Overview

Mexico's Special Climate Change Program—the Programa Especial de Cambio Climático (PECC), published in August 2009—sets Mexico's long-term climate change agenda, together with medium-term goals for adaptation and mitigation. This study—known as México: Estudio sobre la Disminución de Emisiones de Carbono (MEDEC)—is intended to contribute to the implementation of that long-term climate change agenda.

The study evaluates the potential for reducing greenhouse gas emissions in Mexico over the next 20 years. It evaluates low-carbon interventions across key emission sectors in Mexico using a common methodology. Based on the interventions evaluated, it develops a low-carbon scenario through 2030.

Benefits of Moving to a Low-Carbon Economy

Reducing greenhouse gas emissions is critical in Mexico, not only to address climate change but also to facilitate economic development, a key emphasis of the country's climate change agenda. Moving to a low-carbon economy could benefit Mexico in at least four ways:

- Because it is likely to suffer disproportionately from the impacts of climate change (drought, sea level rise, increased severity of tropical storms), Mexico has a strong interest in becoming a leading participant in an international agreement to cap emissions.
- Numerous "no-regrets" low-carbon interventions (interventions that have positive economic rates of return and should be undertaken irrespective of climate change considerations) can contribute substantially to economic development in Mexico.
- Many low-carbon interventions have important co-benefits for Mexico, including the enhanced energy security associated with energy

efficiency (on both the supply and demand sides) and renewable energy projects; the human health benefits from transport and other inventions that reduce local air pollutants; and the environmental protection benefits that can be achieved through forestry and natural resource management, waste-reduction programs, and reduced emissions of local pollutants from energy facilities.
- Countries that pursue low-carbon development, including the transfer of financial resources through the carbon market and new public programs that support climate change mitigation, are likely to reap strategic and competitive advantages.

Mitigation Options, by Sector

The MEDEC study evaluated low-carbon interventions in five sectors: electric power, oil and gas, stationary energy end-use, transport, and agriculture and forestry. Three criteria were used to select interventions:

- Interventions had to have substantial potential for reducing greenhouse gas emissions. The threshold for including an intervention was 5 million tons of CO_2–equivalent (Mt CO_2e) over the 2009–30 implementation period.
- Interventions had to have low economic and financial costs. First priority was given to no-regrets interventions. A second tier of projects—with carbon costs of $25/t or less—was also included.
- Interventions had to be feasible in the short or medium term. Ensuring that this criterion was met required investigation of information, regulatory, and institutional barriers that are keeping low-carbon interventions from being adopted on a large scale. Feasibility was first determined by sectoral experts; it was then discussed with government officials and international experts. All MEDEC interventions have already been implemented, at least on a pilot level, in Mexico or in countries facing similar conditions. Some interventions face barriers in the short term (next five years), but the barriers preventing their adoption are believed to be surmountable in the medium term.

Electric Power

The demand for electric power in Mexico has been growing faster than gross domestic product (GDP) over the past several decades, and this trend is likely to continue. Under a baseline scenario, meeting the increasing demand for power would increase total CO_2e emissions from power generation by 230 percent between 2008 and 2030 (from 142 Mt CO_2e to 322 Mt CO_2e). Both coal- and gas-fired power generation would increase under this scenario, with coal accounting for 37 percent of new installed capacity and natural gas accounting for 25 percent.

Assuming a net cost of CO_2e of as little as $10/ton, additional low-carbon energy technologies—small hydro, wind, biomass, geothermal, cogeneration (that is, the combined generation of heat and electricity in the

same facility)—could replace much of the fossil fuel generation (principally coal but also natural gas) in the baseline scenario. Under the low-carbon MEDEC scenario, the share of power generated by coal would decline from 31 percent to 6 percent, and the contribution of low-carbon technologies would increase substantially, rising from 1.4 percent to 6.0 percent for wind, 2 percent to 11 percent for geothermal, 0.1 percent to 8.0 percent for biomass, and 14 percent to 16 percent for hydro. At net costs that are less than current marginal costs of power generation in Mexico, cogeneration would provide 13 percent of new power capacity under the low-carbon scenario. Abatement costs were calculated by comparing the net costs (including capital, energy, and operations and maintenance costs) of each low-carbon technology with the costs of the displaced coal and natural gas capacity.

