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WORKING PAPER

ACHIEVING MEXICO'S CLIMATE GOALS: AN EIGHT-POINT ACTION PLAN

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EXECUTIVE SUMMARY

In recent years, Mexico has developed and implemented a range of policies and targets to address climate change, reduce greenhouse gas (GHG) emissions, and transition toward a low-carbon and climate-resilient society. These policies respond both to global efforts to limit climate change, and to Mexico's own need to maintain energy security, curb air pollution, and improve the health and well-being of its people.

In 2012, Mexico became one of the first countries to pass comprehensive climate change legislation to guide national policy. The legislation comprises a general law, a special program on climate change, and a national strategy on climate change, and addresses a wide range of concerns including mitigation, adaptation, and institutional arrangements. Foremost among its objectives, the legislation aims to guarantee the right to a healthy environment and to regulate GHG emissions to achieve stabilization at a level that prevents dangerous anthropogenic interference with the climate system, as specified in the United Nations Framework Convention on Climate Change (UNFCCC). To this end, the legislation also establishes GHG reduction targets for 2020 and 2050.

In institutional terms, according to Mexico's General Law on Climate Change, the Intersecretarial Commission on Climate Change (CICC) must promote actions necessary for compliance with the commitments and objectives of the UNFCCC and other instruments derived from it. Mexico's Secretariat of Environment and Natural Resources (SEMARNAT) is the responsible implementation agency, which has technical support from the National Institute of

CONTENTS

Working Papers contain preliminary research, analysis, findings, and recommendations. They are circulated to stimulate timely discussion and critical feedback and to influence ongoing debate on emerging issues. Most working papers are eventually published in another form and their content may be revised.

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Environment and Climate Change (INECC). SEMARNAT periodically reports to the CICC, which reports to the Secretariat of Foreign Affairs to communicate Mexico's actions to international agencies and organizations.

In the lead-up to the 2015 Paris Agreement, Mexico became the first developing country to submit its intended nationally determined contribution (INDC) to the UNFCCC, outlining the country's plans for post-2020 climate action. In its INDC, Mexico set two GHG emission reduction targets (Government of Mexico 2015):

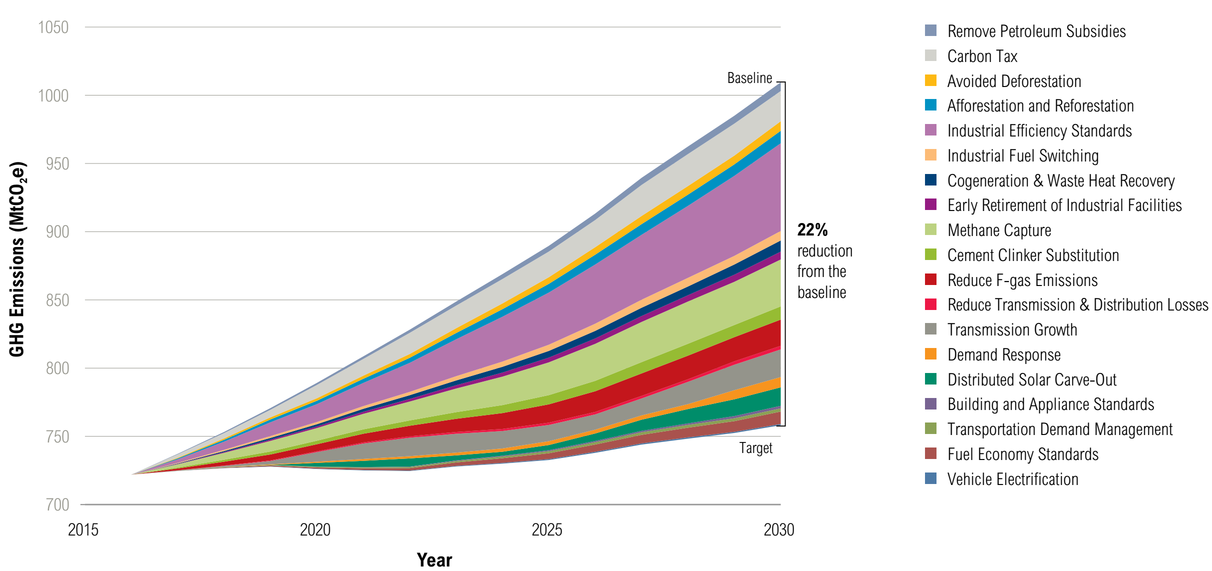
- An **unconditional target** to reduce GHG emissions by 22 percent below the baseline by 2030.
- A **conditional target** to reduce GHG emissions by up to 36 percent below the baseline by 2030, contingent on a global agreement that addresses, among other issues, an international carbon price, carbon border adjustments, technical cooperation, access to low-cost financial resources, and technology transfer (all at a scale commensurate to the challenge of global climate change).

At the global level, the Paris Agreement set forth a goal to limit global average temperature rise to well below 2°C and to pursue efforts to limit it to 1.5°C, and established a process to enhance the ambition of national commitments every five years in pursuit of this goal. In addition, the Agreement invited countries to communicate "mid-century, long-term low greenhouse gas emission development strategies" to the UNFCCC by 2020. Mexico has committed to develop its strategy by the end of 2016.

