (MEDEC)," Presentation, September 2009.

## STEP 7. Implement Strategies

Among the biggest challenges countries face in implementing low carbon interventions are (a) establishing a cohesive institutional framework and supporting policies and regulations for effective implementation across many sectors, (b) financing the upfront costs of low carbon interventions, and (c) creating partnerships for implementation.

### Establish an Enabling Environment

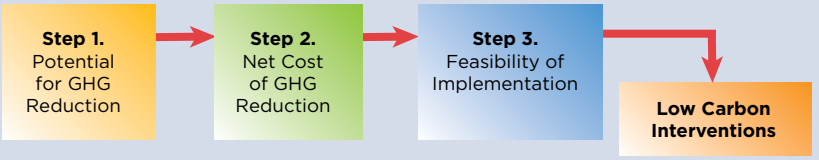
Transition to a low carbon scenario requires new policies, or amendments to existing policies, to accelerate implementation of prioritized interventions. Figures 3 and 4 show a sample of the fiscal policy instruments that Indonesia needs to support a low carbon transition and how they can be applied in the manufacturing sector. Policy changes are supported by parallel efforts to refine implementation strategies, plans, and related institutional arrangements, and can be informed by a review of international best practices. Implementation plans need to include a revision process so that changes, such as slippages in implementation schedules, can be reflected (Box 11). The South African study supports implementation of EE and DSM programs alongside a Global Energy Facility-funded Renewable Energy Market Transformation project and illustrates the type of support required for implementation (Box 12). As other studies move into implementation, the demand for international experience and best practices for policy and regulatory measures, as well as implementation, institutional arrangements, capacity building, and financing mechanisms, is likely to increase.

**BOX 10.**

### Mexico's Low Carbon Intervention Analysis

In **Mexico,** 40 near-term priority mitigation measures have been identified using three principle criteria to rank options:

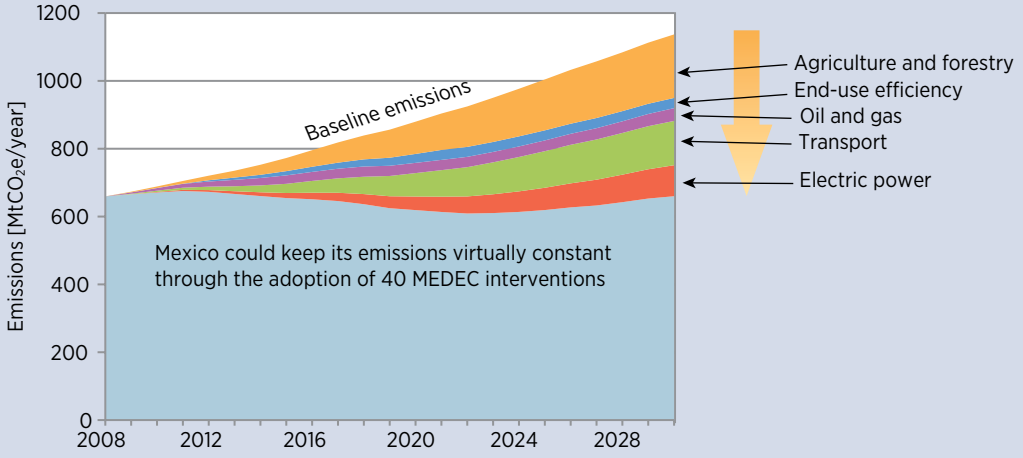
1. ***$CO_2$ emission reduction potential.*** An intervention must generate 5 $MtCO_2e$ emission reductions by 2030.
2. ***Low cost per ton of $CO_2e$ reduced.*** Only interventions with positive economic and social rates of return (at a given discount rate or cost of capital) and an abatement cost of US$25 per ton $CO_2e$ reduced or less were considered. Interventions with positive net benefits are "no-regrets" measures as the financial and economic benefits more than cover the costs.
3. ***Feasibility of implementation.*** Determined by sector experts who took into consideration technical potential, market development, and institutional needs; and by government officials who considered the political and institutional feasibility of scaling up interventions across the economy. Before adopting an intervention, public discussion with sector experts, government officials, the private sector, and civil society will take place.




*Source:* World Bank, "MEDEC (*México: Estudio sobre la Disminución de Emisiones de Carbono*): Mexico Low Carbon Study," June 2009.