Several policy and regulatory changes are needed to expand the share of renewable energy and energy efficiency in the power sector. Although the costs of wind generation in Mexico are among the lowest in the world—because of the high-quality wind resources in the isthmus of Tehuantepec, where some new wind projects are being developed—the country's enormous wind resources have not been widely developed. Factors inhibiting the development of wind and other renewables include low planning prices and the absence of externalities that Mexico's federal electricity commission, Comisión Federal de Electricidad (CFE), has historically assumed for new fossil fuel–based power generation; the lack of recognition of the portfolio effect in power planning, which would increase the share of renewable energy interventions based on their lower fuel risk; and the inability to adjust procurement procedures to the particularities of renewable energy projects. New contracting procedures are needed for cogeneration and other small-scale projects to reduce the risks and transaction costs of small power producers.

Oil and Gas

There is significant potential to reduce greenhouse gas emissions in Mexico's oil and gas sector through both no-regrets and low-cost interventions. In particular, significant cogeneration potential at Pemex facilities could provide more than 6 percent of Mexico's current installed power capacity.

Specific interventions that can reduce greenhouse gas emissions and have good economic rates of return include reducing gas distribution leakage; increasing efficiency at Pemex oil, gas, and refining facilities; and realizing the cogeneration potential at Pemex's six refineries and four petrochemical plants. Developing this potential will require a regulatory framework that enables and encourages the sale of excess energy and capacity to the electricity grid.

Despite their excellent rates of return, investments in cogeneration and reductions in gas leakage are less attractive to Pemex than investments in oil exploration and development. Financing of investment is also difficult, for two reasons. First, Pemex's high debt—the highest of any oil company in the world in 2007—has made it difficult to tap commercial credit markets

at reasonable terms. This problem will become even more difficult given the recent international financial crisis, despite the recent passage of oil industry reform measures. Second, although the oil industry accounts for only about 6 percent of GDP, oil revenues account for more than one-third of Mexico's federal budget. This constrains the government from taking measures that reduce tax payments from Pemex in the short term. Measures to allow contracting with the private sector to tap cogeneration and reduce gas flaring and leakage could reduce the need for public investment.

Although the MEDEC scenario reduces the demand for natural gas compared with the baseline, MEDEC and other recent studies foresee a major increase in the absolute amount of natural gas consumption. The success of the government's plan to expand natural gas production is therefore extremely important.

Energy End-Use

Electricity demand in Mexico has grown by more than 4 percent a year since 1995. Managing this growth through energy-efficiency measures in the end-use sectors will be critical to mitigating greenhouse gas emissions.

More than half of industrial energy use occurs in three subsectors: cement, iron and steel, and chemicals and petrochemicals. Many of Mexico's large-scale basic materials industries, including iron, steel, and cement, are among the most efficient in the world. The problem is that a large portion of the industrial sector is made up of small and medium enterprises that often use old equipment and lack access to technical know-how and financing for upgrades. These companies have relatively high energy intensity. The main sources of energy savings in the industrial sector come from energy-efficiency improvements in motor and steam systems and in kilns and furnaces, as well as from cogeneration—for which more than 85 percent of the industrial potential has not been utilized.

Air conditioning, refrigeration, and electronics are expected to be the main growth areas of residential electricity demand in Mexico. Air conditioner saturation rates in Mexico were about 20 percent in 2005—far lower than the 95 percent rates in regions of the United States with similar cooling-degree days. The saturation rate of refrigerators is relatively high in Mexico, at 82 percent in 2006, but it is still expected to grow considerably. Recent efforts to promote compact fluorescent lamps notwithstanding, incandescent lamps account for about 85 percent of in-use residential light bulbs in Mexico, indicating large potential for scaling up replacement efforts. There is also significant mitigation potential through solar water heating in urban areas and improved fuelwood cookstoves in rural areas.

Policies to improve efficiency in the residential, commercial, and public sectors—including tightening and enforcing efficiency standards for lighting, air conditioning, refrigeration, and buildings—will be critical to limit greenhouse gas emissions. As the analysis shows, the investment required in all electricity-efficiency interventions is significantly less than the investment in power plants that would otherwise be needed.