How can Mexico achieve its targets and work toward the Paris Agreement goals? This working paper addresses this question by identifying and evaluating the key climate and energy policy options available to Mexico to support the implementation of its INDC. By applying a stepwise policy screening process—one which involved evaluating 56 planned and potential policies in Mexico for GHG abatement potential, cost effectiveness, political feasibility, health benefits, and energy security—we found several policies that, when combined in a package, can achieve deep cuts in GHG emissions, while at the same time providing significant co-benefits. We input these policies into a system dynamics computer model developed by Energy Innovation[1] and known as the Energy Policy Simulator to estimate the effects of various policies on emissions, financial metrics, and the electricity system structure, among other things. Our analysis shows that Mexico can meet its unconditional and conditional targets while at the same time saving money and lives.

Mexico can meet its announced unconditional GHG emission reduction target with 19 climate and energy policies, while at the same time achieving a net savings in expenditures of over 500 billion pesos (about 2 percent of 2015 GDP) cumulatively through 2030. Meeting the unconditional target would involve expanding and strengthening some

Figure ES-1 | **Policy Contributions to Meet Mexico's Unconditional Emission Reduction Target**



current and proposed policies and standards, and also implementing additional policies. These policies cover all sectors of the economy, with the largest level of GHG abatement achieved through implementing efficiency standards in the industrial and oil and gas sectors[2] (contributing 24 percent of the emission reduction required to meet this target), followed by methane capture (15 percent contribution), and a carbon tax (12 percent contribution at a level of US$15 per tonne of CO_2 equivalent (tCO_2e)).

Figure ES-1 presents an indicative package of policies that, when fully implemented, could reduce Mexico's GHG emissions by 22 percent below the baseline (based on data from the Mexican government and other sources) by 2030.

By significantly enhancing existing policies, and implementing two additional policies, Mexico can reach its conditional emission reduction target, while still achieving cost savings. Meeting the conditional target could require further strengthening existing policies (beyond what is required to reach the unconditional GHG reduction target), pricing carbon economy-wide according to its true external costs to society, and developing additional mitigation interventions in the industry and oil and gas sectors. In the indicative conditional policy package, a carbon tax is the strongest policy (contributing, at US$55/$tCO_2e$, 19 percent of the emission reductions required to meet Mexico's conditional GHG emission reduction target), followed by methane capture (18 percent), and industrial efficiency standards (15 percent).

Figure ES-2 presents an indicative package of policies that, when fully implemented, could reduce Mexico's GHG emissions by 36 percent below the baseline by 2030, while achieving net savings in direct expenditures of nearly 200 billion pesos (about 0.8 percent of the 2015 GDP).

An overview of the "policy settings" selected to reach Mexico's unconditional and conditional GHG reduction targets is presented in Table ES-1. A policy setting reflects the level of abatement to be achieved by the policy. A conditional policy setting (with a carbon tax of US$55 per tonne of CO_2e) would be more ambitious than an unconditional policy setting (with a carbon tax of US$15 per tonne of CO_2e) because the conditional policy package's end goal of reducing Mexico's GHG emissions by 36 percent below the baseline by 2030 is more ambitious than the unconditional goal of 22 percent.

As detailed in section 5 of the working paper, these policy settings reflect several important criteria—GHG abatement, cost-effectiveness, political feasibility, and health and energy security co-benefits—which were explored through literature review and stakeholder consultations. They do not, however, represent the only packages of policies that could achieve the unconditional and conditional GHG targets. Therefore, they should be read as indicative combinations of policies that are consistent with the targets and with the achievement of other co-benefits. Readers can explore other combinations of policies in the Energy Policy Simulator (see Box 1).

Figure ES-2 | **Policy Contributions to Meet Mexico's Conditional Emission Reduction Target**