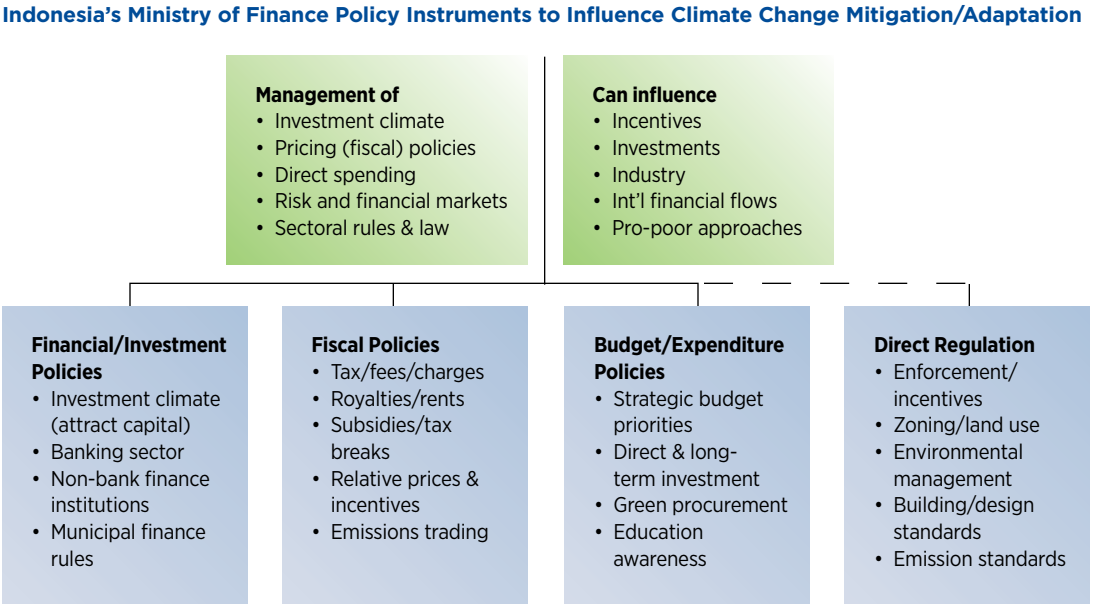
The analysis highlights Mexico's significant GHG reduction potential at relatively low financial and economic cost. This can be achieved through implementing options that have been demonstrated at scale in Mexico or internationally. In the short term, priorities lie with urban transport, energy efficiency, renewable energy, and forestry.

**MEDEC Baseline and Low Carbon Scenarios**



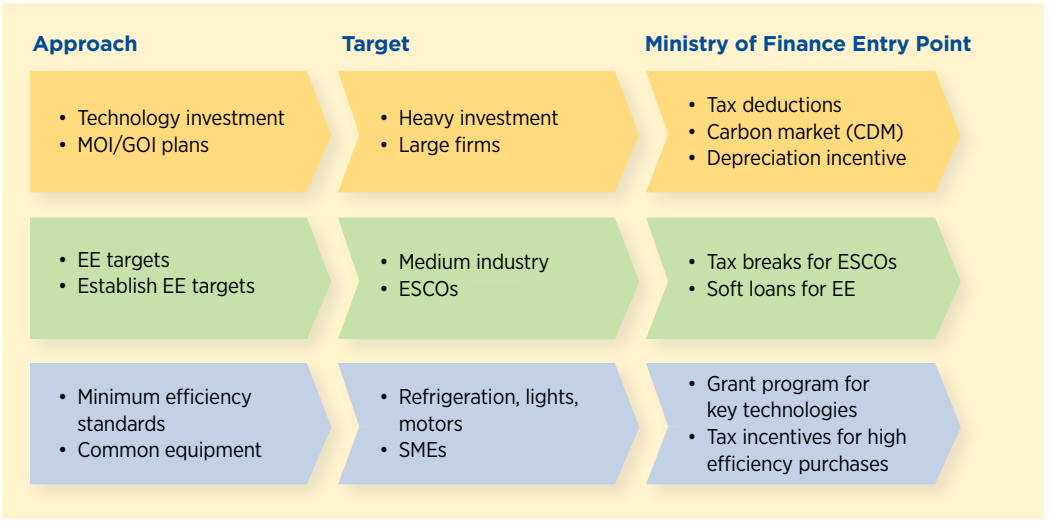

*Source:* World Bank, "Low Carbon Development for Mexico (MEDEC)," Presentation, September 2009.