Transport

Transport is the largest and fastest-growing sector in terms of both energy consumption and greenhouse gas emissions in Mexico, with road transport accounting for about 90 percent of the sector's CO_2e emissions. Between 1996 and 2006, Mexico's vehicle fleet nearly tripled, increasing from 8 million to more than 21 million vehicles. Energy use by road transport increased more than fourfold between 1973 and 2006. The importation of used vehicles from the United States has been an important factor behind the growth of the vehicle fleet, which has also led to an increase in the average fleet age and concerns about low gas mileage and high emissions of air pollutants.

A number of interrelated interventions that reduce greenhouse gas emissions in the transport sector were evaluated. They included increasing the density of urban development, raising energy-efficiency standards for new vehicles, optimizing transportation routes, creating a bus rapid transit (BRT) system, encouraging nonmotorized transport, mandating the inspection and maintenance of in-use vehicles in major cities, imposing import restrictions on vehicles through inspection, coordinating road freight, and promoting freight trains.

Given the historical and projected urbanization pattern in Mexico, urban transport and related land-use planning issues will be a critical component of overall energy usage by the transport sector and associated emissions. The analysis reveals the importance of addressing transport issues in an integrated and programmatic approach rather than as individual measures. The interventions with the largest potential that are most cost-effective are those that increase the percentage of trips by public transportation and improve the efficiency of the vehicle fleet. Increasing the use of public transportation—including through private concessions—will require the development of mechanisms that integrate public transportation and urban development efforts by both federal and municipal governments. Promoting more sustainable transport policies can provide numerous co-benefits in addition to climate change mitigation, including reductions in traffic congestion (and the associated time savings per trip) and improvements in public health as a result of reduced air pollution.

Agriculture and Forestry

Agriculture and forestry is one of the key sectors in which greenhouse gas emissions can be reduced in Mexico. The MEDEC interventions are based on a geographical model that determined the areas that can be devoted to various rural activities while minimizing possible negative impacts on food production and biodiversity conservation. The interventions in forestry—including reforestation, commercial plantations, and measures to reduce emissions from deforestation and forest degradation (REDD)—account for 85 percent of the proposed mitigation in the agriculture and forestry sector. They are among the most important mitigation options for Mexico. The interventions in this sector that have the highest benefits are those that both

substitute fossil fuel use through the sustainable production of biomass energy and reduce deforestation and forest degradation.

Many of the forestry interventions have unquantified environmental benefits, such as soil conservation, improvements in water quality, and preservation of ecosystems, in addition to the quantified benefits of income generation and employment for rural communities. Successful expansion of forestry sector interventions in Mexico depends on institutional changes in forest management, improved public financing mechanisms, and the development of a market for sustainable forest products.

Cost-effective measures for reducing greenhouse gas emissions from the agricultural sector are more limited, partly because of the lack of research and development on low-carbon measures. However, minimum tillage for maize production—which requires less energy and appears to facilitate soil carbon sequestration—appears to be a promising technology.

Sugarcane ethanol has significant greenhouse gas reduction potential, although the productivity of sugarcane production in Mexico is currently low (production costs are significantly above world market prices of sugar). Other liquid biofuels interventions—ethanol from sorghum and biodiesel from palm and jatropha—are estimated to have limited reduction potential without impinging on land use for food crops, forests, or conservation lands. All liquid biofuels options have positive net economic costs when compared with the opportunity cost of selling the feedstocks for food or other nonfuel uses.

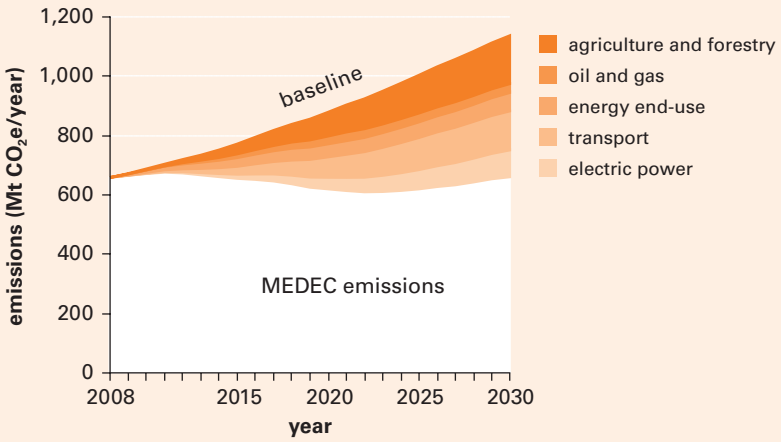
Emissions Reductions Associated with a Low-Carbon Scenario

The baseline scenario was generated using the LEAP (Long-range Energy Alternatives Planning) model, based on macroeconomic assumptions for GDP, population growth, and fuel prices that are in line with Mexican government estimates made at the beginning of 2008. Under the baseline scenario, total CO_2e emissions are estimated to grow from 659 Mt in 2008 to 1,137 Mt in 2030.