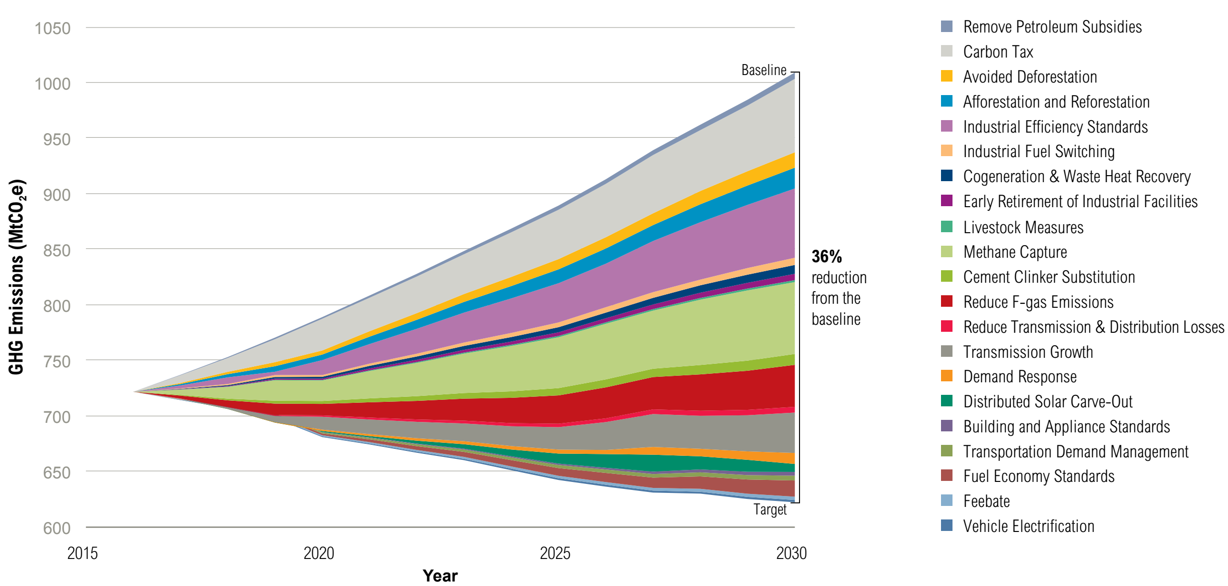


Table ES-1 | **Summary of Policy Settings Used in Baseline, Unconditional, and Conditional Policy Packages, 2017–30**

SECTOR	POLICY	BASELINE POLICY SETTING	UNCONDITIONAL POLICY SETTING	CONDITIONAL POLICY SETTING
Cross-Sector	Carbon tax	$0/tCO_2e$	$15/tCO_2e$	$55/tCO_2e$
Cross-Sector	Reduce petroleum subsidies	Average petroleum subsidy per unit ($/BTU) is 3.15E-06	All petroleum subsidies are removed	All petroleum subsidies are removed
Transportation	Light-duty vehicle (LDV) fuel economy standards	14.9 km per liter	40% improvement above the baseline	87% improvement above the baseline
Transportation	Heavy-duty vehicle (HDV) fuel economy standards	No standard currently enacted. Baseline is the calculated current average fuel economy of Mexico's HDVs (51.02 - 56.43 freight tonne-km/l)	20% improvement above the baseline	45% improvement above the baseline
Transportation	Passenger LDV electrification	<1% of passenger LDVs electrified	2% of passenger LDVs electrified	5% of passenger LDVs electrified
Transportation	Passenger HDV electrification	<1% of passenger HDVs electrified	2% of passenger HDVs electrified	5% of passenger HDVs electrified
Transportation	Transport demand management measures	No additional transport demand management measures enacted above the efforts in place in 2014	4% reduction in passenger-km traveled in LDVs, 9.3% increase in HDVs, 4.5% decrease in aircraft, 16% increase in rail, 7.5% decrease in motorbikes (no effects on freight transport)	8% reduction in passenger-km traveled in LDVs, 18.6% increase in HDVs, 9% decrease in aircraft, 32% increase in rail, 15% decrease in motorbikes (no effects on freight transport)
Transportation	Passenger LDV feebate	None	None	$210/.01 liters per km
Electricity	Transmission growth	16,655,698 kilovolt kilometer (kV-km) increase above 2014 levels	30% above the baseline	60% above the baseline
Electricity	Reduce transmission and distribution losses	13.9% reduction relative to 2014 levels	22% reduction relative to baseline	43% reduction relative to baseline
Electricity	Demand response	4,248 MW capacity is on the grid by 2030 to improve flexibility	12,340 MW capacity is on the grid	12,340 MW capacity is on the grid
Electricity/Buildings	Distributed solar carve-out	<1% of total electricity generated from distributed solar (on residential and commercial buildings)	1% of total electricity generated from distributed solar	2% of total electricity generated from distributed solar
Buildings	Standards for cooling equipment	Based on the National Commission for Energy Efficient Uses (CONUEE's) estimations on energy use reductions derived from the levels enforced	30% reduction in energy use relative to baseline	50% reduction in energy use relative to baseline

