RFF REPORT

Feasibility Assessment of a Carbon Cap-and-Trade System for Mexico

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1. Introduction

> "I announce that Mexico is elaborating the Special Climate Change Program, through which Mexico promises right now to reduce 50 million tons per year of carbon dioxide emissions starting now [June 2009] with a completion date of 2012… This is the first step to demonstrate our interest in contributing to the solution to the climate change problem."
> —President Felipe Calderón

In his speech at the 2009 World Environment Day celebrations in Cozumel, President Felipe Calderón established Mexico as a leader among developing countries in efforts to combat climate change by announcing that the Special Climate Change Program (Programa Especial de Cambio Climático, PECC) established by his administration would reduce carbon dioxide (CO_2) emissions by 50 million tons by 2012. President Calderón noted the program's goals of implementing cost-effective emissions reductions over the medium and long term.

Acting to reduce its greenhouse gas (GHG) emissions quickly will present Mexico with both opportunities and challenges. Various climate and energy bills have been proposed in the U.S. House and Senate over the last year. At the end of June 2009, the U.S. House of Representatives passed H.R. 2454, the American Clean Energy and Security Act of 2009. Sweeping in scope, the bill establishes a GHG emissions cap-and-trade system within the United States designed to reduce its emissions 83 percent from 2005 baseline emissions by 2050. Along with the cap-and-trade system, the bill also establishes renewable energy standards, a major offset market for regulated entities, and programs for reducing deforestation in the developing world. The Obama Administration had hoped that legislation would be completed ahead of the Conference of the Parties (COP) negotiations in Copenhagen in December, but legislation is awaiting debate in the Senate, where various comparable bills have been proposed. Most recently, in May 2010, Senators Kerry and Lieberman proposed similar legislation which also includes an 83 percent reduction of 2005 emissions by 2050, offset markets, and possible funding mechanisms for reducing international deforestation.

* This report was initially prepared for the World Bank in November 2009 and includes only minor updates.

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Provisions in H.R. 2454 establish avenues through which international actors may take advantage of the new carbon markets generated by the bill. Mexico's close relationship with the United States and sizable potential for emissions reduction presents an opportunity for it to link up with these new markets to the benefit of both parties.

Mexico has multiple options through which it can effectively reduce its greenhouse gas (GHG) emissions in the future. This study is intended to assist the Mexican government in determining what type of emissions regulation is most beneficial to the country's economy and citizenry and how some of these regulations, specifically a cap-and-trade system, can be deployed effectively. In Chapter 2, we present three broad strategies for reducing Mexico's current GHG emissions levels: Enhancement of Existing Policies, Sectoral Offset Policies, and Economy-Wide or Sectoral Binding Targets. Chapter 3 delves deeper into the details of implementing emissions control regulations and requirements to install and execute a successful cap-and-trade system in Mexico. Chapter 4 is dedicated to understanding the multiple key issues that must be addressed for Mexico to move closer to effectively reducing its GHG emissions. Chapter 5 highlights major findings and identifies paths for future research.

The objectives of the report are to (1) assess and compare the benefits of different types of GHG control policies, including cap-and-trade and carbon taxes, (2) identify some important aspects of mitigation policy design most applicable to Mexico's governance systems, and (3) highlight key issues that will help determine the feasibility and efficacy of a future emissions mitigation program in Mexico.

To do this, we have presented basic illustrations of how to incorporate some aspects of cap-and-trade into Mexico's federal structure and some simplified examples from international experiences in regulating emissions. Not addressed in detail in this report, however, are a number of issues that have major implications for controlling GHG emissions. Deforestation and forest offsets play a large role in H.R. 2454 and forestry negotiations progressed in Copenhagen, where new forestry financing mechanisms were established. Future analysis will undoubtedly include substantive discussions of the potential for Mexico to generate forest offsets and reduce emissions from deforestation and forest degradation (REDD) credits. Additionally, we have not explicitly addressed regulation of the transportation sector, although this sector could be regulated by a cap-and-trade approach, which makes refineries responsible for the eventual release of GHGs from their products, as is proposed in H.R. 2454. These and other important issues fall outside the scope of this report, but they could be tackled by future research.

2. Greenhouse Gas Mitigation Policy Strategies for Mexico

President Calderón has clearly signaled that Mexico is determined to significantly reduce its emissions of GHGs over the coming decades. Mexico can follow many strategies in pursuit of this goal. In this section, we present three broad strategies that encompass the relevant policy options. The three strategies are Enhancement of Existing Policies, Sectoral Offset Policies, and Economy-

Wide or Sectoral Binding Targets. Each strategy is further refined and discussed in greater detail in section 3 of this report.

It is important to be cognizant of an important distinction among the three strategies. Strategy 1—Enhancement of Existing Policies—relies predominantly on Mexico's own resources to fund the GHG mitigation efforts. The strategy does assume greater use of the Clean Development Mechanism (CDM), as well as new funds that may be made available through the post-2012 Copenhagen process, but the bulk of the resources would be provided by Mexico. In contrast, Strategies 2 and 3—Sectoral Offset Policies and Economy-Wide or Sectoral Binding Targets—require some Mexican resources but are designed to leverage a great deal of international resources, primarily from the United States.

Enhancement of Existing Policies

The first policy strategy for Mexico involves a continuation and enhancement of current energy and climate change policies as well as increased emphasis on advancing project-based offset opportunities. The Calderón administration has already begun focusing on enhancing current carbon policies. The administration's 2007 National Climate Change Strategy and its National Development Plan 2007–2012 became the foundation for the recently released Special Climate Change Program (PECC). PECC lays out long-term vision, mitigation, adaptation, and transversal policy as the key elements of a climate change policy and establishes mitigation and adaptation as Mexico's first priority elements. Through PECC, Mexico assumes an aspirational target of reducing its emissions to 50 percent of the volume emitted in 2000 by 2050. To do so, PECC establishes 303 specific aspirational goals, 95 of which focus on GHG mitigation. The PECC goals are organized around three main categories of emissions sources: energy generation and use; agriculture, forestry, and other land use; and waste.

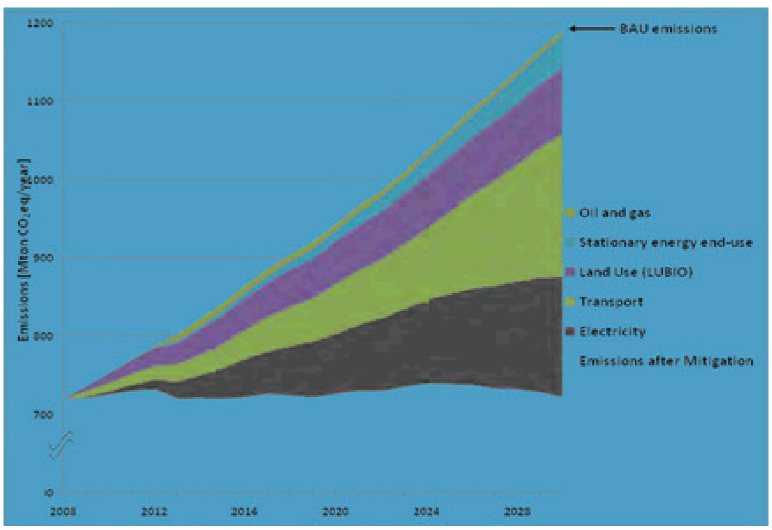
While the PECC goals are ambitious, not all the identified measures have been fully budgeted. The PECC report (Federal Executive Branch 2009) notes that to achieve its goals in full, a multilateral regime with an unprecedented scale of financial and technological support from developed countries would be required. Based on official estimates, the $7 billion dollars assigned to certain goals will allow for reductions of 93.5 million tons of CO_2 equivalent ($MtCO_2e$) during the 2008–2012 period, only 36 percent of the 260.45 $MtCO_2e$ PECC aims to mitigate during that period. An additional $6.6 billion–dollar investment is needed, according to the PECC report, of which 3.3 billion pesos per year could come from the Energy Transition and Sustainable Energy Use Fund (a product of the recent energy reform), as well as additional international funding sources. While the international community pledged prompt-start financing in Copenhagen and will continue to elaborate financing details in the post-2012 Conference of Parties (COP) process, Mexico is less likely to receive the "unprecedented scale of financing and technological" support mentioned in the PECC report without establishing a baseline with the international community (Federal Executive Branch 2009, vi). Regardless, Mexico may adopt those PECC policies that can be funded with the aforementioned existing domestic resources.

Mexico could also continue to take advantage of project-based offset markets through the CDM. Anecdotal evidence suggests there is ample room to expand use of CDM projects in Mexico; most projects focus on agriculture (47 percent) or biogas (19 percent), and few projects cover the oil and gas or electricity sectors. Institutional barriers, however, may need to be addressed before use of CDM projects, in the aforementioned sectors in particular, expands and project performance improves. See section 4.1 for further discussion of Mexico's CDM experience.

Strategy 1 would also involve continued momentum toward reform in the oil and gas sector and electricity pricing. Recent reforms of Mexico's state-owned petroleum monopoly, Pemex, expand its financing options and could potentially help address some of the capital allocation and budgetary planning issues that have been an impediment to CDM and other energy-efficiency projects. The recent Renewable Energy Use and Financing the Energy Transition Law addresses the electricity sector's "lowest-cost provisions" and expands the valuation of costs associated with electricity generation and distribution to consideration of externalities and "potential net economic benefits." This expansion of electricity cost valuation, as well as efforts to change interconnection, dispatch, and other rules in the electricity sector, represent a positive step in clearing barriers to renewable energy expansion in Mexico.

Sectoral Offset Policies

Figure 2.1. Climate Change Mitigation Wedges for Mexico (2008–2030)



Note: MtonCO$_2$eq=million tons of carbon dioxide equivalent; BAU=business as usual.
Source: Johnson et al. 2009.

The bulk of Mexican GHG emissions come from energy generation (24 percent), the production and consumption of petroleum-based fuels (18 percent), and forests and land use changes (14 percent) (CICC 2007). Figure 2.1 is drawn from the World Bank's MEDEC: Mexico Low-Carbon

Study (Johnson et al. 2009) and shows the study's estimated potential for emissions reductions in these and other important sectors. While the nature and magnitude of the emissions reduction potential cited in the MEDEC study is debated, there is little argument that electricity generation, the production and consumption of petroleum-based fuels, and forests and land use are the key candidates for government polices to reduce emissions in the near term.

Mexico is already making progress to limit emissions from these sectors and will do more under the PECC. However, the magnitude and pace of these reductions could be increased with the addition of international financial resources. Provisions within the recently passed U.S. House of Representatives bill H.R. 2454—the American Clean Energy and Security Act of 2009—provide an array of programs within which Mexico can participate. These programs would enable Mexico to undertake a wide range of emissions reduction policies with the three sectors noted above and monetize those emissions reductions in the U.S. GHG market established by the legislation or possibly in other international markets.

H.R. 2454 would place a cap on the bulk of U.S. GHG emissions from 2012 to 2050.[1] Each year, entities whose emissions are regulated under the cap must surrender U.S. government-issued allowances (permits) corresponding to their annual emissions. These allowances may be purchased in the GHG market established by the legislation in allowance auctions the government will run on a quarterly basis. In some cases, they are received for free directly from the government. The U.S. Environmental Protection Agency (U.S. EPA) estimates the price of U.S. allowances to be between $13 and $26 in 2015 in 2005 dollars.

Importantly, regulated entities may augment the allowances issued by the U.S. government with "offsets." Offsets are verified emissions reductions that have taken place outside the U.S. emissions cap, either from uncapped domestic sources like U.S. agriculture, or from foreign entities like Mexico. Regulated U.S. entities may meet their compliance obligations by surrendering either allowances or verified offsets.

Section 743(c) of H.R. 2454 addresses international offsets that could be generated from reductions in Mexican emissions from electricity generation, and the production and consumption of petroleum-based fuels. The legislation places conditions as to which countries may participate in the offset program. The legislation states:

> International offset credits will be issued only if the United States is a party to a bilateral or multilateral agreement or arrangement that includes the country in which the project or measure achieving the relevant greenhouse gas emission reduction or avoidance, or greenhouse gas sequestration has occurred, and such country is a developing country.

In addition, the program is potentially limited to:

- countries that have comparatively high GHG emissions, or comparatively greater levels of economic development; and

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1 In 2012 the cap on emissions would capture 66 percent of all U.S. GHG emissions. This would grow to 75 percent in 2014 and 85 percent in 2016.

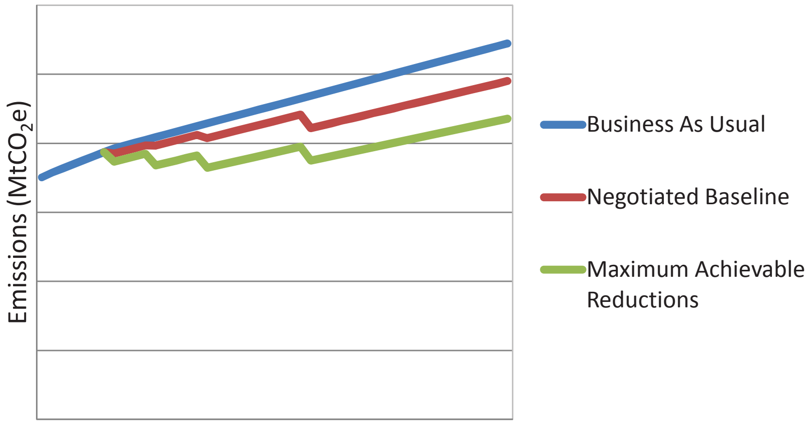
- if located in the United States, entities within a sector subject to the compliance obligation.

Appendix 1 lists additional factors mentioned in H.R. 2454 that are taken into account when considering participation in the offset program. Given the requirements for country participation contained within the current legislation, there is every reason to believe the Mexican electricity generation sector and the petroleum sector would be prime candidates for inclusion in the offset program.

Here's how the program would work: Mexico would signal to the U.S. Department of State that it wished to enter into bilateral negotiations regarding sector-based international offsets under section 743 of H.R. 2454 for its electricity generation sector, for example. Since electricity generation is one of the controlled U.S. sectors under the cap, the United States likely would welcome this request for engagement. Everything that follows is the result of the bilateral negotiations.

Mexico submits a sectoral business-as-usual (BAU) forecast of electricity sector emissions over some projected time period, say until 2050, 2030, or the end of the first post-Copenhagen commitment period (2020). Figure 2.2 contains such a hypothetical BAU forecast.

Figure 2.2. Hypothetical Business-as-Usual Forecast, Negotiated Baseline, and Maximum Achievable Reductions



Mexico then submits as part of the negotiation a "sectoral baseline" for its electricity sector—that is, the emissions path against which offsets would be measured. This is labeled "Negotiated Baseline" in Figure 2.2. Part of the negotiation, as discussed below, is ensuring stringent monitoring and enforcement such that actual emissions from covered sources are verifiable. To the extent that electricity sector emissions are below the baseline, offset credits are generated and may be sold in the U.S. market.