Implementing the 40 MEDEC interventions that meet the criteria outlined for inclusion would reduce CO_2e by about 477 Mt in 2030 relative to the baseline (figure 1). Adopting these interventions would yield a level of emissions that is virtually the same as that in 2008, despite significantly higher GDP and per capita income. The emission reductions would come from agriculture and forestry (162 Mt), transport (131 Mt), electric power (91 Mt), energy end-use (63 Mt), and oil and gas (30 Mt). The emissions reduction potential of the MEDEC low-carbon scenario is conservative, in that only 40 interventions were considered and the analysis did not assume any major changes in technology.

How much would low-carbon development cost in Mexico, and how do the costs of interventions compare across sectors? Nearly half of potential emissions reduction comes from interventions that have positive net ben-

Figure 1 Projected Emissions Reduction by Sector under the MEDEC Low-Carbon Scenario



Source: Authors.

efits (negative costs), meaning that their overall cost is less than the respective high-carbon alternative (figure 2). Interventions that have both high potential and low cost include the following:

- Public transport and vehicle efficiency
- Most energy-efficiency measures, including electricity supply improvements, lighting, refrigeration, air conditioning, and improved cookstoves
- A number of low-cost energy supply options, including industrial (and Pemex) cogeneration and solar water heating

At a value of \$10/t CO_2e, a number of other large interventions, including reforestation and restoration, and afforestation, yield positive benefits. Fully 80 percent of the greenhouse gas reduction potential of the MEDEC interventions lie below the \$10/t CO_2e level. Raising the cost threshold to \$25/t CO_2e allows more than 5 billion tons of CO_2e to be avoided through 2030.

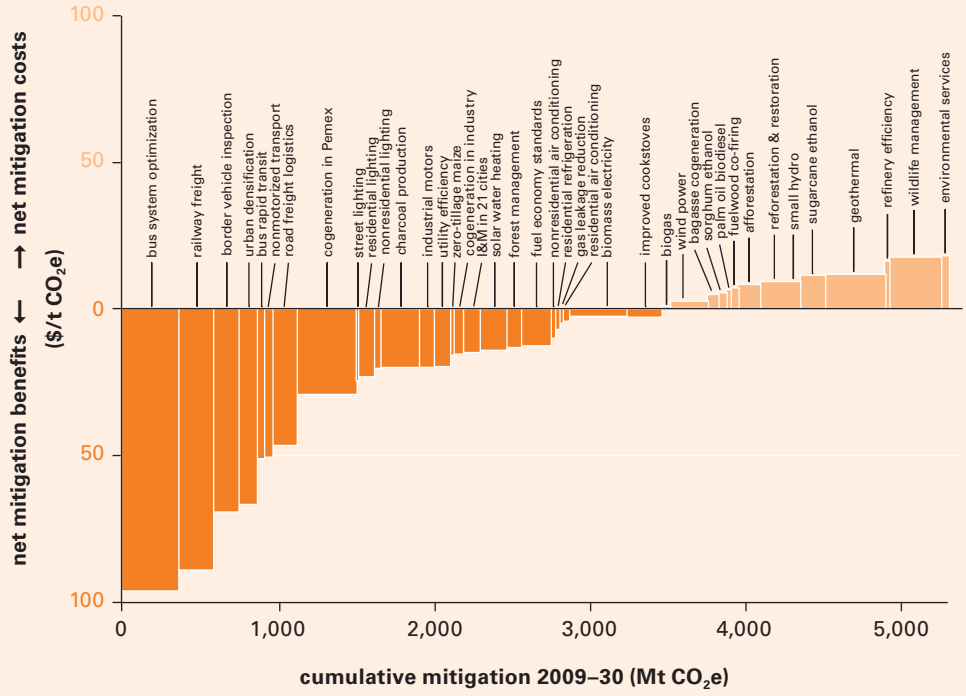
Elements of a Low-Carbon Program

Many high-priority interventions in the transport, electric power, energy efficiency, and forestry sectors have net costs that are low or negative. The fact that many of these interventions have not already been adopted on a large scale suggests that there are barriers to implementing them.