Buildings	Standards for building envelope	Based on CONUEE's estimations on energy use reductions derived from the levels enforced by existing regulations in 2014	20% reduction in leakage relative to baseline	40% reduction in leakage relative to baseline
Buildings	Standards for lighting	Based on CONUEE's estimations on energy use reductions derived from the levels enforced by existing regulations in 2014	10% reduction of energy use relative to baseline	20% reduction of energy use relative to baseline
Industry	Cement clinker substitution	No change in clinker percentage from 2014 levels	15% reduction from 2014 levels	15% reduction from 2014 levels
Industry	Reduce fluorinated gas (F-gas) emissions	F-gas emissions are 37.7 $MtCO_2e$ in 2030	50% reduction relative to baseline	98% reduction relative to baseline
Industry	Convert natural gas to electric equipment	No additional equipment is converted from natural gas to electricity	2% of the natural gas used in industry is replaced by electricity	5% of the natural gas used in industry is replaced by electricity
Industry	Early facility retirement	Industrial facilities are used for the duration of their expected useful economic lifetimes	Early retirement affects 6.3% of cement facilities, 4.5% of natural gas and petroleum facilities, 8.5% of iron and steel facilities, 2.0% of chemical facilities, and 1.6% of other industrial facilities	Early retirement affects 6.3% of cement facilities, 4.5% of natural gas and petroleum facilities, 8.5% of iron and steel facilities, 2.0% of chemical facilities, and 1.6% of other industrial facilities
Industry	Methane capture	Methane leakage and venting from industry is 9.4 $MtCO_2e$ in 2030	16% reduction relative to baseline	36% reduction relative to baseline
Industry	Cogeneration and waste heat recovery	No increase in rate of usage of cogeneration and waste heat recovery in industrial facilities	All identified opportunities are realized, resulting in a 3.9% reduction in fuel use for non-agriculture industries	All identified opportunities are realized, resulting in a 3.9% reduction in fuel use for non-agriculture industries
Industry	Equipment efficiency standards	8% improvement relative to 2014 levels	30% improvement relative to baseline	30% improvement relative to baseline
Land Use	Avoid deforestation[a]	No additional avoided deforestation measures are implemented, above those already in place in 2014	CO_2 emissions from Land Use Land-Use Change and Forestry (LULUCF) are reduced by 16% relative to baseline	CO_2 emissions from LULUCF are reduced by 43% relative to baseline
Land Use	Afforestation/ reforestation[a]	No additional afforestation/ reforestation measures are implemented above those already in place in 2014	CO_2 emissions from LULUCF are reduced by 21% relative to baseline	CO_2 emissions from LULUCF are reduced by 58% relative to baseline
Agriculture	Livestock measures	None	None	GHG emissions are reduced by 3.5 $MtCO_2e$/yr (2.3% of Agriculture Sector emissions)

Note: Values given for unconditional and conditional targets are for 2030; policies are phased in linearly from baseline level beginning in 2017.
a. The combined effect of the two Land Use policies in the Conditional Scenario achieve Mexico's objective of net zero anthropogenic CO_2 emissions from forests, which is in line with current consolidation of Reduced Emissions from Deforestation and Forest Degradation (REDD++) strategies.

Box 1 | **Energy Policy Simulator**

> The Energy Policy Simulator is a free open-source web tool created by Energy Innovation LLC. It allows users to explore many different policy packages in real time, learning about the available options and their effects on emissions, costs/savings, and other outputs. It also allows users to adjust policy levers to design their own policy scenarios. See https://energypolicy.solutions/.

This analysis focuses on current technically feasible policy solutions that provide high abatement potential. These options were identified through model testing and expert feedback, as detailed in section 5 of the working paper.

Our analysis shows that Mexico can achieve its unconditional and conditional GHG reduction targets—while at the same time saving money and lives. To realize these savings, the government will need to take effective and enhanced climate action in several sectors of the economy, with a focus on driving the necessary up-front investments—from sources both domestic and international, public and private—and addressing barriers to implementation.

We propose an eight-point action plan comprising the policies in Table ES-1 to support the achievement of Mexico's unconditional and conditional INDC targets, as well as the Paris Agreement mitigation goals. The purpose of this plan is to outline in broad strokes the type and magnitude of interventions that can help steer Mexico toward its goals. Further detailed analysis will no doubt be necessary to inform specific implementation approaches—including considerations related to competitiveness and distributional impacts—as well as barriers to implementation.

Points one through seven are listed in decreasing order of GHG abatement potential.

POINT 1 Improve fuel efficiency and promote the switch to clean fuels in industrial activities[a]

- The Secretariats of Economics and Energy (SE and SENER) align the Official Mexican Standard (Norma Oficial Mexicana; NOM) with the industrial efficiency standards highlighted in the North American Leaders Summit declaration, such as the adoption of the voluntary ISO 50001 energy performance standard, and commit to set a North American common target date for ISO 50001 uptake by 2017.
- The Secretariat of Finance and Public Credit (SHCP) expands the fiscal incentives program for cogeneration projects to support cleaner power on the grid.
- Begin the process of transitioning from natural gas to electricity in industry to improve Mexico's energy security and to support the Paris Agreement goals that underscore the need to achieve net zero emissions globally around the middle of the century.

POINT II Strengthen actions to reduce emissions of non-CO_2 gases

- The Secretariat of Environment and Natural Resources (SEMARNAT) and the National Hydrocarbon Commission (CNH) ensure the reduction of methane leaks and gas venting from oil and natural gas exploration, production, processing and distribution processes by setting performance standards for natural gas extraction, mandating leak detection and repair, and providing specific guidance for the management of flaring and venting methane volumes under CNH.06.001/09,[b] along with penalties if these volumes are exceeded.
- The Secretariat of Energy and the National Hydrocarbon Commission implement methane capture and utilization projects at solid waste disposal sites and wastewater treatment plants.
- The Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) promotes methane reduction technologies in the agriculture sector, following the lead of the United States' AgSTAR program[c] which promotes the use of biogas recovery systems to reduce methane emissions from livestock waste.
- Contain and destroy hydrofluorocarbons (HFCs) under a coolant substitution program that could be either reintroduced by the Trust for Energy Efficiency or developed as part of a new program with similar objectives under the umbrella of the North American Climate, Clean Energy, and Environment Partnership Action Plan.