Establishing the baseline is at the heart of the bilateral negotiations. The value of the offsets generated by the program equals the area between the negotiated baseline and the actual emissions (assumed in the diagram to be the maximum achievable emissions) times the U.S. market price for offset credits, which is closely linked to the value of U.S. allowances. The standard advice when entering a negotiation relationship is to understand one's own reward structure, options, and reservation price. Therefore, it is crucial for Mexico to know with a great deal of certainty its maximum achievable emissions path (see Figure 2.2) that can be implemented with politically and economically acceptable efficacious regulatory policy. This will provide Mexico information and confidence when negotiating a baseline, as well as a practical understanding of the design of the domestic regulatory policies that would follow the negotiated international agreement.

Mexico is in a position to negotiate a second sectoral agreement for its petroleum sector (Pemex), including upstream oil and gas emissions, refining, and the CO_2 emissions from all its refined products (transport fuels). Once again, the U.S. oil and gas sector would be regulated under the H.R. 2454 cap (including emissions from all refined products sold), and the United States likely would welcome this sector into its offset program for two reasons. First, Mexico's oil and gas sector can meet the H.R. 2454 participation requirements previously listed (and expanded on in Appendix 1), and second, its inclusion addresses the possibility of leakage—that is, the situation in which one country's emissions reductions are offset by increases in another—from the United States to Mexico.

The negotiation process for the petroleum sector would follow that of the electricity sector. As with electricity, Mexico would need to negotiate a baseline based on a solid understanding of the BAU emissions path for the petroleum sector as well as detailed information about its maximum achievable emissions reduction path and the associated costs.

Mexico may engage the United States with respect to international offsets in a third sector, forestry. H.R. 2454 establishes a separate and important program to reduce rates of deforestation under section 743(e), Offsets from Reduced Deforestation. Mexico can participate in this program in many ways, but given preexisting Mexican commitments to reduce deforestation on a national scale, it seems most appropriate to engage the United States in negotiations under section 743(e)(4), National Deforestation Baseline. In principle, the negotiation follows that of the electricity and petroleum sectors. A national baseline for emissions from deforestation must be negotiated (this is the "national deforestation baseline"). Actual emissions below that baseline generate offset credits. Once again, the heart of the negotiation is the national baseline, and the crucial parameter from Mexico's perspective is the expected level of reductions in deforestation that can be achieved through government policy.

All of the aforementioned sectoral policies allow access to the U.S. GHG market through the use of an offset mechanism. The offset approach has the benefit that it does not require Mexico to take on legally binding targets. However, the United States limits the number of international offsets that can enter the market during a given year and can impose discounts such that offsets may not be fungible one-for-one with allowances. Also, offsets are subject to the rules and negotiating power of the county into whose market Mexico wishes to sell offsets, and these rules will likely vary across markets (for example, in the United States and the European Union).

Economy-Wide or Sectoral Binding Targets

In contrast to offsets, Mexico might consider a third strategy in which it adopts legally binding targets, sets up its own within-Mexico cap-and-trade program,[2] and sells "international emissions allowances" to the U.S. market rather than offsets. Such a policy could place Mexico on a par with the European Union from the perspective of the United States—that is, in a situation where both entities have adopted legally binding emissions reduction targets over a subset of their emitting sectors and established a cap-and-trade program for those sectors. Section 722(d)(3) of H.R. 2454 permits a regulated U.S. entity to meet its compliance obligations by surrendering U.S. government-issued allowances, domestic or international offsets (subject to quantity limitations), or international emissions allowances. Section 728 describes international emissions allowances as follows.

The U.S. EPA Administrator, in consultation with the Secretary of State, may by rule designate an international climate change program as a "qualifying international program" if:

> 1. the program is run by a national or supranational foreign government and imposes a mandatory absolute tonnage limit on GHG emissions from one or more foreign countries, or from one or more economic sectors in such a country or countries; and
>
> 2. the program is at least as stringent as the program established by this title, including provisions to ensure at least comparable monitoring, compliance, enforcement, quality of offsets (e.g., those bought from other uncapped sectors), and restrictions on the use of offsets.

A "qualifying international program" is one in which the allowances of the program are fungible one-for-one with U.S. allowances without restriction or any further rules. Clearly, this language was developed so the coming U.S. GHG market could link with the EU Emissions Trading Scheme (EU ETS), but the language has applicability to Mexico. Here's how the program would work in Mexico:

Mexico would engage with the U.S. State Department and the U.S. EPA and express its desire to place "mandatory absolute tonnage limits on GHG emissions from" Pemex and/or the electricity sector. Moreover, Mexico would express its interest in regulating those emissions using a cap-and-trade program very similar to the EU ETS and the GHG market to be established in the United States. Finally, Mexico would state that it wishes for the program to be accepted under section 728.

What follows is a bilateral negotiation over the items in the second bullet point above. Importantly, the language "as stringent as" does not refer explicitly to the severity of the cap. One can anticipate that stringency can be interpreted to apply to the program design and implementation of Mexico's domestic program, including monitoring, data reporting, enforcement, and penalties for noncompliance. If Mexico were able to negotiate caps similar to those it would negotiate as

2 See section 3.3 for further discussion of features of a Mexican cap-and-trade system.

sectoral offset baselines, it would gain all the considerable advantages of international emissions allowances over offsets (such as their higher value) without agreeing to deeper reductions than it would in the offset program. Moreover, there is reason to believe the United States would show more flexibility in negotiations over mandatory absolute tonnage limits than it would offset baselines due to the global precedent set by Mexican adoption of such limits.

3. Mitigation Policy Design

The policy strategies of section 2 describe three broad approaches Mexico might pursue to achieve its GHG emissions reduction goals. Underlying each strategy is a set of government policies that give rise to the desired emissions reductions. The purpose of this section is to discuss elements that are important in the design of those policies. Current policies—for example, those described in the Special Climate Change Program (PECC) (Federal Executive Branch 2009)—are in the process of design and implementation. The timing and stringency of those policies are likely to affect the opportunity for adoption of the additional policies that we describe below. We treat the Current Policies strategy as given and focus attention in this section on the two optional strategies: Sectoral Offset Policies and Economy-Wide or Sectoral Binding Targets.

Scope of Regulation

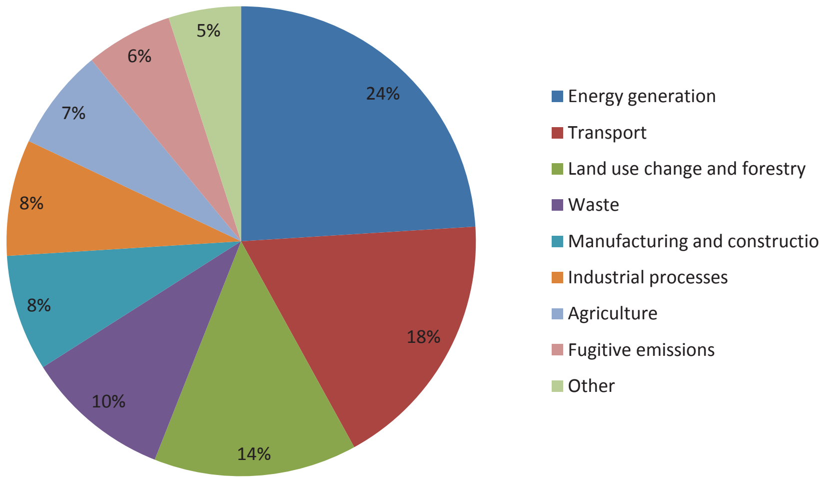
The logical place to begin the design of GHG mitigation regulatory policies is with a determination of scope. In the context of policy design, scope has two parameters: (1) the magnitude of the desired GHG reductions from BAU, and (2) and the number of emitting sources that will be subject to regulation—that is, the portion of the total Mexican GHG emissions subject to government regulatory policy. For example, the scope parameters embedded in the U.S. House of Representatives passed bill (H.R. 2454) binds the United States to reductions in all GHG emissions of 80 percent below the 2005 level by 2050. In terms of emissions sources covered by the U.S. policy, the bill states that 66 percent of all GHG sources will be regulated by the legislation in 2012, growing to 84.5 percent by 2016.

The two scope parameters are not independent: the decision regarding the magnitude of the reductions has a bearing on the number of sources to be regulated, and the political and economic tractability of regulating particular sources has a bearing on the decision regarding the magnitude of the reductions. In other words, the greater the desired GHG reduction, the more sources will likely have to be regulated, and the more sectors that can be effectively regulated, the greater the GHG emissions reduction targets can be.

Choice of scope parameters will have the greatest impact on the economic ramifications of the mitigation policy. The greater the emissions reductions and the shorter the timeline for those reductions, the higher the economic cost will be. Moreover, the smaller the base of emissions selected for regulation (the larger the base of excluded emissions), the greater will be the cost. Thus, the choice of scope parameters represents a complex political–economic balancing act that deserves a great deal of attention.

Figure 3.1 displays the sources of Mexican GHG emissions in 2002 and the percent of total emissions attributable to each source category. As noted in section 2, energy, transport, and land use represent more than 50 percent of all Mexican emissions. Adding industrial emissions as well as construction and agriculture brings the total to almost 80 percent of all Mexican GHG emissions.

Figure 3.1. Mexican GHG Emissions by Source in 2002



Source: CICC 2007.

Point of Regulation

Choosing the point of regulation presumes a decision has been made with respect to the sectoral emissions sources that will be subject to regulation. For concreteness, let us assume that emissions from electricity generation have been selected as an emissions source to be regulated. In the jargon of GHG mitigation design, electricity emissions can be regulated "upstream" or "downstream." Downstream regulation would mean regulating at the point of CO_2 emissions—that is, where the carbon-bearing fossil fuel (coal, oil, or natural gas) is combusted to produce electricity. If Mexico chose downstream regulation, the regulated entity would be any electricity generation source emitting more than, for example, 25,000 metric tons of GHGs annually. This would likely include all fossil-generating units from the state electricity utility CFE but could be expanded to include all private merchant generators and large self-generating units at commercial or industrial facilities.

On the other hand, electricity generation emissions could be regulated upstream. Since the carbon content of fossil fuels determines the CO_2 emissions once combusted, the entities providing the fuels to the economy can be regulated entities. That is, those entities providing fossil fuels to electricity generators can be regulated on the basis of the carbon content of the fuels they sell.

In both cases, upstream and downstream, all the CO_2 emissions from electricity generation would be subject to regulation. Policymakers can choose either approach simply on the basis of regulatory expediency.[3]

Point of regulation is more important when it comes to the regulation of transport emissions. In the case of transport, downstream sources are individual cars, trucks, buses, trains, and planes. The number of downstream sources is huge. In contrast, the number of upstream sources—oil refineries or importers—is very small.

One can regulate downstream emissions with technology controls on vehicles as the State of California and the federal government are planning to do with CO_2 tailpipe standards for GHG emissions on all new cars. The U.S. federal corporate average fuel efficiency standards for new vehicles represent an input standard that reduces GHG emissions on new cars. One of the drawbacks to the standards approach is that it solely focuses on new vehicles. Given the time necessary to roll over the transport fleet with new, low-emissions vehicles, the effect on total emissions from the sector tends to be very gradual.

Upstream regulation would make oil refineries responsible for the downstream emissions from the refined products they produce and sell. This is the approach the United States has adopted in H.R. 2454. It provides an economic incentive for drivers of all vehicles to reduce vehicle miles traveled, something that does not occur under a vehicle standard. In addition, it provides an incentive to purchase more efficient vehicles. However, the drawback of this approach in transportation is that it may take even more time to roll over the transport fleet than it would with vehicle standards. Many policy advocates argue that climate policy can incorporate both a standards- and a price-based approach in order to affect the composition of the vehicle fleet and also provide an incentive for driving less. That type of complementary policy approach is emerging in U.S. policy.

Form of Regulation

Form of regulation concerns the character of the actual policies used to limit emissions from regulated sources. Treating the choice over form of regulation as a sequential decision following previous decisions regarding scope and point of regulation is a convenient assumption for expositional purposes. In reality, decisions on scope, point of regulation, and form of regulation are often made simultaneously.

GHG regulations are usually grouped into two broad categories—prescriptive regulation (for example, vehicle performance standards mentioned above), and incentive-based regulation.

3 In previous emissions cap-and-trade programs for sulfur dioxide and nitrogen oxides in the United States and under the CO_2 trading programs in the European Union and in the ten U.S. Northeast states, emissions from electricity generation are regulated downstream. In H.R. 2454, electricity generation from coal and natural gas is regulated at the point of combustion, but petroleum liquid fuels are regulated at the refinery level, and natural gas liquids are regulated at the point where they are converted into merchantable products.

Prescriptive regulation has been the dominant form of U.S. environmental air and water regulation. While greatly oversimplifying, for the most part this form of regulation involves permits for sources that limit emissions rates and/or total emissions to specific quantities and requires pre-specified emissions control devices and procedures. Prescriptive regulation can be quite effective and economically efficient for particular types of emissions.

In the 1970s, a new incentive-based form of regulation entered the picture. Incentive-based regulations come in two generic forms—emissions cap-and-trade programs and emissions taxes. Early forms of emissions trading programs emerged widely in the 1980s at the regional and local level within informal markets where trades had to be individually approved by the regulator. Cap-and-trade was first deployed on a large scale in the United States in the 1990s to control sulfur dioxide emissions from power plants. Experience with that regulatory policy revealed that cap-and-trade can be environmentally effective and cost-effective, perhaps considerably more so than prescriptive regulation applied to the same environmental pollutant.

A cap-and-trade program sets an upper bound on the aggregate annual or seasonal emissions of a particular pollutant. In the case of GHGs, this could be $CO_{2.}$ The regulatory authority then issues allowances (one per metric ton of CO_2) equal to the cap. Regulated entities must surrender allowances in an amount equal to their annual emissions. The regulated entities are free to determine how they will reduce their emissions and/or choose to purchase allowances from other entities that have reduced their emissions. In a very real sense, cap-and-trade places a market price on the heretofore unpriced emissions of CO_2. The CO_2 price introduces incentives for private entities to reduce their emissions in the most effective manner.

A carbon tax theoretically establishes the same CO_2 price as cap-and-trade and has roughly the same incentive effects. Yet the two approaches have important differences, as described in Appendix 2.

Using the European Union as model for the choice of regulatory form, one finds a combination of prescriptive and incentive-based policies. Certainly, the EU ETS has attracted a great deal of attention and is often referred to as the cornerstone of EU GHG mitigation policy, but there is a good deal of prescriptive regulation in the EU as well. The same is true for the fledgling U.S. policy, where proposed cap-and-trade legislation has center stage, but a great deal of additional prescriptive policy is included. Unless precluded by new cap-and-trade legislation, regulations will be promulgated under the Clean Air Act that ultimately will address emissions from every type of source. California, which is developing policy to implement a state law that caps emissions by 2020, is implementing prescriptive measures that are expected to achieve more than 80 percent of the emissions reductions required under its state law. A cap-and-trade policy is being developed to make up the difference. Hybrid policies that rely on well designed incentive-based policies combined with well designed and targeted prescriptive regulation seem to be the emerging norm.