**Figure 3. Role of the Indonesian Ministry of Finance in Managing Fiscal Policy for Low Carbon Growth**




*Source:* World Bank, "Low Carbon Development Options for Indonesia: Phase 1 Status Report and Findings," November 2008.

**Figure 4: Policy Options to Reduce Emissions in Manufacturing in Indonesia**




Adapted from World Bank, "Low Carbon Development Options: Indonesia Country Study," Presentation, August 2009.

### Assess Financing Needs

Many low carbon interventions have positive net present values but still require new sources of financing for the substantial initial investments required. Most of these studies looked at the additional investment needs and compared them with national investment plans. This highlighted the need for increased public (national and international) and private investment support to implement the reference and low carbon scenarios. Private sector investment was identified as particularly important for sectors, such as transport, industry, and power.

### Create Partnerships for Implementation

Participation in a low carbon study helps forge national and international partnerships and cooperation to advance policy initiatives, tackle implementation challenges, and address funding constraints. It promotes knowledge exchange with other emerging nations that face similar challenges and resource constraints. China, India, and South Africa, for example, all have energy sectors heavily reliant on coal; they all need to implement strategies for substantial power expansion on a low carbon path. Also in South Africa, stakeholder consultations recommended that a value added of the low carbon study would be to assist the government in developing sector implementation plans for priority mitigation options, such as the standard offer approach for EE (Box 12).

**BOX 11.**

**Impact of Plan Slippages: Example from the India study**

As energy emerges as a binding constraint on growth, efforts to meet targets in national energy plans are crucial to support **India's** growth strategy. When the impact of the unfolding global financial crisis is taken into account together with lower GDP growth rates, energy supply requirements by 2031–32 are estimated at 4 times 2007–08 levels and $CO_2$ emission levels 3.4 times those of 2007 levels.

Under this scenario, coal-fired generation plants still dominate energy supply to the grid; 53–55% of installed capacity and 73–76% of supplied energy over this period. If the program to reduce transmission and distribution losses (from 29.3% to 15%) slips by 5 years, GHG emissions are significant (an additional 56 Mt $CO_2e$ per year equivalent to approximately 1/10 of 2004 emissions in the power sector). If grid supply in India does not expand as fast as expected, GDP growth may be affected. While India has laid out a comprehensive low carbon growth path based on national plans, performance suggests targets are unlikely to be achieved without significant resources, including financial, technical, institutional, and knowledge-based skills.

*Source:* World Bank, "Low Carbon Growth in India: Bottom-up Capacity Building," Presentation, September 2009.

**BOX 12.**

### Introducing Energy Efficiency and Demand-Side Management in South Africa

The Government of **South Africa** sought technical assistance to establish institutional arrangements and financing mechanisms to facilitate uptake of EE, DSM, and solar water heating. To achieve this, support was provided to the following institutions:

1. Department of Energy to develop overall EE implementation strategies (institutional arrangement and financing mechanisms)
2. National Energy Regulator of South Africa to develop appropriate regulatory frameworks for EE
3. Eskom's EE/DSM fund to revamp operations using the standard offer model (below)
4. National Energy Efficiency Agency (NEEA) to define organizational and business planning needs
5. NEEA and the Department of Public Works to develop a new business model for EE public procurement in government buildings
6. Review and propose international best practice approaches to market-based power rationing; subsequently incorporated in the Power Conservation Program in South Africa

**The standard offer option**—The low carbon study team and experts from Eskom worked together to develop the standard offer option that provides a streamlined mechanism for acquiring demand-side resources (EE and load management). A fund administrator (utility or a public agency) "purchases" energy and/or demand savings using a predetermined and prepublished rate. These rates are based on the value of energy and demand savings to the utility system and not on the cost of implementation. Any energy user or energy service company (ESCO) that can deliver energy and demand savings is paid a fixed amount per kWh and kW upon completion of the project and certification of achieved energy savings. As designed, the standard offer approach opens the following benefits to South Africa:

- Streamlined project approval and accelerated implementation
- Improved market penetration; ESCOs generate projects more quickly and clients see the benefits of a shorter project completion cycle
- Simplification of all contractual arrangements (Eskom-developer, asset owner-developer, lender-developer)
- Greatly reduced burden on Eskom staff; due diligence requirements (e.g., detailed evaluation of the technical and cost elements of the proposed projects) are reduced or eliminated
- Project risk is borne by the ESCOs
- Leveraging of commercial lending is enabled; the project cycle is shortened and the risk of approval and subsidies are eliminated

Eskom piloted a standard offer project for commercial lighting and the Department of Energy is adopting the standard offer approach to manage treasury funding of EE and DSM.