POINT III Reduce distortions in the economy through introducing carbon pricing and phasing out fossil fuel subsidies

- SEMARNAT and the Secretariats of Energy and Finance and Public Credit step up efforts toward effectively implementing carbon pricing by increasing the current carbon tax, extending the tax to include natural gas, and planning for an emissions trading pilot project.
- Work with the United States and Canada to develop a North American carbon price, to strengthen Mexico's leadership within the Carbon Pricing Leadership Coalition, and to provide support for additional research to explore the economic implications of carbon pricing under different instruments (taxes and permit trading).
- The Secretariats of Finance and Public Credit, Economics, and Energy build on recent progress to develop a plan to phase out the remaining subsidies to fossil fuel production and use in Mexico, while ensuring protection for the poor.

POINT IV Increase capacity and efficiency in the electricity sector (transmission and distribution)

- Develop and implement an effective collaboration scheme between the Secretariat of Energy, the Federal Commission of Electricity, the Energy Regulatory Commission, the Centre for Energy Control, and the Federal Regulatory Improvement Commission to avoid potential land disputes over transmission lines.
- The Secretariat of Finance and Public Credit provides economic incentives to meet electricity demand with distributed solar photovoltaic power (for example, guarantee a zero percent import tax on solar panels).
- The Secretariat of Energy and the Federal Commission of Electricity commission a study on the potential for demand-response in Mexico as a means to reduce peak electricity demand (as a preliminary step toward implementing a demand-response program).

POINT V Promote synergies with adaptation objectives (deforestation and reforestation) and other sectoral actions (agriculture)

- Take action—under leadership of SEMARNAT and the National Forestry Commission (CONAFOR) and others—to reduce the complexity of the forestry sector's legal framework by harmonizing federal laws, regulations, and objectives related to sustainable forestry management.
- Improve coordination between SEMARNAT and CONAFOR to set transparent, clear, and measurable forestry targets.
- Take advantage of Mexico's affiliation with the Global Methane Initiative to identify actions (especially in the livestock, agro-industrial and wastewater sectors) with the greatest cost-effective methane reduction potential and develop new market opportunities.

POINT VI Prompt the transition to clean and well-designed transport options

- The Secretariat of Transport and Communications and the Federal Support Program for Mass Transportation focus efforts on an electrified and/or cleaner passenger and freight fleet, transport-demand management, and improved fuel efficiency through stronger light-duty vehicle and heavy-duty vehicle standards and feebates.[d]
- The Secretariats of Economics, Energy, and Transport and Communications harmonize fuel economy and emissions-related standards with the United States and Canada for passenger and freight vehicles.
- Strengthen local planning to support transport-demand management, and improve collaboration between the Secretariat of Energy and the automotive industry.
- Allocate increasing resources to implement the Secretariat of Rural, Territorial and Urban Development's Urban Mobility National Strategy,

including the Program for Urban Mobility Promotion and the Infrastructure Program, with a change in the rules of operation for the Federal Support Program for Mass Transportation to orient funding toward less carbon-intensive options.

POINT VII Increase energy efficiency in commercial and residential buildings

- The Secretariats of Economics and Energy, and the National Commission for Energy Efficient Uses strengthen and publicize efficiency standards for new buildings under the Mexican Official Standards and verify their proper compliance.
- The Secretariats of Economics and Foreign Affairs broaden international learning and capacity development under bilateral and multilateral energy efficiency programs, such as Mission Innovation and Sustainable Energy for All.

POINT VIII Develop a comprehensive, long-term strategy for achieving net zero GHG emissions in line with the long-term goals in the Paris Agreement

- The Intersecretarial Commission on Climate Change (CICC) and SEMARNAT review and if necessary revise the existing target to reduce GHG emissions by 50 percent from 2000 levels by 2050 in light of the Paris Agreement goals to limit the increase in global average temperature to "well below 2°C...and to pursue efforts to limit the temperature increase to 1.5°C."[e]
- SEMARNAT develops sectoral pathways and associated milestones for implementing the (potentially revised) target.
- The Institute of Environment and Climate Change (INECC) undertakes analysis of carbon lock-in risk for key infrastructure, including in particular coal- and natural-gas-fired power generation and fossil-fueled vehicles.
- CICC and SEMARNAT refine plans to achieve INDC targets in a manner that ensures consistency with the above-mentioned pathways and milestones and avoids costs associated with early retirement of emissions-intensive infrastructure.

Implementing this eight-point plan—in the context of a long-term strategy consistent with the Paris Agreement goals—has the potential to put Mexico on a path toward achieving its INDC targets, while at the same time improving economic competitiveness, energy security, and the health and well-being of its people. Through concerted and sustained effort, Mexican policymakers can work in cooperation with the private sector and civil society to achieve these benefits on behalf of the Mexican people.