Matching Strategies to Forms of Regulation

As noted above, the recently passed legislation in the U.S. House of Representatives provides many opportunities for Mexico to reduce its GHG emissions and secure U.S. financial support to assist in the endeavor. Obtaining U.S. support will require the formulation of Mexican GHG policy in a manner that aligns it with provisions of the U.S. legislation, but this does not impose a great burden on Mexico. Indeed, the necessary policy alignment may very well result in the same effective and efficient policy formulation Mexico would choose in the absence of U.S. funding opportunities.

The sectoral offset and binding targets strategies introduced in section 2 were developed to align with the new U.S. legislation and are the strategies we focus on in this section. Both strategies are scalable in terms of the scope parameters discussed above; the magnitude of the GHG emissions reductions and the breadth of the regulatory program can be increased by adding sectors. The smallest scope program would focus exclusively on forestry. An expansion of the scope could entail the addition of electricity generation, and a further expansion could add upstream and downstream oil and gas.

Land use (forestry)

Existing Mexican policies to reduce land-use emissions by reducing rates of deforestation and increasing sinks through afforestation should be quickly aligned with provisions of H.R. 2454 under section 743(e). Such alignment is discussed above in section 2.2. To achieve these goals, Mexico can deploy a vast array of on-the-ground policies, ranging from protected areas, to community forestry, to payments for ecosystem services. Many of these are already identified in the PECC (Federal Executive Branch 2009) and will not be discussed further, except to say that additional analysis of the cost and efficacy of these policies is needed before bilateral negations over baselines are initiated with the United States.

Electricity generation

Almost a quarter of Mexican GHG emissions come from the electricity generation sector, and the lion's share of those emissions is attributable to CFE. If the United States is any guide, some of the lowest cost GHG mitigation efforts will be found within this sector. Thus, based on the magnitude of emissions from this sector and the likely cost-effectiveness of mitigation efforts, electricity generation in general, and CFE in particular, should be a top priority of mitigation policy. However, it is important to point out that the discussion of CFE's GHG mitigation potential is more conceptual in this section and is addressed in more detail in section 4 of this report.

Under the Sectoral Offsets strategy of section 2, Mexico is free to choose any regulatory policy most fitting for this sector and CFE. The generation of offsets is measured solely on the basis of verifiable differences in actual emissions below the negotiated baseline. The regulatory policies used to achieve those reductions have no bearing on the generation of offsets. However, arguments from the perspective of environmental and economic efficiency favor a suite of policies. That suite would build on a cap-and-trade component at the core and include reforms of retail pricing and tariffs for non-CFE generated electricity, plus enhanced competitiveness in the generation side of the sector. However, we have undertaken no analysis of such electricity pricing and competitiveness reforms in this section. We focus instead on a cap-and-trade program for the sector generally, but with special attention to CFE.

Unlike the United States, where electricity generation is composed of numerous privately owned generating entities and a minority of publicly owned entities, electricity generation in Mexico is a state monopoly on the transmission and distribution side, while generation is nearly a state monopoly, with a small but growing constituent of privately owned independent power producers and self generators. The question naturally arises, how will a cap-and-trade regulatory program invented to regulate numerous private electricity generators perform when there is one large predominant entity?

The answer to this question begins with the acknowledgement that an intra-company emissions trading program could function within that dominant entity alongside a sector-wide program. While sector-wide emissions programs are more commonplace and better understood than intra-company trading programs, intra-company emissions trading programs have successfully functioned at BP and have already been piloted closer to home at Pemex. Yet given the relative novelty of a single-company emissions program, this discussion focuses on the intra-CFE portion of the electricity sector emissions market. CFE has numerous point sources of emissions (perhaps as many as 177 generating facilities) that range from CO_2-free hydro facilities to carbon-intensive coal and oil-fired plants. CFE can create a cap-and-trade program within its organizational structure by treating individual power plants as individual entities or grouping them by geography or business units for the purposes of emissions mitigation and trade. When BP undertook a very similar exercise between 1999 and 2001, it trimmed corporate GHG emissions by 10 percent. The sheer numbers and heterogeneity of CFE sources provide reason to believe that differences exist in the cost of CO_2 mitigation across these point sources. Thus, the most efficient approach may be an incentive-based regulatory program that gets the largest reductions from the lowest control cost sources, while providing incentives for all sources to reduce emissions.

Here's how the system would work:

- CFE would establish a CO_2 monitoring and reporting system at each emitting facility to monitor emissions at the generating facility level and create an emissions inventory and directory.
- The government of Mexico would establish annual caps on electricity sector emissions as a whole, the majority of which would be allocated to CFE emissions for the period 2012–2020.
- CFE would create allowances equal to the cap and distribute those allowances to all facilities pro-rata on the basis of their monitored emissions—or, alternatively, hold auctions of allowances and require facilities to purchase allowances in these auctions.
- Each facility would be required to surrender allowances equal to the past year's emissions on a designated day each year.

- Allowances in excess of the facility's needs could be sold to other facilities in an internal market that CFE would establish.
- Allowances could be banked from one year to the next.

The allowance price prevailing on the electricity market (and auction if it were established) would be embedded in the cost of doing business at each facility. In the short run, the immediate impact of the program would be to provide incentives to improve generating efficiency at each facility and, depending on the carbon price, to alter the dispatch order of the units. In the longer term, the allowance price changes the internal rate of return on generation technologies, disadvantaging high-carbon technologies and advantaging low-carbon technologies.

The degree to which an allowance price of a given magnitude can generate emissions reductions depends on the marginal cost schedule of abatement options across the entire CFE landscape. And the magnitude of emissions reductions depends on the response to the price signal associated with the emissions allowance.

How well would a near state–owned monopoly respond to the price signal? The U.S. sulfur dioxide (SO_2) emissions allowance trading program was implemented when all electricity generators were subject to monopolistic cost-of-service regulation for the establishment of electricity pricing.[4] Overall, analysts have found the SO_2 trading program achieved environmental goals in a fairly cost-effective manner. Firms responded efficiently to the incentives they perceived, but regulators at the state level introduced policies favoring one or another type of compliance strategy (such as the use of in-state coal) that affected the compliance activities of firms. This, coupled with the experience of BP, provides evidence that a trading program can flourish both within CFE and in the broader electricity sector. However, its success will depend on leadership from the government and the top of the organization.

As noted above, other complementary policies should be deployed with the cap-and-trade program. Any institutional impediments that prevent a CFE facility from benefiting from reduced emissions or shield a facility from the added cost of purchasing allowances must be identified and removed.

Upstream and downstream oil and gas

The last sectoral component is Mexican oil and gas—that is, Pemex, the oil and gas state-owned monopoly. Pemex is responsible for upstream oil and gas development and extraction, refining, petrochemical production, and downstream refined products. GHG emissions occur at each stage of the oil and gas business. Like CFE, Pemex is a single entity with numerous point sources of emissions, and like CFE and BP, Pemex emissions can be regulated using an intra-company cap-and-trade program. The program would follow the same steps as those discussed above for CFE. Also, and importantly, complementary policies that reformed the Pemex pricing structure and

4 Over the last decade roughly half of U.S. electricity generation has been deregulated.

further opened Pemex investment demand to private capital would be critical to the success of the mitigation program.

Indeed, such a cap-and-trade program is not without precedent. The company developed an internal carbon emissions permit market that operated from 2001 until 2005. The program was designed to stimulate competition between Pemex subsidiaries to identify cost-effective abatement options and operational best practices. Twenty-five business units participated in the voluntary market, including the company's four regional exploration and production units, the well-drilling and maintenance unit, six refineries, seven gas processing centers, and eight petrochemical centers. By year-end 2004, 3.64 million tons of CO_2 had been traded with a virtual market value of 198 million *pesos.* While the market's non-obligatory nature and capital budget constraints may have been factors in the decision to terminate the program in 2005, the fact that a comprehensive internal market framework—that considers business-unit baselines, pricing, and verification—has already been developed should facilitate creation of a trading program within Pemex.

While the upstream, refining, and petrochemical operations of Pemex have significant GHG emissions, the company could focus the bulk of its reductions on emissions from the refined product it sells into the transport sector. Making Pemex responsible under a cap for the downstream product it sells is consistent with the manner in which the United States plans to regulate its petroleum products.

A within-Pemex cap-and-trade would distribute or auction allowances to all the business units on the basis of a past benchmark-year emissions (in a manner analogous to within-CFE trading). Estimates of downstream emissions would be calculated and those emissions assigned to the individual Pemex refineries on the basis of benchmark year sales. The upshot of including downstream emissions under the Pemex cap would be to add the cost of allowances to the wholesale price of refined products. Clearly, the economic rationale for adding the carbon charge to transport fuels would be muted if government transport-fuel subsidies remain in effect or are increased to cover the carbon charge.

CFE–Pemex trading

Only by chance would the marginal abatement costs in CFE and Pemex be equal. In the likely case they are unequal, aggregate control cost can be reduced by linking (merging) the CFE and Pemex cap-and-trade programs. If marginal abatement cost curves for CFE and Pemex were estimated (and we are arguing strongly in favor of such analysis), it would be straightforward to model the combined market and estimate both the allowance price and the tons reduced by CFE and Pemex individually.

Still, there are benefits to separate sectoral offset programs where each program has its own BAU emissions path and negotiated baseline. Two separate programs are to Mexico's benefit since one sector's failure to generate offsets (that is, its inability to lower emissions below the baseline) would not jeopardize the offsets generated in the other sector where emissions might be below the baseline.

For example, suppose the electricity sector and oil and gas sector each had 100-million-ton baselines, but during negotiation they were aggregated to a single 200-million-ton combined-sector baseline. Now assume the electricity sector reduces its emissions to 90 million tons, generating 10 million tons of offset credits, but Pemex cannot reduce its emissions at all, and in fact, is 10 million tons above their baseline. In this case, the aggregated emissions are still 200 million tons, and no credits are generated. If the two programs were separate, Mexico could still sell the 10 million tons of electricity sector credits, while Pemex would lose the opportunity to profit from offset credits that were never generated but would not suffer financial penalty.

Creating a Mexican Cap-and-Trade Program

If Mexico pursues the sectoral offsets strategy, any form of regulation may be used; however, if Mexico chooses to establish legally binding targets for sectors such as electricity and oil and gas, there are reasons to choose an approach that has cap-and-trade at its core. A cap-and-trade approach would best align with the United States under section 728 of H.R. 2454. This section of the House bill envisages the U.S. cap-and-trade program linking with the programs of other countries, where each country's emissions allowance is accepted on a one-for-one basis.

As noted above, the framers of the House bill likely had the European Union in mind when drafting section 728, but it could apply equally well to Mexico if Mexico had a national cap-and-trade program with binding tonnage limits that met the stringency requirements established in H.R. 2454. The intra-company cap-and-trade programs discussed above can be easily adapted to a government-administered national plan.

Leaving out a great many details, here are the core elements of a Mexican Emissions Trading Scheme (ETS):

- Mexico would establish the point of regulation at the CFE generating-facility level and the Pemex oil and gas field, refinery, and petrochemical plant.
- Mexico would establish a CO_2 monitoring-and-reporting system at each emitting CFE and Pemex facility that would monitor and report the carbon content of all fuels leaving Pemex refineries.
- Using that system, Mexico would monitor emissions at all regulated sources and create an emissions inventory and directory.
- Mexico would establish annual caps on emissions from the regulated sources for the period 2012–2020.
- Mexico would create allowances equal to the cap. Mexico would then decide the distribution of the value of emissions allowances throughout the economy. For example, Mexico could distribute those allowances to all regulated entities pro-rata on the basis of their monitored and reported emissions for a chosen benchmark year.Alternatively, Mexico could hold auctions of allowances and require regulated entities to purchase allowances in these auctions. In this case, Mexico could designate auction

revenues to a variety of desired outcomes.

- Each regulated entity would be required to surrender allowances on a determined day each year equal to the past year's emissions.
- Allowances in excess of an entity's need can be sold to other entities on a market Mexico would establish.
- Allowances could be banked from one year to the next.

The Mexican emissions trading scheme could be expanded to include other large industrial emitting entities in the private sector. Domestic offset provisions (like those in the U.S. legislation) for agriculture and waste management could be added as well.

4. Key Issues

This section discusses the following range of issues critical to the development of new GHG mitigation policies in Mexico: Mexico's experience with the Clean Development Mechanism (CDM), the potentially regulated electricity and oil and gas sectors, competitiveness, and distributional effects.

Mexico's Experience with the Clean Development Mechanism

By some measures, Mexico has been one of the top performers under the CDM established by the Kyoto Protocol. As of November 1, 2009, Mexico had 119 registered projects, resulting in more than nine million Certified Emission Reductions (CERs).[5] By 2012, Mexico is expected to be responsible for having reduced 64 million tons of GHG emissions through the CDM. Only China, India, and Brazil have more registered CDM projects. Moreover, a major brokerage firm rates Mexico as the fourth highest–ranking country for CDM investment potential, behind India, China, and Chile.[6] Although Mexico may have a relatively large number of CDM projects, individual projects tend to be of a relatively smaller scale.

At the same time, according to measures of absolute volumes of emissions reductions, Mexico lags behind countries such as China, India, and Brazil. For example, Brazil is expected to reduce more than double the amount of emissions (175 million tons) as Mexico by 2012, with India and China far outperforming both; South Korea, which currently has only 34 registered CDM projects, is expected to outperform Mexico in 2012 by about 40 million CERs.

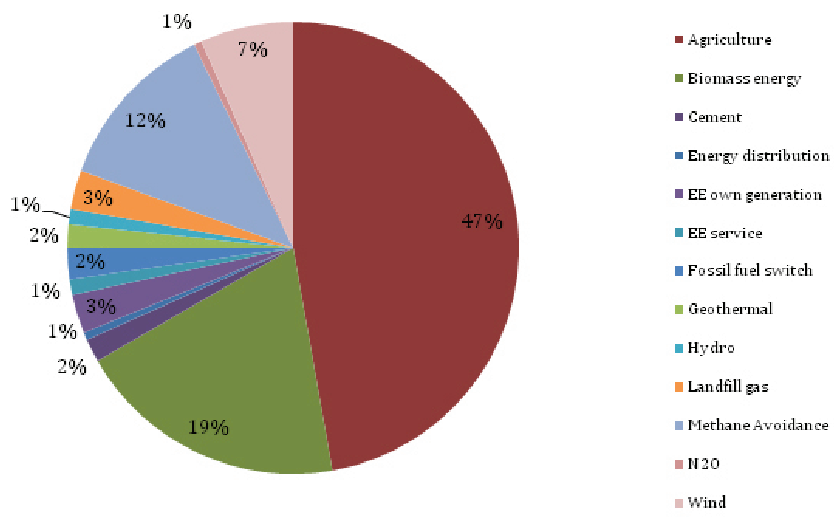
Mexico's current suite of CDM projects, illustrated in Figure 4.1 below, heavily focuses on meth-

5 UNEP Risoe CDM/JI Pipeline Analysis and Database, January 2009, http://cdmpipeline.org/ (accessed November 1, 2009).

6 Point Carbon, CDM Country Rating January 2009, http://www.pointcarbon.com/research/carbonmarketresearch/cdmhost-countryrating/cdm/?quickfinder (accessed July 10, 2009).

ane-related projects. Agriculture, biomass energy, and methane avoidance account for 78 percent of project types, with all other land-use and energy-related projects lumped into the remaining 22 percent. This reliance on methane-based projects differs from many other developing nations. Worldwide, methane-related projects account for only 26 percent of all CDM projects, on par with hydropower projects (27 percent). A focus on more energy-related projects would bring Mexico's CDM portfolio more in line with those of other CDM countries.