Policies and Investments Required for Low-Carbon Development

Two of the greatest challenges Mexico will face in moving to a low-carbon economy are financing the (generally higher) upfront costs of low-carbon

Figure 2 Marginal Abatement Cost Curve



Source: Authors, based on MEDEC study results.

investments and putting in place supportive policies and programs to overcome the regulatory, institutional, and market development barriers. Renewable energy investments generally have higher initial costs than other investments. These costs are often compensated for by lower operating costs, yielding a net economic benefit (in present value terms). Even where the discounted life-cycle costs are lower, however, higher upfront investment costs often inhibit such investments. For some interventions, in particular in energy efficiency, the initial investments are offset by the savings in new generating capacity, resulting in "negative" investment cost differences when upstream effects are considered. The overall new investment required to achieve the MEDEC low-carbon scenario is about $64 billion between 2009 and 2030, or about $3 billion a year, equivalent to about 0.4 percent of Mexico's GDP in 2008.

Investment by the public sector will be critical, but financing will not have to come entirely from the government; there is considerable room to involve the private sector in financing investments in energy efficiency, renewable energy, and sustainable transport. The recent reform of the oil and gas industry represents a positive step in promoting greater efficiency in the sector and attracting investments from the private sector. Since the

mid-1990s, there has been a dramatic increase in the number of independent power producers for natural gas power plants. This model could be improved and extended to promote investments in energy efficiency, cogeneration, and renewable energy generation.

Changing the rules that limit Pemex from tapping its cogeneration potential and providing substantial electricity production to the grid is a high priority for low-carbon development. Other important policies could include increasing energy-efficiency standards for both new and used vehicles; revising residential electricity tariffs and increasing the prices of petroleum products and natural gas; changing public procurement rules to facilitate investments in energy efficiency in schools, hospitals, government buildings, and municipal services; improving coordination by federal, state, and municipal governments and by different sector agencies at all levels of government concerning urban land-use planning and public transport; improving fuel quality and enforcing air quality standards; and expanding forest management programs.

Almost all of the MEDEC interventions have already been implemented in Mexico as commercial-scale investments projects or pilot programs, thus demonstrating the feasibility of implementing them in the near term. For many of the interventions, it is the scale-up from an individual project scale to a wider program that is needed. Scaling up these projects will require new policies and the financing of incremental investments, as well as other institutional and behavioral changes.

Some of the MEDEC interventions could be supported by resources from the Clean Development Mechanism (CDM) or other international carbon finance mechanisms. Most, however, would require new rules—in the context of either a reformed CDM or new mechanisms—to qualify for support. Understanding the mitigation potential, net costs, and implementation barriers is therefore crucial in the light of ongoing international climate negotiations.

Near-Term Priorities

Several low-carbon interventions could be implemented in Mexico in the near term. High-priority actions that have already been proven in Mexico and could be scaled up over the next five years include the following:

- Bus rapid transit, based on projects in Mexico and pioneered in other parts of Latin America
- Expansion of the efficient lighting and appliances programs developed by Fideicomiso para el Ahorro de Energía Eléctrica (FIDE) (Fund for Electricity Savings) and the Secretaría de Energía (SENER) (Ministry of Energy)
- Wind farm development in Oaxaca and elsewhere, based on CFE's pilots
- Avoided deforestation, based on the Los Tuxtlas project in Veracruz
- Cogeneration in Pemex facilities, based on the project at Nuevo Pemex.

Wherever Mexico's low-carbon development projects begin, there will be a need to experiment and gain experience, especially with new investment mechanisms and regulatory policies. To establish domestic support for a low-carbon program, Mexico should begin with measures that have positive economic rates of return. As the analysis shows, such interventions are plentiful. A second priority is to promote interventions that have positive social and environmental benefits, such as those with positive environmental externalities in the forestry sector and those that reduce local air pollution and health impacts in both sustainable transport and rural fuel use.