Notes:

a. The Energy Policy Simulator model's industry section encompasses a broader set of activities than the traditional industry sector definition (e.g., from National Accounting Systems). We account for activities associated with industrial process emissions, either public or private, in sectors beyond the manufacturing sector such as agriculture, mining, oil and gas as well as waste management.

b. National Hydrocarbon Commission (CNH.06.001/09) – Performance criteria and application for the calculation of flaring and venting of natural gas. http://www.cnh.gob.mx/_docs/QuemaVto/DT_QyV.pdf

c. The United States AgSTAR program promotes the use of biogas recovery systems to reduce methane emissions from livestock waste by identifying project benefits, risks, options, and opportunities. https://www.epa.gov/agstar/what-epa-doing-agstar.

d. A feebate is a fee on inefficient vehicles and a rebate on efficient vehicles.

e. To have a likely chance of limiting warming to 1.5°C, global carbon dioxide emissions must reach net zero by 2045-2050, and global total GHG emissions by 2060-2080 (UNEP 2015b). (For a likely chance of limiting warming to 2°C, the same milestones must be met no more than 15 to 20 years later.)

1. INTRODUCTION

In early 2015, Mexico became the first developing country to propose an intended nationally determined contribution (INDC) in the lead-up to the December 2015 Paris Agreement, pledging unconditionally to reduce its greenhouse gas (GHG) emissions by 22 percent by 2030.[4] This development followed on a history of leadership on climate action: In 2012, the country passed one of the first pieces of comprehensive climate change legislation to guide national policy, comprising a General Law, a Special Program on Climate Change, and a National Strategy on Climate Change. In 2015, it was one of the first countries to join the "high ambition" coalition pushing for a global goal to limit global warming to 1.5°C; and between 1997 and 2012, the country submitted five national communications[5]–more than any other developing country–under the United Nations Framework Convention on Climate Change.

In July 2016, President Peña Nieto joined with Prime Minister Justin Trudeau of Canada and President Barack Obama of the United States to issue a series of trilateral commitments on climate change. Their joint declaration included pledges to achieve 50 percent clean power generation[6] across North America by 2025, to reduce emissions of methane–an especially potent GHG–in the oil and gas sector by 40 to 45 percent by the same year, and to present "mid-century, long-term low GHG emission development strategies" to the UN climate change secretariat by the end of 2016 (White House: Office of the Press Secretary 2016).

Mexico now faces the challenge of delivering on these commitments–which, in turn, presents the opportunity to grow its economy, strengthen energy security, and improve human health and well-being. Arguably, the timing for this undertaking couldn't be better. Several developments at the global, national, and local levels point toward a conducive environment as well as an urgent need for implementation:

Climate change mitigation and economic growth go hand in hand: A growing body of evidence indicates that action on climate change and economic growth are mutually complementary. In light of estimates from Mexico's Central Bank—that Mexico will target GDP growth rates between 2.5 and 3.5 percent per year in 2016 and 2017 (Morales 2016)—lessons from around the world on tackling growth and climate together through common-sense measures like promoting innovation, eliminating inefficient subsidies, and fostering livable, vibrant cities are of particular relevance (The New Climate Economy 2014).

Energy reform paves the way for cleaner energy and energy efficiency: Mexico's Energy Transition Act of 2015 represents a major step toward diversifying Mexico's energy matrix and mandates an energy efficiency target. The Act also sets a goal of a 35 percent minimum share of clean energy in power generation by 2024. While this goal coincides with the General Law of Climate Change, it also includes intermediate targets of 25 percent by 2018 and 30 percent by 2021.

In addition to the clean energy targets, the Energy Transition Act mandates setting a national economy-wide energy efficiency goal, previously unprecedented in the country.[7] To achieve this end, the law establishes a series of adjustments to policy instruments related to energy efficiency and dictates new procedures: strengthening the Energy Transition Strategy to Promote the Use of Cleaner Technologies and Fuels as a guiding instrument of national policy in the medium and long term, preparing a Roadmap for Energy Efficiency to fulfill the indicative energy efficiency target, forming an Advisory Council for Energy Transition, and preparing a Special Program for Energy Transition, along the lines of the Special Program for Climate Change.

Renewable energy technology costs continue to fall: A global transition to zero-carbon energy by mid-century will underpin the achievement of the Paris Agreement goals. While the challenge of making this transition should not be underestimated, thanks to rapidly falling costs of renewable energy technology, it has never looked easier. This global trend is playing out in Mexico as well. At the first renewables auction in early 2016, solar providers outbid competitors and set record low prices. According to Bloomberg, the auction "ended with winning bids from companies that promised to produce [solar] electricity at the cheapest rate, from any source, anywhere in the world" (Bloomberg 2016).