Figure 4.1.Distribution of Mexican CDM Project Types as of 2009



Source: UNEP Risoe Centre. 2009.

Various reports, including a Mario Molina Center study (2008), assert that Mexico has not come close to realizing its full potential for CDM projects. Substantial untapped CDM opportunity remains in Mexico's energy sector, in particular. Studies including a 2009 World Bank report indicate that the country could achieve up to 100 million tons of GHG reduction per year in the energy sector alone (Sustainable Development Department 2009). According to that World Bank report, roughly half of this potential lies in petroleum production (Pemex) and electricity generation (primarily CFE and, until CFE took it over in 2009, Mexico's smaller public electric utility, LFC). Additionally, Mexico currently receives far fewer CDM credits related to wind and hydropower than other CDM countries. One major reason South Korea will achieve more 2012 CERs than Mexico, despite having only two-fifths as many projects as Mexico, is because of its heavy use of hydropower for CDM credits.

To summarize, Mexico has a fairly strong performance in terms of the number of projects approved. This outcome is encouraging with respect to the development of an infrastructure that positions the country for expanded CDM use. However, the projects realized in Mexico generally have been small in scale and have not taken advantage of substantial opportunities in the energy sector. Several possible explanations exist for Mexico's comparatively weak CDM performance, including official and regulatory obstacles in Pemex and CFE, underperformance of Mexico's favored CDM project type, and general difficulties with the CDM process.

Official and regulatory obstacles in Pemex and CFE

The publicly owned, monopolistic nature of Pemex and CFE can create multiple barriers. The government sets annual capital budgets and allocates resources, which can make it difficult to set aside funding specifically for CDM project development. Within these capital budgets, CDM projects compete for funding with core business activities such as exploration and production at Pemex, which are the top budgetary priorities and typically offer a higher rate of return.

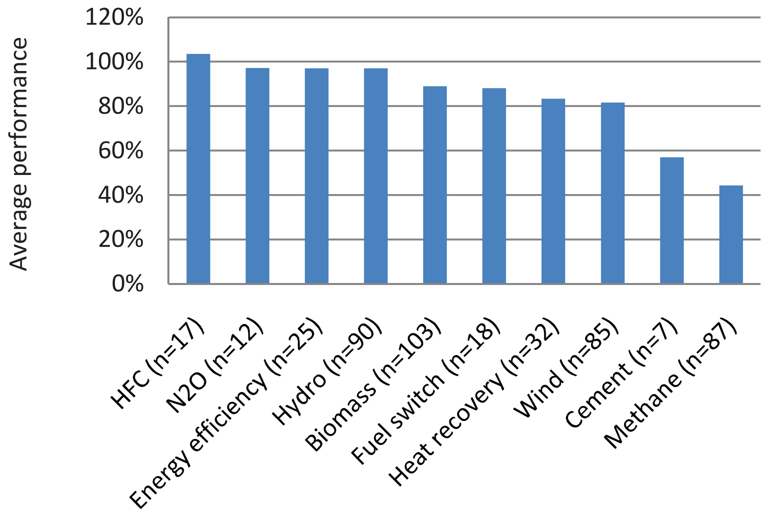
Also, CFE and Pemex operate with the intention of reducing short-term costs to consumers as much as possible. This prioritization may favor reliance on cheap and dirty forms of energy generation and can exclude cleaner, more expensive sources of energy that might qualify for CDM credits. Independent power producers (IPPs) are similarly affected by requirements to provide lowest-cost energy. Efforts to increase energy efficiency and advance new technologies, which often attract private investors, stagnate because incentives are inadequate to drive progress (Sustainable Development Department 2009). As mentioned, Pemex faces budgetary restrictions that prioritize energy production over other items such as energy efficiency CDM projects. Additionally, several interviewees reported concerns about the complex and lengthy coordination between offices and working groups required to establish new CDM projects.

Performance of selected CDM projects

As noted, the vast majority of CDM projects in Mexico have involved methane capture, including agriculture, biomass energy, and methane avoidance. While these projects are likely desirable "low-hanging fruit" and can be implemented without having to navigate the Pemex and CFE bureaucracies, methane projects in general are more likely than other project types to underperform and can be difficult to verify. Figure 4.2 below shows performance of methane projects in relation to other project types. The performance rating for projects is a ratio of the average number of CERs issued and the average number of CERs expected. The results are expressed as a percentage.

Mexico's heavy reliance on methane projects likely prevents the country from achieving anticipated CERs on the same level as other major CDM countries. Figure 4.3 shows the relative performance of five of the top six CDM host countries in terms of 2012 CERs. Chile, which has fewer projects and expected 2012 CERs than Mexico, outperforms Mexico by more than 20 percent in terms of achieving expected reductions. If Mexico continues to rely on mostly methane-related projects, it will likely result in its sustained underperformance with the CDM.

Figure 4.2 Relative Average Performance of Different CDM Project Types



Source: Boisnier 2009.

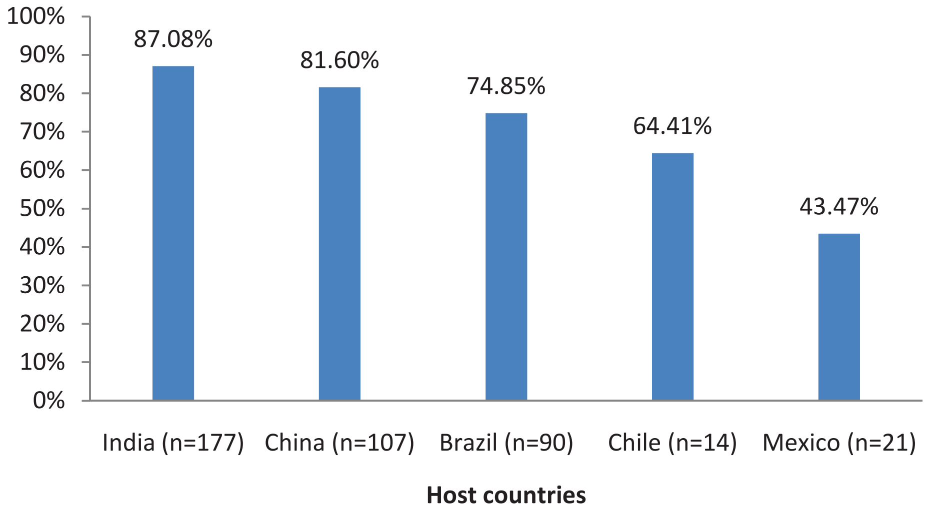
General problems with the CDM process

All countries must suffer multiple barriers that are endogenous to the CDM process, but some barriers appear to stymie Mexico's efforts specifically. Designated Operational Entities, which are the bodies responsible for registering and verifying CDM projects, must contend with complex and confusing rules for project validation and verification. A lack of staff technically skilled in processing CDM projects in Mexico delays the process and can lead to incorrect registration of some projects. In addition to these issues, project methodologies are often limited and can be inflexible. The intricate rules governing CDM projects can stifle innovation and adaptation of methodologies to fit circumstances on the ground. Many projects in Mexico that appear to be useful means of emissions reduction have not immediately been ready to fit into the CDM guidelines. Making them CDM-ready requires additional time, staff, and other resources, which can discourage project sponsors.

Improving Mexico's CDM performance

It is important to note that Mexico currently has a number of robust climate-related institutions. Historically, the problem lay not with institutions that govern the CDM process, but rather with the institutions responsible for implementing the CDM-eligible projects, namely Pemex and CFE. Recently, Pemex has introduced reforms to take better advantage of the CDM, including de-

Figure 4.3.Relative average performance of top CDM host countries.



Source: Boisnier 2009.

veloping business models for CDM projects and identifying potential projects. See section 4.3 for further discussion of these policies. These reforms should help move the organization in the right direction.

Diversifying its CDM project portfolio is a key issue for Mexico. Continued reliance on methane-based projects will not spur growth in Mexico's volume of CERs over the long term. A focus on improving institutional coordination and communication combined with cultivating various project types and robust training of professionals who are well-versed in technical and administrative issues will likely improve Mexico's performance in the CDM.

Potential Regulated Sector: Electricity

Identifying emissions sources and mitigation prospects

Emissions sources

The electricity sector contributes roughly 18 percent of Mexico's GHG emissions through combustion of fossil fuels for electricity generation (Quadri de la Torre 2008, 15). As is apparent in Table 4.1, emissions from Mexico's electricity sector grew substantially between 1990 and 2006, largely due to population growth and related growth in electricity demand.

Table 4.1. 1990–2006 Emissions from Electricity Generation (million tons CO_2 equivalent, excluding fugitive emissions)

Year	1990	1995	2000	2006
Electricity emissions	66.8	77.6	110.7	112.5
Population (millions)	81.3	91.2	100.3	107.4
GDP (billion *pesos*, 2003 price base)	5,270.8	5,679.7	7,406.5	8,526.0

To understand what drives emissions from the electricity sector, it is necessary to first understand Mexico's electricity generation and consumption dynamics. Sector consumption has grown at an average annual rate of 3.9 percent over the last decade, generally outpacing the growth in gross domestic product, which grew at a rate of roughly 2.7 percent over the same period. On an interannual basis, GDP and consumption are correlated, reflecting the important role industrial activity plays in electricity demand. Industrial consumption represented 59 percent of total domestic sales in 2007. Two-thirds of this consumption came from medium-sized business, and the rest was by large industry (such as iron, steel, glass, and aluminum). The residential sector constituted 25 percent of electricity consumption in 2007, while commercial consumption and public services consumed 11 percent, and agricultural pumping consumed 4 percent. The largest growth rate in electricity consumption over the last decade came from medium-sized business (4.7 percent annually), followed by the residential sector (4.5 percent per year). It is also noteworthy that load curves representing the relationship between periods of peak consumption and average consumption are relatively flat over the time of day for the country as a whole, unlike those for the United States.

Installed electricity generation capacity totals 59 gigawatts (GW), with the lion's share (51GW) for public service. Public utility CFE is the largest operator, accounting for 65 percent of the country's total electricity generation capacity. CFE also is the sole purchaser of power from independent power producers, which account for another 19 percent of domestic capacity. The smaller public utility LFC accounted for 2 percent of electricity capacity until CFE took over its operations in October 2009. The private sector includes cogeneration (5 percent), self-supply (6 percent) and exports (2 percent). Independent power producers are the fastest-growing segment of power production in percentage growth rate terms. Overall, however, the greatest absolute growth continues to come from CFE. Electricity production corresponds roughly to capacity, although independent power sold to CFE has a relatively high utilization rate (28 percent of generation, though only 19 percent of domestic capacity) compared to CFE's fleet of plants. Nonetheless CFE plants (including those formerly operated by LFC) contribute 61 percent of total generation.

CO_2 emissions correspond directly to the fuel and the efficiency of technologies used for generation. Public service generation's 51 GW capacity includes 12 GW of non-emitting sources (mostly hydro and more than1 megawatt (MW) nuclear), roughly 5 GW coal, 13 GW conventional thermoelectric using natural gas or fuel oil, 17 GW combined cycle, and 3 GW gas turbine. Coal-fired power is the highest emitting source and is located in two regions—the northeastern and south–southeastern parts of the country. Actual generation varies somewhat from this capacity mix. Combined cycle plants contribute the greatest share of generation (44 percent in 2007), and conventional thermoelectric facilities generate the second largest share (20 percent in 2007). Coal-fired generation contributes roughly 12 percent of generation.

In its *Electricity Outlook 2008–2017*, the government forecasts that annual electricity consumption will grow 3.3 percent per year over the next decade, compared to 3.9 percent annually in the previous decade (SENER 2008). The growth rate is expected to decline for most users except for agriculture. Currently about 2 GW of capacity are under construction, and another GW is in the bidding process. The majority is non-emitting (hydro, geothermal, and wind), and roughly 1 GW is combined cycle. However, the coal-fired Guerrero plant, which is expected to bring 678 MW of power online in 2010, will affect emissions.

Over the longer term, combined cycle is expected to add 7.5 GW of capacity by 2017, and coal is forecasted to add another 700 MW by 2017. Cumulative additions from non-emitting sources are expected to be of comparable magnitude. The potential shape of climate policy will affect the profitability and relative performance of these investments in an important way.

Prospects for emissions reductions

Ample room exists for emissions reductions within the electricity sector. The government's PECC aspirational targets aim to reduce electricity-sector emissions from 112.5MtCO_2e in 2006 to 15.3MtCO_2e by 2050, an almost 90 percent reduction. Studies such as the MEDEC (Johnson et al. 2009), Mario Molina Center (2008), and Quadri de la Torre (2008) reports consistently cite the electricity sector as a key component in achieving the country's abatement potential, with electricity sector opportunities comprising roughly a quarter of tons mitigated in various GHG reduction scenarios. Electricity sector emissions can be reduced by improving either emissions intensity (the ratio of GHG emissions relative to economic output) or energy intensity (the ratio of energy consumption relative to economic output).

Emissions intensity of electricity. Emissions reduction efforts that focus on emissions intensity aim to improve (or reduce) the ratio of GHG emissions to output. One of the greatest opportunities to improve the electricity sector's emissions intensity is to replace conventional thermoelectric generation with natural gas combined cycle generation and, to the degree possible, non-emitting generation from nuclear or renewable sources. Over the last decade, conventional thermoelectric generation has fallen 5 percent per year but still constitutes one-fifth of total generation. High-emitting coal-fired generation has changed very little over the last decade, growing at just 0.3 percent per year, reflecting greater use of unchanging capacity over this time frame. However, investment plans could see a substantial increase in the role for coal under some scenarios.

Studies of emissions abatement opportunities tend to find significant low-cost and high-impact abatement potential in various strategies that address emissions intensity of electricity. The Mario Molina Center study (2008), to which McKinsey & Company contributed data and analysis, sees the shift from oil to gas as its largest single abatement option for the power sector (21.0 $MtCO_2e$ potential annual abatement by 2030) and estimates a relatively low cost of $10/$tCO_2e$ of doing so. The study highlights non-emitting generation from renewable sources as one of the cheapest power sector options, which it estimates costs $-12.20/$tCO_2e$ abated (net savings) for geothermal plants and $-5.40/$tCO_2e$ (also net savings) abated for small hydro plants; total abatement potential is also quite large, at 10.3 and 15.0 $MtCO_2e$ per year, respectively, for each technology by 2030. Quadri de la Torre's (2008) broader, less site-specific estimates of geothermal costs (drawn from general Intergovernmental Panel on Climate Change and CDM estimates) are more expensive and variable at $25–$205/tCO_2e. Regardless, he recommends doubling geothermal capacity by 2020. Similarly, Quadri de la Torre cites various more expensive hydropower costs, ranging from $2.72–$17.40/t up to $41–$205/tCO_2e abated. His cost estimates are not specific to the small-scale hydro plants the Mario Molina Center study recommends, which could explain some of the discrepancy in cost estimates.