Adapted from World Bank, "Low Carbon Study: South Africa," Presentation, April 2009.

## MOVING BEYOND THESE EXPERIENCES

Substantial experience and knowledge has been gained through the Low Carbon Growth Country Study Program. Opportunities for growth on lower carbon pathways exist in all six countries and significant GHG reduction potential exists in EE, DSM, RE for power production, sustainable transport, forestry, agriculture and livestock management, and cogeneration, etc. Country-based studies, with their attention to detail at a national level, have helped identify relatively low-cost mitigation options that could be overlooked in global modeling efforts. Steps are being taken to implement mitigation strategies, but practical problems, capacity limitations, and market and institutional barriers are endemic. Stakeholders spanning multiple sectors of the economy—including the public and private sector, academia, and civil society—are central to the study. Time spent on engaging key constituents supports sustainability and a national dialogue on lower carbon development. The average timeframe for implementation of a study is 30 months and costs range from US$0.5 to $1.5+ million.

A question arises: how do we learn from and take these experiences to other countries? While country-level GHG mitigation opportunities vary significantly, the Low Carbon Growth Country Study Program highlights a number of opportunities to streamline and standardize analytical tools in collaboration with other bodies working in this area:

- Refine and share tools and methodologies
- Develop guidance to ensure consistency across studies (e.g., standardizing discount rates, establishing baselines, understanding data needs and sources)
- Identify specific short-term investments and medium-term actions that make economic sense now (e.g., EE, sustainable transport) and are applicable across countries
- Build capacity, brief others on the study process, and share best practices for implementation

These can be achieved by drawing on approaches, tools, and methodologies developed and/or tested across existing studies; and extracting lessons and examining results from ongoing studies to identify common elements or practices that could be applicable to others (Box 13).

To a country wishing to embark on a low carbon growth study, collective experience from this program offers the following:

- **Learn by doing.** Get started and define a process for re-evaluation.
- **Collaborate** with others working in this area and learn from their experience (e.g., countries, United Nations Framework Convention on Climate Change, multilateral development banks, etc.).
- **Communicate** across sectors and traditional boundaries and bring ministries of economy and finance into the process to complement bottom-up, sector-based planning with a review of macroeconomic effects and fiscal implications.
- **Invest** in capacity building to discover low cost emission mitigation options, build capacity for future work and implementation, and ensure sustainability.

**BOX 13.**

### Experiences from the Field

Although each of the six studies was unique, there are many shared experiences.

#### WHAT WORKED?

- **Trusting relationship.** Teams leveraged existing relationships with government counterparts to build trust in the transparency and objectivity of the low carbon growth studies.
  - *Transparency* in approach, modeling, data, and assumptions works.
  - *Objectivity and flexibility* in approach promotes collaboration and national ownership of results.
  - *Active stakeholder participation* ensures sustainability.
  - *Study teams* selected in collaboration with national stakeholders supports legitimate and credible results.
  - *Links* among stakeholders, study participants, and government ministries facilitates cross-sector dialogue, a crucial input when developing mitigation strategies and prioritizing interventions.
- **Advisory services** provided an important value added, introducing international best practices to inform the low carbon growth path(s).
  - *Capacity building and knowledge exchange* develops expertise for national climate change policy.
  - *Technical assistance for EE and DSM* was successful during **South Africa's** national energy crisis.
  - The newly developed **India** model has been used by countries in South Asia and by **Brazil** to model transport emissions.
- **Low-cost, user-friendly approach** for low carbon growth analysis worked and is useful for further mitigation work.
  - *Demand driven.* Customized studies respond to country needs and sensitivities, engaged clients, and cultivated commitment.
  - *GHG mitigations options* identified through active stakeholder participation in a workshop setting.
  - Studies capture *short quick lessons* in study outputs.