These promising developments are arriving just in time, as the status quo is increasingly recognized as untenable. Over the last half century, Mexico has warmed on average by 0.85°C and has experienced an increase in extreme weather events such as tropical cyclones, floods, and droughts (DOF 2014). It is categorized as one of the most vulnerable to natural hazards—for example, in 2010–11, Mexico experienced one of its worst droughts in seven decades (losing more than US$100 million on bean yields alone), as well as historically high negative impacts caused by hurricane Alex (Borja-Vega and de la Fuente 2013). As of 2014, 319 municipalities (13 percent of the national total) were characterized as highly vulnerable to the adverse impacts of climate change including droughts, floods, and landslides. Perhaps it is not surprising, that in a 2015 public opinion poll, Mexicans ranked climate change as their top global concern (Carle 2015).

Likewise, at the local level, the latest air pollution crisis caused by ozone in the Mexico City Metropolitan Zone had authorities scrambling for makeshift solutions–including banning around 40 percent of the vehicles in the metropolitan region on the worst days–and potentially increasing financial support to address the problem (EFE 2016). According to the nongovernmental organization CEMDA (2016), an estimated 1,823 of the city's residents died prematurely in 2015 because of air pollution, 90 percent of which came from vehicles. More sustainable solutions are urgently needed. Many of the same interventions needed to tackle climate change–including improved planning, transportation demand management, and cleaner, more efficient vehicles–can help alleviate this situation.

Taken together, promising developments in policy and technology, as well as the urgent need for action, create an unprecedented opportunity for change. It is not enough, however, to sit back and hope that change will occur. Despite its promising history of leadership, Mexico's record on climate change has been mixed–the country is not yet on track to meet its 2020 climate targets (UNEP 2015b), much less those for 2030 and beyond. Mexico will need to spell out a concrete plan for achieving its goals–one that takes into account the long-term goals in the Paris Agreement–and work diligently to integrate this plan horizontally across sectors, such as energy, transportation, industry, and land use, and vertically across jurisdictions, working in tandem with states and cities.

The Study in Brief

To help meet this need, this study aims to identify and evaluate the policy options available to Mexico to support the implementation of its INDC GHG mitigation targets in the context of national health and well-being and energy security.

We began by reviewing Mexico's GHG emission trends through 2030 from a 2014 baseline. Then, we constructed two "policy packages," one for achieving the unconditional target to reduce GHG emissions by 22 percent and the other for achieving the conditional target to reduce GHG emissions by 36 percent relative to the 2014 baseline by 2030. In constructing these policy packages, we emphasized options that provide the largest abatement opportunities, are cost-effective, and maximize co-benefits to human health and energy security. We also gave special consideration to policies that support long-term decarbonization of the economy, consistent with the goals of the Paris Agreement. Policy selection was informed by a literature review and a stakeholder consultation workshop, as well as computer modeling, described in section 2.1.

Stakeholders consulted during the development of the policy packages included:

- **Federal government:** Secretariat of Environment and Natural Resources (SEMARNAT), Secretariat of Energy (SENER), Secretariat of Foreign Affairs (SRE), Secretariat of Rural, Territorial and Urban Development (SEDATU), National Institute of Environment and Climate Change (INECC), National Commission for Efficient Energy Use (CONUEE), National Commission for Protected Areas (CONANP), National Center for Energy Control (CENACE).
- **Nongovernmental organizations:** Climate Initiative Mexico (ICM), Environmental Communication and Education S.C., Institute for Development and Transport Policies (ITDP).
- **The private sector:** Private Sector's Commission for Sustainable Development Analysis (CESPEDES-CCE), Alliance for Energy Efficiency (ALENER).
- **International agencies and organizations:** Danish Energy Agency, UN Food and Agriculture Organization-Mexico (FAO-México).

We propose a plan of action for Mexico to undertake the measures necessary to achieve its goals, while improving economic competitiveness, energy security, and the health of its citizens, and placing its economy on the track to longer-term decarbonization (Box 2).

Box 2 | Thinking Ahead: Toward a Long-Term, Low-Emission Development Strategy for Mexico

In June 2016, Mexico became the first developing country to commit to prepare a "mid-century, long-term low greenhouse gas emission development strategy," joining Canada, Germany, and the United States in pledging such a document by the end of 2016. These long-term strategies are an instrument of the Paris Agreement that can help bring national pledges into line with global goals. Under the 2015 Paris Agreement, Parties agreed to long-term goals to hold the increase in global average temperature to well below 2°C, to pursue efforts to limit the increase to 1.5°C, and to achieve net zero emissions in the second half of this century (UNFCCC 2015). Parties' current national commitments, however, are not consistent with these goals–warming is on track to reach 2.6°C to 3.1°C under current pledges (Rogelj, et al. 2016).

Fortunately, several mechanisms in the Paris Agreement and its accompanying decision can help strengthen future national commitments (Levin, et al. 2015). Among these are that by 2020, Parties will communicate or update their national commitments, and they will strengthen them every five years thereafter. Additionally, by 2020, Parties are invited to communicate "mid-century long-term low GHG emissions development strategies," or "long-term strategies." While the Paris text does not provide further guidance on the nature of these strategies, if used effectively, they can help ensure that future national commitments, as well as the implementation of existing commitments, are in line with the Agreement's long-term goals.