Use of non-emitting nuclear, wind, and solar power plants also represents similarly large abatement potential, though cost estimates tend to be substantially higher, with the Mario Molina Center/McKinsey (2008) study estimating $25.5/$tCO_2e$ for nuclear; $30.60 and $54.60/$tCO_2e$ abated from onshore and offshore wind, respectively; and $31.70 and $51.70/$tCO_2e$ for solar photovoltaics and concentrated solar power, respectively. Quadri de la Torre (2008) also cites high cost estimates for nuclear, wind, and solar, ranging from $20 to $245/t abated for nuclear power, $14.82–$23.70/t up to $184/t abated for wind power, and $34/t up to $513¬–3,285/t abated for solar photovoltaics.

Energy intensity of economic activity. The second broad opportunity for electricity sector emissions reduction comes from reducing the energy intensity of economic activity—that is, the ratio of energy consumed to economic output.

Since the rate of growth in electricity use has outstripped the rate of growth in GDP, it would appear that there are opportunities to improve the efficiency of end use. Some policies identified in the PECC explicitly aim to do this. Energy intensity of economic activity can also be reduced by cutting losses associated with transmission and distribution, which reportedly total more than 16 percent of total generation and 17.4 percent of public service generation (SENER 2008; Johnson et al. 2009, 15). A large portion of these losses are not due to technical factors but instead to pirated electricity. If line losses including theft were reduced, it would bring new demand into the electricity market, providing opportunities for reduction in energy intensity of economic activity. Electricity consumption is likely to grow relative to other types of energy use because of greater use of consumer and production electronics and perhaps ultimately the emergence of electric vehicles. However, for the electricity sector to realize this growth potential, it also must improve the overall efficiency of production, delivery, and use of power.

Various studies cite ample opportunity to mitigate end-user emissions by implementing low-cost energy efficiency measures. According to Mexico's National Energy Savings Commission (CONAE), more than 20 percent of Mexico's electricity consumption could be reduced through cost-effective energy efficiency measures (CTF Trust Fund Committee 2009). The MEDEC study highlights various negative cost (or net benefit) end-user measures. For example, it finds a large potential abatement opportunity in a residential lighting program that substitutes all home lightbulbs with compact fluorescent lighting, abating 10 $MtCO_2e$ annually by 2030 at a cost of $-38/$tCO_2e$ (a net benefit) (Johnson et al. 2009). The Mario Molina Center (2008) study finds 11.4 $MtCO_2e$ abatement potential for efficient lighting measures in buildings at costs ranging from $-160 to $-142.80/$tCO_2e$. The Mario Molina Center study also finds various other mostly negative-cost building and home efficiency measures that range in cost from $-140.90 to $52.40/$tCO_2e$. Cogeneration in various industries also would be cost-effective and substantially contribute to abatement efforts. According to the MEDEC study, cogeneration in the cement industry would mitigate 2.1 $MtCO_2e$ annually by 2030 and cost $-38/$tCO_2e$ (a net benefit), while cogeneration in the iron and steel industries could reduce emissions by 6.1 $MtCO_2e$ per year in 2030 and cost $-110/$tCO_2e$ (also a net benefit) (Johnson et al. 2009). The Mario Molina Center/McKinsey (2008) similarly finds negative costs for iron and steel cogeneration ($-116 to $-107/$tCO_2e$), though it estimates a positive cost of $22.30/$tCO_2e$ for cement industry cogeneration.

Current electricity policies

Constitutional provisions establish that electricity generation (though the generation mandate was repealed in 1992), transmission, distribution, and supply for *public service* are exclusively the federal government's responsibility. As a result, the electricity sector is dominated by state-operated CFE, which owned two-thirds of Mexico's installed electric generation capacity in 2009. The autonomous Energy Regulatory Commission (Comisión Reguladora de Energía, CRE) regulates the electricity and natural gas industries, promotes their efficient development, and grants private generation permits.

Reforms to the Electricity Public Service Law in 1992 opened up the government's electricity generation monopoly to participation from private companies. The regulator CRE thus now grants permits for five types of generation not considered for public service: self-supply for plants built by private companies for their own use; cogeneration, which must be self-used or sold to CFE, not to the grid;[7] independent power producers who have more than 30MW generation capacity and sell capacity exclusively to CFE through power purchasing agreements; imports and exports; and small-scale generation of up to 30MW capacity, which is operated by private companies and sold to CFE without a power purchasing agreement. Thus electricity generation is open to private companies, while transmission and distribution remain state-run, and CFE operates the national transmission grid.

Electricity tariffs

Electricity tariff methodologies and prices vary substantially across customer classes. Certain electricity class prices are subject to automatic monthly adjustments reflecting factors such as fuel price variations and inflation, except in the agricultural sector, where fees are adjusted annually. The agricultural sector has the lowest prices of any sector and, correspondingly, the highest subsidies per customer; agricultural customers' electricity prices covered on average only 30 percent of CFE and LFC costs in 2006 (Komives et al. 2009, 3). Residential customers have the second highest subsidies per customer; as an aggregate amount, residential subsidies comprise roughly two-thirds of total electricity subsidies. The price paid by the average residential customer in 2006 covered only 41 percent of costs (Komives et al. 2009). The commercial sector pays the highest tariffs—prices are more than five times greater than those faced by agriculture—and effectively ends up cross-subsidizing other customer classes, such as residential customers. Medium-sized business, large industry, and the residential sector, which collectively constitute 84 percent of demand, face fairly similar prices, which are up to about twice the price paid by agriculture. Industrial and medium-to-large commercial customers also face time-of-use prices.

Electricity subsidies, defined as the difference between electricity price to consumers and the average cost of supply, have historically been financed by a government discount to taxes and *aprovechamiento*, a dividend equaling 9 percent of net fixed assets that the utility pays to government. In recent years, as electricity costs have rapidly outpaced subsidized electricity tariffs, subsidies have surpassed the *aprovechamiento*. Although this may be accounted for as an insufficient *aprovechamiento* or return on investment against the utility's assets, a bookkeeping transfer from the government effectively has financed subsidies (CTF Trust Fund Committee 2009, 19). Only a small portion of residential users pay the marginal cost of electricity services, and the fee structure generally does not allow for cost recovery. Compared to other Organisation for Economic Co-operation and Development (OECD) and middle-income Latin American countries, average residential electricity prices in Mexico are among the bottom third of the distribution (Komives et al. 2009, 8). Utility cost recovery aside, electricity subsidies insulate end-users from true costs and discourage demand-side conservation and associated emissions reductions. A tariff review in 2002 attempted to address tariff structure incentives that discourage conservation by adding a "DAC" or High Consumption Residential Tariff for homes with the highest consumption volumes; yet the simultaneous creation of a new, more heavily subsidized summer tariff category and the ensuing reclassification of many customers into more subsidized tariff groups contributed to further subsidy growth. Recent trends are not promising as subsidy growth rates have been substantial; subsidies to CFE consumers in 2008 were expected to be $87 billion pesos (29 percent higher than the previous year) while subsidies to LFC consumers were estimated at $46 billion pesos (12 percent higher than the previous year)(SENER 2008, 94).

Recent electricity reform

Mexico's government has passed and begun implementing a wide range of electricity sector reforms during the Calderón administration that potentially lay the groundwork for lower sector emissions. In late 2008 and early 2009, the legislature approved a law that is key to driving GHG reductions from the electricity sector. The Law on Renewable Energy Use and Financing the Energy Transition substantially improves the legal framework and incentives for private investment in renewable projects. The law expands permit-granter CRE's powers regarding renewables. By law, CRE verifies that provision of electricity uses the lowest-cost option that offers optimal stability and quality for the grid. Yet, this new law opens the opportunity to take into account "potential net economic benefits." Thus, renewable generators could be dispatched ahead of conventional sources that may seem less expensive when externalities are excluded, and the law dictates that compensation should include payment for both generation cost *and* capacity cost. Compensation can vary by technology and location of the projects. CFE is obligated to receive and thus pay for reasonable amounts of surplus production.

This reform details specific tasks for Mexico's Ministry of Energy (*Secretaría de Energía*, SENER) and regulator (CRE) as they move into the reform implementation phase. SENER is charged with developing and coordinating the implementation process and must establish renewable participation targets, which will grow based on economic viability. The targets will be expressed in terms of a minimum percent of renewable installed capacity and electricity supplied. SENER must also develop (with input from the Treasury and Environment and Health Ministries) a methodology to value externalities associated with electricity generation based on renewables at various project sizes, as well as any other policies in the act associated with externalities. The new law empowers regulator CRE to issue various new renewable energy rules, methodologies, and procedures, including: grid interconnection rules for renewable and cogeneration; energy exchange procedures and compensation systems; methodologies to determine the capacity and generation charge, as well as surplus energy compensation, for renewables and cogeneration; and guidelines to utilities for entering into long-term contracts with renewable generators. The law also creates an Energy Transition and Sustainable Energy Use Fund with an annual budget for the 2009–2011 period allotted from the federal budget.

Beyond efforts to reduce emissions at the source through, for example, the promotion of renewables, Mexico's recent reforms have also targeted end-user emissions through energy efficiency measures. The Sustainable Energy Use Law was signed at the same time as the Renewable Energy Law and establishes energy efficiency programs and bodies, including a national program to promote energy efficiency, which has a lighting efficiency mandate, a National Commission for Energy Efficiency to promote incorporation of energy efficiency measures by government and companies, and an Advisory Council and National Information System. All of this critical groundwork indicates substantial promise for abatement in the electricity sector; how implementation progresses and whether institutional barriers are overcome remains to be seen.

Institutional and operational barriers to reform and emissions reduction

Institutional barriers to implementation of electricity reforms and investment in emissions reductions are many. As with Pemex, CFE typically experiences unique challenges as it is burdened by various political, funding, and administrative requirements. Investment in new or upgraded electricity infrastructure, let alone GHG mitigation, is a challenge as electricity costs have rapidly grown in recent years while growth in subsidies has kept tariffs down and thus prevented utilities from recovering their full generation costs. Barriers to reform include:

- *Heavy subsidies discourage conservation and drain resources.* Substantial electricity subsidies reduce consumers' incentive to conserve electricity and thus fuel the country's rapid demand growth. This exacerbates funding *needs* for new capacity investment, while potentially reducing funds available to invest in new capacity as subsidies potentially reduce investment capital available. The subsidies represent a potential drain on scarce funds, as some argue that not enough is invested in maintaining grid infrastructure or reducing distribution line loss.

- *Flexible budget line not linked to actual costs.* State utilities can operate with budget deficits year after year (as was the case with LFC) and still remain in business as the government provides direct transfers. Operations do not directly determine available capital, salaries, or even ultimate survival of the utility. Without a firm budget line, long-term capital expenditure planning and cost-reduction efforts can be quite difficult.

- *Inefficiencies.* In line with the previous point, when "parastatal bodies" such as the state-run utility are supported by the government, which covers operational deficits, there is little incentive to improve efficiency and cut costs. Lack of competition or a firm budget tends to make state-run entities inefficient at various points in the supply chain, including: oversupplying inputs (labor); purchasing inputs at higher costs; using outdated technologies; and under-billing or failing to collect bad debt (ESMAP et al. 2004). For instance, these pressures may be at play in the high 21 percent operating reserve margin reported in Johnson et al. (2009, 14), compared to a typical 15 percent operating reserve margin elsewhere; this figure is consistent with the 24.7 percent operating reserve margin reported for 2007 and 21.3 percent margin forecasted for 2008 in Mexico's 2008 Electricity Sector Outlook (SENER 2008, 128). This higher operating reserve margin could be a result of actual growth levels failing to reach the official growth estimates used for long-term economic planning. Regardless, given the political pressure sometimes exerted on state-run entities and a lack of the price-cutting incentives inherent to private companies, construction of power plants could be motivated in part by non-economic factors that encourage excess capacity.

- *Public administration rules*. CFE is subject to various public administration and civil service requirements on hiring, raises, procurement. Thus operational costs, including employment levels, that may adjust to market conditions or earnings in a private company are insulated from such changes in CFE.

- *Low prioritization of emissions reduction in the face of scarce capital.* Given the rapid growth in electricity demand and limited capital for infrastructure investment in some of the fastest-growing areas (Mexico City's former utility LFC had run an operational deficit in recent years, for example), available capital is likely to be diverted to broader infrastructure investment, such as meeting demand growth or maintaining ailing infrastructure, rather than to GHG mitigation. This is true despite the fact that many of these investments could save money and reduce the need for new capacity.

- *Low electricity tariffs could discourage independent renewable energy generation.* Questions remain about whether compensation from CFE to independent power producers would be sufficient given the difference between government-mandated low electricity tariffs and potentially higher electricity costs (the consumer subsidy). Given recent electricity reforms that alter the lowest-cost provision to account for externalities and net economic benefits of renewable generation, these issues may be resolved as reforms are implemented.

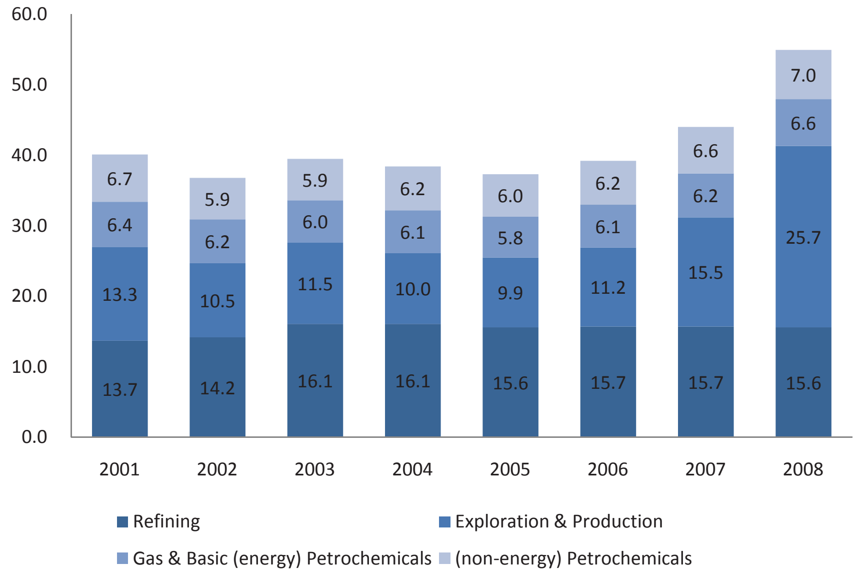
- *Lack of renewable and energy efficiency financing instruments.* Lack of adequate financial instruments to advance renewable and energy efficiency projects creates a barrier to such investment. A Climate Investment Funds report argues that a lack of initial investment capital, lenders' risk aversion for new product lines, a lack of access to risk capital to prospect renewable projects, a lack of incentives or cost-benefit analyses of new technologies, and a lack of expertise to structure such deals hinders development of renewable and energy efficiency projects (CTF Trust Fund Committee 2009, 12).
- *Lack of information on renewable resources.* Renewable energy development is also impeded by a lack of basic types of prospective information on available renewable resources, such as a detailed map of the country's renewable resources. While a resource map is under development, both government authorities and potential investors would need such information on hand before planning and investing in renewable resource development.