#### WHAT REQUIRES CAUTION?

- **Concept or scope for study.**
  - *Overly ambitious* objective and scope for the study.
  - *Prevailing international climate change debate* can hamper collaborative efforts between nations.
  - Some countries, for a range of reasons, *may prefer not to involve outside institutions*.
- **Choice of model,** creating a model, and collecting input data specifically for the low carbon study is difficult and time consuming.
  - *Bottom-up models* do not provide all feedback loops of a general equilibrium model.
  - *Good quality data* is difficult to obtain, particularly for land use and forestry sectors.
  - *Inadequate budgetary support* hurts study results.
- **Technical assistance** needs to be workable, well-targeted, focused, and flexible to support implementation.
  - *Formulating policy recommendations* from study results is difficult and politically sensitive.
  - *Results can be contrary* to expected outcomes.
- **Coordinating** funding streams, expectations, and reporting requirements for multiple parties can be difficult.
  - *Cross-sector work* can fall victim to competing priorities.
  - *Transport sector is difficult* to study with diffuse ownership and policy-making across multiple ministries and municipalities.
  - *Low carbon growth study needs broad support* of larger ministries, particularly energy and industry.
  - *Energy efficiency engagement can decline* when a power crisis is averted.

## REFERENCES

World Bank. 2009. "Low Carbon Development for Mexico (MEDEC)." PowerPoint presented at the World Bank Workshop, "Low Carbon Growth Country Studies: Emerging Lessons and Results," Washington, DC, September 10.

World Bank. 2009. "Low Carbon Development Options: Indonesia Country Study." PowerPoint presented at the World Bank Workshop, "Low Carbon Growth Country Studies: Emerging Lessons and Results," Washington, DC, September 10.

World Bank. 2009. "Low Carbon Growth in India: Bottom-up Capacity Building." PowerPoint presented at the World Bank Workshop, "Low Carbon Growth Country Studies: Emerging Lessons and Results," Washington, DC, September 10.

World Bank. 2009. "Low Carbon Study: South Africa." PowerPoint presented at the World Bank Workshop, "Low Carbon Growth Country Studies: Emerging Lessons and Results," Washington, DC, September 10.

## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| ANU | Australian National University |
| AusAID | Australian Agency for International Development |
| BLUM | Brazil Land Use Model |
| CDM | clean development mechanism |
| CGE | computable general equilibrium |
| $CO_2$ | carbon dioxide |
| $CO_2e$ | carbon dioxide equivalent |
| CSIRO | Commonwealth Scientific and Industrial Research Organization of Australia |
| DANIDA | Danish International Development Agency |
| DSM | demand-side management |
| EE | energy efficiency |
| ESCO | energy service company |
| Eskom | South Africa Electricity Supply Commission |
| ESMAP | Energy Sector Management Assistance Program |
| GDP | gross domestic product |
| GHG | greenhouse gas |
| GoI | Government of Indonesia |
| ICONE | Institute for International Trade Negotiations |
| Int'l | international |
| JICA | Japan International Cooperation Agency |
| LEAP | Long-range Energy Alternatives Planning System |
| LTMS | long-term mitigation scenario |
| MoI | Ministry of Industry |
| $MtCO_2e$ | million tonnes $CO_2e$ |
| NAMA | nationally appropriate mitigation action |
| NEEA | National Energy Efficiency Agency |
| NGO | nongovernmental organization |
| PV | photovoltaic |
| RD&D | research, development, and demonstration |
| RE | renewable energy |
| REDD | reducing emissions from deforestation and forest degradation |
| Sasol | South African Coal, Oil and Gas Corporation |
| SIM Brazil | Simulate Brazil |
| SME | small and medium enterprise |
| UNDP | United Nations Development Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |

**Photo Credits**
Cover: iStockphoto
Page 8: Dominic Sansoni / World Bank
Page 10: Gennadiy Ratushenko / World Bank
Page 17: Jim Pickerell / World Bank

**Production Credits**
Design: Naylor Design, Inc.

The Energy Sector Management Assistance Program (ESMAP) is a global knowledge and technical assistance program administered by the World Bank that assists low- and middle-income countries to increase know how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth.

For more information on the Low Carbon Growth Country Studies Program or about ESMAP's climate change work, please visit us at www.esmap.org or write to us at:

Energy Sector Management Assistance Program
The World Bank
1818 H Street, NW
Washington, DC 20433 USA
email: esmap@worldbank.org
web: www.esmap.org

The primary developmental objective of Carbon Finance-Assist (CF-Assist) is to ensure that developing countries and economies in transition are able to fully participate in the flexible mechanisms defined under the Kyoto Protocol, and benefit from the sustainable development gains associated with such projects.

CF-Assist is a cosponsor of the Low Carbon Growth Country Studies knowledge program.

Carbon Finance-Assist Program
World Bank Institute
1818 H Street, NW
Washington, DC 20433 USA
email: cfassist@worldbank.org
web: www.cfassist.org