Potential Regulated Sector: Oil and Gas

Identifying emissions sources and mitigation prospects

Emissions sources

Figure 4.4. Pemex CO_2 Emissions by Subsidiary (million tons)



Pemex contributes roughly 12 percent of Mexico's GHG emissions through the various stages of hydrocarbon production (oil and gas extraction, refining, and processing). Taking into account end-use of Pemex products, however, Pemex's ultimate GHG impact is much larger, as the transportation sector emits an additional 18 percent of Mexico's GHG emissions. Pemex emissions come from six refineries, ten gas processing complexes, seven (non-energy) petrochemical plants, and multiple exploration and production installations—including leaks and venting along different points in the hydrocarbon supply chain.[7] According to 2002 data, Pemex's emissions are composed of fugitive methane emissions (from production, transport, and transformation), which contributed 6 percent of the country's GHG emissions (roughly half of Pemex's total emissions), while oil refining contributed the remaining 5.62 percent of emissions (National Ecology Institute 2006; Quadri de la Torre 2008). As is apparent in Figure 4.4, for most of the last decade Pemex's Refining subsidiary emitted the largest portion of emissions, ranging from 34 to 42 percent of company-wide emissions. The Exploration & Production (E&P) subsidiary followed close behind, contributing 26–35 percent of total Pemex emissions. In 2008, however, E&P emissions spiked to 47 percent of total Pemex emissions due to flaring and venting of high nitrogen–content sour gas from the Cantarell field in the Gulf of Mexico (Pemex 2008).

Prospects for emissions reductions

Opportunities for emissions reductions within Pemex's operations include: reducing flaring and venting by re-injecting gas for pressure maintenance or using associated gas for processing or petrochemical production; reducing leakage from compression systems and gas transport; cogeneration; and improving efficiency of boilers, pumps, compressors, turbines, and motors. In terms of sheer size of mitigation opportunities, a Mario Molina Center (2008) study undertaken with analytical contributions from McKinsey & Company argues that flaring reduction represents the greatest opportunity for near-term emissions reductions in the industry. Given the spike in 2008 (and bump in 2007) Exploration & Production emissions apparent in Figure 4.4, this argument seems plausible; more than 1 billion cubic feet of natural gas produced on offshore oil platforms are currently flared per day, emitting 26 $MtCO_2e$ per year (Mario Molina Center 2008, 40). Reducing flaring and venting would cost $56.40/t according to the Mario Molina Center (2008) study and roughly $0–$60/t, depending on the degree of the reduction, according to Quadri de la Torre (2008). The Mario Molina Center study estimates flaring emissions reduction potential at 4.7$MtCO_2e$ in 2030. Emissions from flaring should drop on their own by 2030 as production from some of these offshore installations declines.

In the refining and petrochemical businesses, cogeneration could take advantage of wasted heat to generate electricity for use in oil transformation processes. Johnson et al. (2009) also highlight Pemex's significant cogeneration potential, finding that cogeneration at Pemex facilities could provide more than 6 percent of the country's current installed power capacity or roughly 3,700 MW potential capacity. Cogeneration costs estimates range from $-28.60/$tCO_2e$ (a net benefit) (Johnson et al. 2009) to U.S.$2.80/$tCO_2e$ (in 2030) (Mario Molina Center (2008) to $20–$50/tCO_2e, according to Quadri de la Torre (2008), who draws from broader IPCC cost estimates. Various energy efficiency and process improvement measures appear among the most cost-effective as

7 Above figures come from Pemex emissions data; however, Johnson et al. (2009) note only four petrochemical plants.

studies estimate costs ranging from $-120 (a net benefit) to $11/ton (Mario Molina Center 2008) and $-4.40 (a net benefit) to $16.60 (Johnson et al. 2009). The Mario Molina Center study estimates that various energy efficiency measures in the oil and gas industry have the potential to mitigate more than 5MtCO_2e emissions in 2030.

According to PECC (Federal Executive Branch 2009), Pemex has identified 47 projects to improve thermal efficiency, ten to increase electricity efficiency of its processes, and three cogeneration projects that together have the potential to reduce 5.8 MtCO_2e annually with a $1.518billion–dollar investment. Pemex also has an ongoing project to recover, compress, and re-inject sour high nitrogen–content gas in Cantarell in the Gulf of Mexico as part of the actions to reduce offshore gas burning and avoid 7MtCO_2e annually. This project would require a roughly $2.407billion–dollar investment (a figure that includes complementary projects to increase production). The government established upstream oil and gas performance targets through recent regulatory changes, and thus Pemex incorporated venting and flaring reduction into its targets for its 2008–2012 operational efficiency program. Given production shortfalls and Pemex's capital constraints, it is questionable that adequate funding will be available internally to complete these projects.

Pemex has begun laying the groundwork for international support for emissions reduction efforts. In November 2004, Mexico joined the Methane to Markets alliance, which receives technical support from the U.S. EPA. Through this alliance, Pemex has worked on developing a GHG emissions inventory (covering methane and CO_2e) and an energy efficiency evaluation. This has resulted in technical reports aimed at improving operations and reducing emissions. And, as mentioned in section 3.4, the company also developed a voluntary internal emissions permit market that operated until 2005. Pemex designed the program to identify inexpensive carbon abatement options as its subsidiaries competed with one another to reduce emissions using virtual *pesos.* While the market never reached an obligatory phase and ceased operations in 2005, the fact that a comprehensive market framework already has been designed could help facilitate creation of an intra-company trading program in the future.

Although few CDM projects have dealt with Pemex emissions, Pemex has inched toward progress in developing CDM project building blocks. In 2007, the company developed a CDM business model or framework that is made up of legal instruments—a general collaboration agreement, a letter of intent, and an Emission Reduction Purchase Agreement—and a formula to determine the price of Certified Emission Reductions (CERs), which the Treasury authorized in 2008. Various potential CDM projects were identified at the close of 2008 dealing with thermal efficiency, electricity, operations, and cogeneration. In 2008, Pemex signed letters of intent for three projects whose Project Design Documents are being developed (Pemex 2008).

Role of ongoing financing reforms

Given the multiple challenges inherent to a state-run oil and gas monopoly, recent administrations have attempted to reform Pemex and the oil and gas industry. Many institutional challenges that undermine emissions reductions efforts are identical to the institutional barriers that pose challenges across the company—for example, barriers to increasing investment in exploration efforts to ensure future revenues. The capital allocation challenges that arise out of a lack of a firm budget line and variable government-set funding levels have impinged on investments in future reserves, discouraged international technical and financial assistance, and reduced the resources available to emissions mitigation projects.

Table 4.2. Potential Pemex CDM Projects

Group	Type of CDM project	Estimated reduction (tCO_2e/year)
Exploration & Production	Cogeneration, recuperation of fugitive emissions	257,000
Gas & Basic Petrochemicals	Energy efficiency, cogeneration	484,829
Refining	Energy efficiency, fugitive emissions, vapor system efficiency	1,627,980
Corporate Operations/ Gas & Basic Petrochemicals	Cogeneration	962,456
Total		3,332,265

Note: tCO_2e=tons of carbon dioxide equivalent.

Source: Pemex 2008, 61.

President Vicente Fox's administration attempted various free market reforms to attract foreign capital to fund oil drilling and production that ultimately did not succeed. For instance, the Fox administration attempted to use Multiple Service Contracts (MSCs), which allow private firms to subcontract to develop projects that bring in foreign companies' capital and expertise, as a solution to capital and technological constraints. But legal challenges from the legislature over the constitutionality of MSCs followed, and foreign companies became discouraged from investing in Mexico.

In late 2008 under the current Calderón administration, the legislature passed Pemex reforms to help counteract falling oil production. Reforms measures include opening Pemex's board to outside industry experts; creating a new advisory board to independently coordinate long-term strategy; establishing the National Hydrocarbons Commission to regulate the sector as well as set technical standards, supervise E&P, and gather best international practices to improve efficiency; increasing Pemex's financial autonomy so the company can issue its own debt and public bonds; and creating mechanisms for procurement and investment. The mechanisms would also allow Pemex to create incentive-based contracts with private companies (although it is ambiguous how these would work); Pemex would maintain full ownership of hydrocarbons and, to meet constitutional requirements, would have to pay in fixed amounts rather than as a percent of production or sales.

While the Pemex reforms represent a key step in the right direction, institutional barriers remain that may prevent full implementation. Many of the reforms have yet to be enacted, and some politicians are complaining about implementation delays. The reforms measures that increase financial autonomy and create investment and procurement mechanisms, in particular, are key to helping Pemex attract adequate capital, set its own budgeting goals, and ultimately reduce emissions. To achieve abatement goals, it is debatable whether investments in emissions reductions would need an independent capital account that is balanced with CDM revenue and operates outside the broader capital budget for Pemex.

Institutional and operational barriers to reform implementation and emissions reductions

Institutional structures, such as a variable state-driven budget, constrain Pemex's capital, undermine efforts to reduce costs, and make capital for emissions reduction efforts hard to come by. Issues/barriers to investment in emissions reductions include the following:

- *Scarce funds as declining reserves reduce capital.* Mexico seems locked in a vicious cycle where oil reserves are depleted faster than they are replaced. Not enough is invested in new exploration activities, production drops, and then even fewer funds are available for investment in new reserves and emissions mitigation.
- *No hard budget line or direct performance incentives.* Pemex's performance and budget are decoupled, as oil revenues go directly to the Treasury, which returns some funds to Pemex depending on current federal budget demands. Pemex thus becomes a source of government funding, and operations do not directly determine available capital, salaries, or even ultimate business viability. Without a firm budget line, long-term capital expenditure planning and cost reduction efforts are difficult to achieve.
- *Inefficiencies.* In line with the previous point, when budget bears little relation to performance, there is little motivation to improve efficiency and cut costs. And as the World Bank notes in the January 2004 *Energy Policies and the Mexican Economy report, l*ack of competition and lack of a firm budget tends to make state-run entities inefficient at various points in the supply chain, including: oversupply of inputs (labor); purchasing inputs at higher costs; using outdated technologies; under-billing or failing to collect bad debt (ESMAP et al. 2004).
- *Public administration rules.* As a government-owned company, Pemex is subject to various public administration and civil service requirements on hiring, raises, procurement. Thus many costs or employment levels that may adjust to market conditions or earnings in a private company remain immutable/largely fixed.
- *Low prioritization of emissions reduction in the face of scarce capital.* Given the federal government's reliance on Pemex for roughly 40 percent of state revenue, when investment capital is available, current production and exploration products are the top priorities, as this directly drives the budget available to the Treasury. In addition, while emissions reduction measures may also save energy and money, with higher returns from exploration and production projects, it is difficult to divert scarce funds to emission abatement projects. Emissions reductions funded with CDM revenue could

constitute an additional revenue source for Pemex, but investments to realize these reductions have to compete with the core business of Pemex production activities for scarce capital under the organization's capital budget cap.

- *High debt limits external credit access.* Pemex is one of the most indebted oil companies in the world (Johnson et al. 2009, iv and 31). High debt coupled with a poor credit rating make accessing financing through international capital markets difficult or overly expensive. Johnson et al. (2009) point out that Pemex's 3.1:1 ratio of debt to proven reserves in 2007 was well above the 0.7:1–2.1:1 ratio range within which Pemex's peers fell. The current recession should only compound the company's difficulties accessing commercial credit.

Competitiveness

In the U.S. debate on a domestic carbon pricing policy, the potential for adverse effects on energy-intensive, import-sensitive domestic industries; domestic jobs; and the nation's balance of trade consistently emerge as significant concerns. Equally important is the potential for erosion of environmental benefits if an increase in domestic costs causes production to shift to nations with weaker climate mitigation policies, or none at all. These concerns are especially compelling if the policy is unilateral, without a corresponding effort from major U.S. trading partners.

The U.S. legislative provisions designed to address competitiveness issues use two mechanisms targeted at potentially vulnerable industries: free allowance allocation (rebates), and trade-related "border adjustment" policies. The former are designed to kick in simultaneously with the introduction of the domestic pricing policy (cap-and-trade), while the latter could begin as early as 2020, based on a series of U.S. presidential findings to start in 2017.

These U.S. competitiveness provisions are relevant to Mexico for at least two distinct but related reasons:

- If Mexico does *not* adopt domestic carbon pricing or other policies comparable to those in the United States, it might ultimately become subject to U.S. trade sanctions which, in turn, could adversely affect its ability to export certain products to the United States;
- If Mexico does adopt domestic carbon pricing or other policies similar to those in the United States without also adopting industry rebates or other such measures, its own energy-intensive, trade-sensitive industries may be disadvantaged in international markets as they face competition from U.S. firms that receive rebates.

Thus, whether or not Mexico adopts domestic carbon pricing policies, measures adopted in the United States to address competitiveness policy are matters of considerable importance to Mexico. As a first step, this section summarizes the evidence on industry-specific impacts of carbon pricing available from studies of the United States and European Union, and examines the relevant competitiveness provisions contained in the recently approved H.R. 2454 legislation.

The evidence on industry-specific impacts from the United States and European Union

Basic economic logic suggests that the industry-level impacts associated with unilateral carbon pricing are fundamentally tied to the energy- (more specifically, the carbon-) intensity of those industries and the degree to which they can pass costs on to consumers—often other industries—of their products. The strength of competition from imports and consumers' ability to substitute other, less carbon-intensive alternatives for a given product play crucial roles in determining the ultimate effects on domestic production and employment. The impacts are likely to be most pronounced in energy-producing industries and major energy-consuming sectors, especially manufacturing.

The most common approach to assessing the effects of carbon-control policies is to focus on the long-run impacts, after firms have adjusted by using new energy-efficient technologies and new import patterns have been established. Computable general equilibrium models are typically used for this purpose. Such analysis, however, fails to capture an important part of the story—the short-run costs that most firms will experience. A chemical or steel plant suddenly faced with higher energy costs cannot immediately convert to more energy-efficient methods without costs.

From a policy perspective, the path taken to the long-run outcome is extremely important. A carbon control policy that ignores these short- and medium-term impacts will raise concerns about fairness, and many stakeholders will likely oppose it. Further, the appropriate policy response can change over time; a policy that addresses fairness questions in the initial years may not be appropriate in the future.

Accordingly, recent economic research has examined four different time scales over which competitiveness impacts might be relevant:

1. The very short run where firms cannot adjust prices and profits fall accordingly.
2. The short run where firms can raise prices to reflect the higher energy costs, with a corresponding decline in sales as a result of product or import substitution.
3. The medium run where, in addition to the changes in output prices, the mix of inputs may also change, but capital remains in place and economy-wide effects are considered.
4. The long run where capital may be reallocated and replaced with more energy-efficient technologies.

Modeling these different time scales presents many technical and data challenges. One recent analysis, using U.S. input–output data for the year 2002, and assuming \$10/t of CO_2, yields the following results (Ho et al. 2008):

- Measured by the reduction in domestic output, a readily identifiable set of industries is at greatest risk of contraction over both the short and long terms. Within the manufacturing sector, at a relatively aggregated, two- or three-digit standard North American Industry Classification System (NAICS) level, the hardest hit industries are petroleum refining, chemicals and plastics, primary metals, and nonmetallic minerals.

- Although the short-run output reductions are relatively large in these industries, they tend to shrink over time as firms adjust inputs and adopt new technologies. The industries that continue to bear the impacts are generally the same ones affected initially, albeit at reduced levels. When measured in terms of reduced profits, the rebound is generally robust and, for some industries, virtually complete.
- Focusing on the nearer-term timeframes, where certain simplifying assumptions enable a more disaggregated analysis, the largest cost increases appear to be concentrated in particular segments of these industries rather than the entire sector. For example, disaggregated industry categories such as petrochemical manufacturing and cement see very short-run cost increases of more than 4 percent, while iron and steel mills, aluminum, and lime products see cost increases exceeding 2 percent. These impacts are considerably higher than those estimated for the relevant two-digit industry categories.
- In the nonmanufacturing sector, the overall size of the production losses also declines over time, although a more diverse pattern applies. Specifically, the impact on electric utilities does not substantially change over time as broader adjustments occur throughout the economy. In contrast, industries such as mining experience a continuing erosion of sales. Agriculture faces modest but persistent output declines over time, while the service sector is largely unscathed across all four timeframes.
- In terms of employment, short-term job losses are modeled as proportional to those of output. Over the longer term, however, when labor markets are able to adjust, the remaining, relatively small losses are fully offset by gains in other industries.
- Although industry definitions in the United States and Europe are not identical, studies from the two nations or nation groups appear relatively consistent. Cement is one notable exception; it appears as the first or second most impacted industry in recent European studies, while it only ranks in the top quarter in the U.S. analyses. The most likely explanation for this difference is the inclusion of process emissions in the European studies whereas the U.S. excludes such emissions. Structural differences between Europe and the United States may also be relevant.
- Overall, the leakage rate from the United States to other countries—that is, the rate at which reductions in U.S. emissions is offset by increases in foreign emissions—is estimated to be about 25 percent. For the three most energy-intensive sectors—chemicals, non-metallic mineral products, and primary metals—the leakage due to imports and exports is more than 40 percent.

Using a fairly standard industry disaggregation scheme, Table 4.3 displays the results for individual industries across different time frames in terms of reduced output, assuming a \$10/t CO_2 charge. Note that these calculations include the higher costs associated with on-site combustion of fossil fuels *and* the higher costs of purchased electricity and other intermediate goods and services. Principally because these estimates include inter-industry purchases derived from the national input–output table, the calculations are quite data intensive. This contrasts with the formulas proposed for determining rebates in H.R. 2454 (see below), which do not include inter-industry purchases.

Competitiveness provision in H.R. 2454

As a first line of defense, H.R. 2454 has designed output-based emissions allowance distributions to level the carbon playing field for vulnerable U.S. industries until effective international climate agreements are in place. If international agreements that meet the specific negotiating objectives of H.R. 2454 are not in place, then, beginning in 2020, the bill includes provisions to establish an international reserve allowance program, requiring that the importers of "covered goods" into the United States from certain countries purchase allowances for the emissions associated with the production of such products.

A key goal of these measures is to compensate the owners of affected manufacturing facilities via production rebates for their GHG emissions costs incurred. The rebates are designed to prevent carbon leakage while also rewarding investments in energy efficiency.

The universe of covered industries will be based on a formal regulation to be issued by the U.S. EPA Administrator; the precise list will be derived from available data at the six-digit level of the NAICS. The basic formula for inclusion requires a trade-intensity of at least 15 percent and an energy-or emissions-intensity of at least 5 percent. Some additional criteria apply, including an option to include sub-sectors based on individual petitions.

Emissions allowances are distributed to eligible facilities on a product output basis under an overall cap of 15 percent of total allowances. Allowances are designed to cover both direct costs and those indirect carbon costs passed on by electricity suppliers, based on historical information. Special provisions apply to new entrants. Shut-down facilities (but not those with reduced output) would be required to surrender rebates.

Another goal of the competitiveness measures is to induce foreign countries to reduce their GHG emissions through mechanisms that are consistent with U.S. international treaty obligations. In support of that goal, H.R. 2454 requires the U.S. president to prepare a series of reports beginning in 2017 concerning the effectiveness of the rebate system for addressing carbon leakage; the extent to which other nations have adopted the same or similar measures; and the appropriateness of improved or supplemental mechanisms, including the design, feasibility, and usefulness of an international reserve allowance program, sometimes referred to as a border adjustment system.

H.R. 2454 establishes quite formal procedures for the international reserve allowance program, including mandatory steps to be taken by the Executive and Legislative Branches to determine the need for the program, design precise program elements, and implement the overall program. A more detailed summary of the legislative provisions is presented in Appendix 3.[8]

Table 4.3. Effect on Output of a $10/Ton Carbon Dioxide Tax (percent change)

	Short-run partial equilibrium effect only	Medium-run general equilibrium effects with fixed capital	Long-run general equilibrium with reallocation of capital
Manufacturing industries			
Food	−0.38	−0.11	−0.12
Textile	−1.13	−0.51	−0.50
Apparel	−1.03	−0.18	−0.07
Lumber, wood, paper	−0.53	−0.32	−0.32
Petroleum refining	−0.78	−4.72	−5.36
Chemical and plastics	−1.74	−1.11	−1.26
Nonmetallic mineral	−1.20	−0.86	−0.94
Primary metals	−1.57	−1.30	−1.21
Fabricated metals	−0.33	−0.44	−0.43
Transportation equipment	−1.14	−0.35	−0.27
Electrical machinery	−1.00	−0.13	0.08
Other machinery and miscellaneous manufacturing	−0.72	−0.50	−0.49
Nonmanufacturing industries			
Agriculture	−0.54	−0.58	−0.68
Coal mining	−11.01	−4.89	−7.85
Oil mining	−5.60	−1.02	−2.09
Gas	−4.95	−5.33	−10.04
Other mining	−0.49	−0.74	−1.06
Electric utilities	−1.35	−1.37	−1.17
Construction	−0.42	−0.32	−0.39
Transportation	−0.67	−1.02	−1.15
Services	−0.17	0.05	0.06

Source: Ho et al. 2008.

Industries likely to qualify for the emissions allowance rebate program

Only limited analysis has been undertaken to determine the list of industries likely to qualify

8 For further description of the methods and approaches used in this analysis see Ho et al. 2008.

for the emissions allowance rebate program. However, a preliminary assessment based on a draft version of H.R. 2454 (using 2006 data) indicates that several dozen industries are good candidates for the program (on a six-digit NAICS basis), including elements of the following industries: metals, chemicals and fertilizers, nonmetallic minerals, mining, and food processing (Houser 2009). Since these industries are also heavily involved in U.S.-Mexican trade, there is a significant potential to impact bilateral trade flows.

While industry-specific data on the carbon intensity of Mexican industry, especially those industries most involved in U.S.-Mexican trade, have not yet been reviewed, it is likely that the same or quite similar industries identified in the U.S. and European studies, as well as those specifically covered by H.R. 2454, would also be affected if Mexico adopted comparable policies. Further analysis would be required to quantify these impacts in the case where Mexico does not adopt policies comparable to those in the United States and the case where it does.

Distributional Effects

This section presents a preliminary review of the distribution of electricity costs across Mexican households.

How is energy consumption distributed by income class?

According to Komives et al. (2009), the wealthiest decile of the population consumes between two and four times as much electricity as the poorest decile, though the disparity shoots up during hot summer months. Electricity consumption by income decile can be seen in Table 4.4 below. Income decile 1 represents the poorest decile, while decile 10 represents the wealthiest. Electricity prices are also broken down by geographic Tariff Zone. Tariff Zone 1 represents the least subsidized tariffs, while Tariff Zone F represents the most heavily subsidized electricity (for example, in Mexico's hottest climates where summer cooling costs are substantial). As is apparent in Table 4.4, Mexico has a complex electricity tariff system, with a multitude of varying subsidies according to consumption volume and geographic tariff zone. Customers living in warmer regions that may require more air conditioning receive higher electricity subsidies.

Targeting electricity subsidies toward low-income consumers

The Mexican government already annually reviews and sets consumer electricity tariffs and finances electricity subsidies through indirect and direct government transfers, so it could adjust for any potential high CO_2 price at multiple points. Mexico's electricity subsidies, which totaled $9 billion in 2006, equal about 1 percent of GDP—more than one-third of electricity sector revenues and more than twice as much as was budgeted for electricity sector investment that year (Komives et al. 2009). Average residential electricity prices and agricultural tariffs cover roughly 40 percent and 30 percent, respectively, of the cost of supply, and this price distortion reduces conservation and efficiency incentives. Not surprisingly, states with higher subsidies consume more electricity per capita than those with lower subsidies (CTF Trust Fund Committee 2009).

Yet adjusting electricity subsidies need not imply a harsh impact on poor households. In fact, as various studies including Komives et al. (2009, viii) point out, “the bulk of subsidies go to the non-poor” and seem to disproportionately benefit the wealthy; the poorest three deciles of the population account for only 21 percent of total subsidies, while the wealthiest three deciles of the population receive 38 percent of electricity subsidies, as wealthier customers consume more electricity. The researchers examine various electricity subsidy adjustments that reduce both overall emissions and impact on the poor by targeting low-income consumers. Targeting these households remains important because although most residential subsidies currently go to middle- and upper-income households, subsidies are more significant for lower-income consumers for whom subsidies and electricity costs in general represent a higher portion of household income. Comparing Mexican electricity tariffs to those in other countries indicates that there should be room to adjust electricity prices to incentivize conservation without incurring excessive prices. According to a World Bank analysis, average residential electricity prices in Mexico compared to other OECD and middle-income Latin American countries fall in the bottom third of the distribution (CTF Trust Fund Committee 2009).

Table 4.4 Estimated Electricity Consumption (Kilowatt-hours per month) by Income Decile and Tariff Zone

Income	**Average**	**Tariff Zone**						
Decile		1	1A	1B	1C	1D	1E	1F
1	146	115	124	165	222	297	538	345
2	189	129	176	196	309	415	500	804
3	210	146	190	187	360	419	508	640
4	212	143	212	200	329	426	516	545
5	244	159	229	204	372	416	551	791
6	248	167	209	214	380	506	553	806
7	273	167	269	245	411	516	627	1023
8	277	168	245	237	429	606	704	807
9	336	189	262	246	489	581	765	1209
10	391	229	284	349	613	641	901	1405
Average	230	163	221	223	423	506	629	951

Source: Komives et al. 2009, 21.
Note: Income decile 1 represents the poorest decile, and decile 10 represents the wealthiest. Tariff Zones range from Zone 1 (least subsidized) to Zone 1F (most heavily subsidized).

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population account for only 21 percent of total subsidies, while the wealthiest three deciles of the population receive 38 percent of electricity subsidies, as wealthier customers consume more electricity. The researchers examine various electricity subsidy adjustments that reduce both overall emissions and impact on the poor by targeting low-income consumers. Targeting these households remains important because although most residential subsidies currently go to middle- and upper-income households, subsidies are more significant for lower-income consumers for whom subsidies and electricity costs in general represent a higher portion of household income. Comparing Mexican electricity tariffs to those in other countries indicates that there should be room to adjust electricity prices to incentivize conservation without incurring excessive prices. According to a World Bank analysis, average residential electricity prices in Mexico compared to other OECD and middle-income Latin American countries fall in the bottom third of the distribution (CTF Trust Fund Committee 2009).

Targeting programs toward low-income consumers

The Mexican government has recognized the importance of targeting low-income households and already has begun targeting them through its energy efficiency, conservation, and other programs. SENER is working to develop a large-scale energy efficiency program that would include bringing efficient lighting and domestic appliances (such as refrigerators and air conditioners) to low-income households; the program aims to substitute about 72 million incandescent bulbs with fluorescent lamps in these households (CTF Trust Fund Committee 2009). Loans authorized by the National Housing Commission would finance green mortgages for low-income families through a program that aims to make homes more energy efficient with better insulation, appliance substitution, and other similar improvements. PECC mentions other programs targeting the poor, including plans to install 600,000 efficient firewood stoves to substitute for the inefficient open hearths that low-income households often use (Federal Executive Branch 2009).

5. Paths of Future Research and Conclusions

The assessment presented in the previous sections represents a first step in developing detailed options for Mexico to enhance implementation of its GHG reduction goals, as articulated by President Calderón and in the Special Climate Change Program (PECC) (Federal Executive Branch 2009). The key options focus on sectoral policies that would facilitate monetization of emissions reductions via sale of offsets to the United States or the European Union, and economy-wide sectoral binding targets that would allow direct trading with the United States or the European Union. Three sectors are prime targets for such efforts: electricity generation, transmission, and distribution; oil and gas; and forest and land-use activities. In all cases, large-scale emissions reductions could be obtained at low or no cost.

The next step is to develop a sufficiently strong base of information and analysis that includes technical, economic, and institutional assessments to support decisionmaking on the design of specific policies. We have identified five priority areas where we believe further information and analysis are essential to decisionmaking:

- development of marginal abatement cost curves for the electric sector (primarily CFE);
- development of marginal abatement cost curves for Pemex, including oil and gas extraction, refining, and processing;
- development of marginal abatement cost curves for forestry and land use, including issues of deforestation and forest degradation;
- analysis of regulatory options for the design and implementation of a sector-based offset strategy appropriate to CFE and the broader electricity sector, Pemex, and REDD, including technical, economic, and institutional issues; and
- analysis of regulatory options for the design and implementation of an emissions trading system and binding commitments for emissions of CO_2 from the electricity sector and Pemex.

Activities are already underway in Mexico and elsewhere in a number of these areas. In the coming months, building on existing efforts and in consultation with various government officials and experts in and out of government, we propose to develop a work plan to provide comprehensive, transparent, and robust information to support decisionmaking in a timely manner.

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Appendix 1: Summary Checklist for Participation in Offset Program according to H.R. 2452

Section 743(c) of H.R. 2454 addresses international offsets that could be generated from reductions in Mexican emissions from electricity generation, and the production and consumption of petroleum based fuels. The legislation places conditions as to which countries may participate in the offset program. The legislation states:

> International offset credits will be issued only if the United States is a party to a bilateral or multilateral agreement or arrangement that includes the country in which the project or measure achieving the relevant greenhouse gas emission reduction or avoidance, or greenhouse gas sequestration has occurred, and such country is a developing country.

In addition, the program is potentially limited to:

- countries that have comparatively high greenhouse gas emissions, or comparatively greater levels of economic development; and
- if located in the United States, would be within a sector subject to the compliance obligation.

There is a checklist of other factors to take into account when considering participation in the offset program, including:

- The country's gross domestic product.
- The country's total greenhouse gas emissions.
- Whether the comparable sector of the United States economy is covered by the compliance obligation
- The heterogeneity or homogeneity of sources within the relevant sector.
- Whether the relevant sector provides products or services that are sold in internationally competitive markets.
- The risk of leakage if international offset credits were issued on a project-level basis, instead of on a sectoral basis, for activities within the relevant sector.
- The capability of accurately measuring, monitoring, reporting, and verifying the performance of sources across the relevant sector.

Appendix 2: Comparing a Carbon Tax to a Cap-and-Trade Regulatory Program

Point of Regulation: Which economic sectors will be required to pay the tax or hold permits?

Both approaches can regulate the same sectors.

Coverage: Which greenhouse gases (GHGs) can be covered by each program, and how broad can the program be?

All six GHGs[9] can be covered under both programs; coverage in terms of sources would be the same. In both cases, some sources and gases would require the use of a crediting mechanism.

Price Signal: Is there an important economic difference between a price of carbon expressed as a tax and an allowance price?

No. If all allowances in a cap-and-trade program are auctioned, the economy will have the same response to a tax or allowance price in terms of carbon (energy) conservation, as well as development and deployment of new technology.

Revenue Generation: Can equal amounts of revenue be generated by a tax and a cap-and-trade program?

Yes. If the two programs have the same points of regulation and coverage, and are designed to yield the same emissions reductions, full auctioning of allowances under a cap-and-trade program will generate the same revenue as a tax.

Cost Certainty: Can both regulatory programs ensure cost certainty?

Yes. A tax would establish the marginal cost of GHG control at the prevailing tax rate and thus limit the marginal cost of GHG control. A cap-and-trade program with a safety valve would limit the allowance price to a given amount and would not allow it to rise; similarly, a reservation price can set a price floor for allowances.

Environmental Certainty: Can both regulatory programs ensure environmental certainty?

Yes. Assuming compliance by the regulated entities, the cap-and-trade approach (without a

9 The six greenhouse gases recommended by the Intergovernmental Panel on Climate Change comprise carbon dioxide (CO_2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF6).

safety valve) provides great environmental certainty, but this would be eroded with the introduction of a price cap and floor. A carbon tax can provide a comparable degree of certainty if the tax is adjusted in response to environmental outcomes. In the long run, either policy would likely need to be adjusted.

Competiveness Concerns: Would both programs have the same impact on international competiveness?

Yes. If the tax rate and allowance price were equal, the competitiveness effect would be the same. That is, energy prices would rise by the same amount under both approaches.

Distributional Concerns: Would both approaches have the same impact on households?

Yes. If the tax rate and allowance price were the same, energy prices would rise by the same amount under both approaches. The primary effect on households is how the allowance value (in the case of cap-and-trade) or the tax revenue (in the case of a tax) is distributed.

Offsets: Can domestic and foreign offsets be incorporated into a tax program?

Yes. Rules for crediting GHG reduction projects (carbon capture and storage, for example) would be developed by executive branch agencies. In the case of cap-and-trade, allowances would be generated by the projects and sold in the market. In the case of a tax program, a similar market would be established for tax credits generated by these projects.

However, there is an important difference. In a cap-and-trade project, offsets loosen the cap on covered sectors and allow the allowance price to fall, while project-generated tax credits do not lower the tax rate and therefore do not lead to an increase in emissions in covered sectors.

Linking to Other Carbon Markets: Is it possible to link a U.S. carbon tax to the EU carbon market?

Yes. Under a linked program, a regulated U.S. entity would meet its tax obligation by paying the U.S. tax or purchasing an EU allowance for its emissions. A regulated EU entity would meet its obligation by purchasing an EU allowance or paying the equivalent U.S. tax to the European Union. The U.S. tax would then function like a safety valve within the EU cap-and-trade program. Of course, this would require a political agreement between the parties to link the programs.

Administrative Differences: What are the administrative differences between a tax and a cap-and-trade program?

A tax requires an entity to collect taxes and verify emissions levels. A cap-and-trade program requires an entity to allocate allowances, collect allowances, and verify emissions levels. Both approaches require the same information to determine compliance with emissions limits. The cap-and-trade program would require additional public and private institutions to ensure the proper functioning of the allowance market.

Appendix 3: Summary of Key Competitiveness Provisions from H.R. 2454

Subpart 1—Emission Allowance Rebate Program

Section 763. Eligible Industrial Sectors

Public listing of eligible sectors:

- By June 30, 2011, the U.S. Environmental Protection Agency (U.S. EPA) Administrator will publish a list of entities eligible to receive allowance rebates (for indirect emissions) during calendar years 2012 and 2013.
- By June 30, 2013, and every four years thereafter, the U.S. EPA Administrator will publish an updated list of entities eligible to receive allowance rebates for direct and indirect emissions.

Rule for presumptively eligible sectors:

- By June 30, 2011, the U.S. EPA Administrator promulgates a rule, designating industrial sectors eligible to receive allowance rebates under this subpart.
- Working from available data at the six-digit level of the North American Industry Classification System (NAICS) code, industrial sectors and subsectors are presumed to be eligible if they meet both of the following criteria:
    - trade-intensity[10] of at least 15 percent, and
    - energy-intensity[11] of at least 5 percent (or emissions intensity of at least 5 percent[12])
- A sector is also presumed eligible if its energy intensity is greater than 20 percent, regardless of its trade intensity.
- For the purpose of determining eligibility in certain sectors (metal ores, phosphate,

10 Trade intensity = (value of imports + value of exports/value of shipments + value of imports).

11 Energy intensity = (fuel and electricity costs/shipment value).

12 Assuming a $20/ton carbon cost.

and soda ash), the Administrator is required to aggregate energy- and trade-intensity data from upstream, non-extractive mining activities together with energy- and trade-intensity data related to downstream manufacturing activities.[13]

Administrative determinations of eligibility:

- If at any time in the future, an industrial sector that meets the energy-intensity criteria defined in this section (based on data from the years 2004 through 2006) meets *updated* trade-intensity criteria, then that sector would become eligible to receive allowance rebates (for this purpose, updated energy data may not be considered).
- Industrial *sub*-sectors may make an "individual showing petition" to the U.S. EPA that their *sub*-sector should be eligible (when disaggregated from other sectors that share the same six-digit NAICS code), even if other sectors with the same NAICS code fail to meet the above criteria.

Section 764. Distribution of Emission Allowance Rebates

Distribution schedule:

- For each vintage year, the U.S. EPA Administrator distributes allowances to the owners not later than October 31 of the preceding calendar year.
- For the years 2012 and 2013, when electric utilities are covered under the cap but there is no direct compliance obligation on industry, allowances are distributed for indirect costs *only.*
- For the years 2014 through 2025, allowances are distributed for direct and indirect costs.
- For the years 2026 through 2035, allowance distribution is reduced by 10 percent each year, but this reduction is subject to presidential determinations and actions under section 767.
- Any new entrants would begin receiving allowance in the following year, unless unused allowances are available for the vintage year in which they are found to be eligible.
- If a facility shuts down, the owner would no longer receive rebates and would have to surrender any rebates received for future years. The owner would also have to surrender rebates received for the year in which the facility shut down, on a pro-rated basis.

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13 This data aggregation provision is intended to recognize the fact that upstream mining and downstream manufacturing activities are often part of the same integrated operation; yet, their data are arbitrarily collected and compiled by the U.S. Census under separate NAICS codes.

Calculation of allowance rebates:

In general, emissions allowances are distributed to eligible facilities on a product-output basis,[14] with compensation provided for both direct and indirect cap-and-trade compliance costs.

- Up to 15 percent of total emissions allowances, under the cap, are distributed annually to eligible facilities; remaining allowances are sold at auction.[15] If the available allowances are not adequate to meet demand in any year, then rebates are reduced for all on a pro-rata basis.
- For covered entities (with a compliance obligation), rebates are provided for direct and indirect carbon costs.
- For uncovered entities (with no direct compliance costs due to on-site emissions), rebates are provided for indirect carbon costs passed on by their electricity supplier.
- New facilities in eligible industrial sectors would receive allowance rebates during the first two years of operation based on reasonable estimates. The following two years would be a true-up period, and during subsequent years, new facilities would be treated like all eligible facilities.
- For direct compliance costs, allowance distribution is calculated by multiplying a covered facility's product output by the sector average tonnage of GHG emissions per unit of product output:

Direct Compliance Cost

$$\text{Output X } \frac{\text{Sector average tons } CO_2 \text{ emissions}}{\text{Unit of Output}} = \text{Rebate}$$

- Similarly, for indirect costs passed on by electric utilities, allowance distribution is calculated by multiplying a covered or uncovered facility's product output by 1) the sector average electricity use (in Kilowatts-hours, or kWh) per unit of product output, and 2) the emissions intensity of each facility's electric power supplier:

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14 The intent of this approach is for facilities that manufacture products more efficiently to receive more allowances, while less efficient facilities would receive lower levels of compensation.

15 Per a "carryover" provision in section 782 of the Clean Air Act, allowances that are set aside for "trade-vulnerable industries" but not distributed in any given year would be cumulatively credited for distribution in following years.

Indirect Carbon Costs[16]

$$\text{Site output (production)} \times \frac{\text{Sector Average kWh electricity}}{\text{Unit of output}} \times \frac{\text{Utility Ton } CO_2}{\text{kWh electricity}} \times \text{Portion of Permit costs not passed on by utility} = \text{Rebate}$$

- The baseline sector average emissions per unit of output and the sector average electricity use per unit of output updates every four years, based on the most recent four years of available data.
- To ensure efficiency improvements over time, during subsequent periods the sector average emissions and electricity use per unit of output are not allowed to increase. The same is true for the emissions intensity of electricity suppliers.
- The U.S. EPA Administrator may account for the use of combined heat and power technologies when determining sector averages and calculating rebates under this section.

Subpart 2—Promoting International Reductions in Industrial Emissions

Section 765. International Negotiations

- Section 765 states that its purposes can be achieved most effectively through agreements negotiated between the United States and foreign countries.
- The United States will work proactively to establish binding international agreements, including sectoral agreements, committing all major GHG-emitting nations to contribute equitably to the reduction of global GHG emissions.
- The president shall notify foreign countries, as soon as possible after the date of enactment, that products manufactured in such countries and imported to the United States may be required to purchase "international reserve" emissions allowances, beginning January 1, 2020, based on presidential determinations made under this section.

Section 766. U.S. Objectives for Multilateral Environmental Negotiations

List of U.S. negotiating objectives:

1. An internationally binding agreement should include all major GHG-emitting countries to contribute equitably to reducing GHG emissions.

16 With regard to permit costs not passed on by utilities: for allowances distributed upstream to electric power providers, the value of those free allowances that are passed on to eligible facilities are deducted from the indirect allocation provided under this provision.

2. The agreement contains provisions that recognize and address the competitive imbalances that lead to carbon leakage between agreement parties and non-parties.

3. Parties to the agreement are not prevented from addressing competitive imbalances that lead to carbon leakage among agreement parties.

4. Remedies are included for any party that fails to meet GHG reduction obligations in the agreement.

Section 767. Presidential Reports and Determinations

Biennial report to Congress:

The president is required to submit biennial reports to Congress, beginning on January 1, 2017, regarding, for each eligible industrial sector:

- the effectiveness of distributing emissions allowances to industry and utilities for addressing carbon leakage caused as a result of cap-and-trade compliance costs;
- recommendations for how to better achieve the purposes of this subpart, including the feasibility and usefulness of an international reserve allowance program (section 768);
- an identification of alternative actions to achieve the purposes of this subpart; and
- an assessment of the extent to which other countries are providing domestic manufacturers with assistance (including free allowances) to address carbon leakage.

Presidential determination and congressional joint resolution:

If a multilateral agreement consistent with the negotiation objectives listed in section 766 has not entered into force by January 1, 2018, then the international reserve allowance program, detailed in section 768, will be established for each eligible industrial sector, unless the president determines and certifies to Congress, with respect to each eligible industrial sector, that such program would not be in the national economic or environmental interest, and Congress passes a joint resolution approving such presidential determination.

If the president transmits to Congress a multilateral agreement that he deems to be consistent with all the U.S. negotiation objectives listed in section 766, then that agreement shall be considered to be consistent with such negotiation objectives as soon as such agreement is ratified by the Senate (if it is a treaty) or enacted as legislation.

Presidential determination on sectors; countries subject to international reserve allowance program

If the President establishes an international reserve allowance program (under section 768), then he must determine, no later than June 30, 2018, and every four years thereafter, with respect to each eligible industrial sector, whether more than 85 percent of U.S imports of "covered goods"[17] from that sector are produced in countries that meet at least one of the following criteria:

1. the country is a party to an international treaty, to which the United States is a party,
2. that includes a nationally enforceable emissions reduction commitment that is at least as stringent as that of the United States;
3. the country is a party to an international sectoral agreement for that sector, to which the United States is a party; or
4. the country has an annual energy or GHG intensity for that sector that is equal to or less than that of the United States.

If the president makes a positive determination based on the above three criteria, with respect to an eligible industrial sector, then the president shall not apply an international reserve allowance program to the imports of covered goods in that sector.

If the president determines, with respect to each eligible industrial sector, that less than 85 percent of U.S. imports of covered goods from that sector are produced in countries that meet one or more of the above criteria, then the president shall, no later than June 30, 2018, and every four years thereafter, consider the extent to which emissions allowance rebating (under Part 1) and the international reserve allowance program (under Part 2) has effectively mitigated, or could effectively mitigate carbon leakage in that sector, and he shall accordingly modify the distribution schedule of emission allowance rebates (under section 764) and apply an international reserve allowance program to the imports of covered goods in that sector. The president must report to Congress no later than June 30, 2018, and every four years thereafter, regarding determinations and actions taken under this subsection.

Section 768. International Reserve Allowance Program

The U.S. EPA Administrator establishes an international reserve allowance program, no sooner than January 1, 2020.

The U.S. EPA Administrator establishes general methodologies and procedures for:

- determining how many allowances the importers of covered goods must submit;

17 For the purposes of this part, U.S. importers of "covered goods" may be subject to the requirements of the International Reserve Allowance Program. A "covered good" may be manufactured by an eligible industrial sector (see section 763) or it may be a "manufactured item for consumption," which means it meets a set of specified criteria, including that it contains, in substantial amounts, products manufactured by an eligible industrial sector.

- setting allowance prices that are equivalent to U.S. auction clearance prices;
- preventing gaming of the program; and
- including adjustments to reduce the quantity of international reserve allowances required for the import of covered goods to account for free allowances rebated to eligible industrial sectors.

Countries exempt from international reserve allowances requirements are:

- countries that meet criteria listed in the previous section;
- United Nations–identified least-developed countries; or
- countries responsible for less than 0.5 percent of total global GHG emissions.