Why Mexico needs a long-term strategy

Depending on the pathways countries choose to implement their current commitments–which primarily target the period through 2030–there is a risk that they may actually make the long-term goals of the Paris Agreement more difficult to accomplish. This could happen because of the time it takes for expensive infrastructure, like power plants, buildings, and vehicle fleets, to reach the end of its lifespan and be replaced. To the extent that mitigation targets are met by making incremental improvements in the emissions-intensity of fossil-fueled infrastructure, the remaining emissions associated with this infrastructure may be "locked in" for decades to come. Replacing such technologies with emissions-neutral alternatives before the end of their lifespans would be expensive, but waiting until the end of their lifespans could put the Paris goals at risk.

Long-term strategies–that is, those that address emissions pathways through mid-century and beyond–provide an opportunity for countries to think through what the Paris goals mean for their own emissions trajectories, and in turn, what this implies for the best ways to implement their near- and mid-term mitigation targets. Countries like Mexico that take the Paris decision up on its invitation to develop such strategies can:

- Be prepared to make more ambitious commitments by 2020, consistent with the Paris goals
- Save money in the long run by avoiding investments that are inconsistent with achieving net zero emissions
- Foster innovation by sending the right signals to the private sector (Morgan, et al. 2015)

How Mexico can make its long-term strategy consistent with the Paris goals

Long-term strategies should be guided by the long-term goals of the Paris Agreement, including its goals to limit warming to well below 2°C and pursue efforts to limit warming to 1.5°C, as well as its goal to reach net zero emissions in the second half of the century. It will be important for Mexico to re-evaluate its existing target to reduce emissions 50 percent from 2000 levels by 2050 in light of the global milestones that need to be met to achieve the Paris goals. According to Levin et al. (2015), important factors to consider include:

- **When GHG emissions will peak and begin to decline.** IPCC (2014) suggests that emissions in all regions of the world must peak by 2020 to have a likely chance of limiting warming to 2°C in a cost-effective manner. This does not suggest, of course, that all countries must peak in that year–some countries have already peaked, while others (particularly those in earlier stages of development) will peak later. Encouragingly, Mexico's INDC mentions a peak year of 2026.
- **When to phase out net GHG emissions.** To have a likely chance of limiting warming to 1.5°C, global carbon dioxide emissions must reach net zero by 2045–50, and global total GHG emissions by 2060–80 (UNEP 2015b). For a likely chance of limiting warming to 2°C, the same milestones must be met no more than 15 to 20 years later. This does not suggest that every country must reach net zero at the same time, but it does imply that every unit emitted anywhere after these milestone dates must be offset by negative emissions elsewhere.
- **How to achieve a realistic decarbonization rate.** Mexico should ensure that the annual rate of emissions decline is feasible and avoid relying on overly steep reductions in later years, which would be costly and may not be technologically and socially feasible.

- **How to limit its cumulative emissions.** Temperature increase is directly related to the total amount of emissions in the atmosphere. This is the cumulative emissions in all years, rather than emissions in a single target year such as 2030. Setting regular milestones along the emissions reduction pathway to net zero emissions can help ensure that long-term strategies consider the need to limit cumulative emissions.

Implications for Mexico's INDC

Many possible combinations of policies could help Mexico achieve its INDC targets. Some of these combinations will be more conducive to long-term decarbonization than others. Existing literature highlights the key strategies that would underlie decarbonization in Mexico. These include ramping up energy efficiency, redesigning cities, shifting transport toward nonmotorized and mass transit modes, enhancing electrification of energy, and achieving carbon-neutral electricity (Tovilla and Buira 2015), avoiding infrastructure such as natural gas- and coal-fired power generation and fossil-fueled vehicles that presents a high risk of lock-in (Erickson, et al. 2015), and improving grid flexibility to accommodate a greater share of renewables. Many of these policies are emphasized in the scenarios modeled in this report; however, our analysis extends only until 2030, and does not fully address consistency with the Paris Agreement goals. Developing an INDC implementation plan in conjunction with a long-term strategy offers Mexico the opportunity to maximize synergies between near-term and long-term goals and avoid costly missteps that would prevent Mexico from achieving its long-term ambitions.

Source: This box is adapted in part from Fransen and Levin (2016).

2. METHODOLOGY

This study of climate and energy policy for Mexico relies on the Energy Policy Simulator, a powerful System Dynamics computer model that estimates the effects of various policies[8] on emissions, financial metrics, electricity system structure, and other outputs.[9] This section of the report discusses the Energy Policy Simulator and how it was adapted for Mexico.[10]

A wide array of policy options is available to advance the goal of mitigating GHG emissions. Policies may be specific to one sector or type of technology (for instance, light-duty vehicle fuel economy standards) or economy-wide (such as a carbon tax). Sometimes a market-driven approach, a direct regulatory approach, or a combination of the two can be used to advance the same goal. We used a computer model to help analyze the effects of these policies quantitatively, accounting for interactions among policies. Multiple policies enacted together often produce different results, such as more or less emissions abatement, than the sum of the effects of those policies enacted individually.

A satisfactory model must be able to represent the entire economy and energy system with an appropriate level of disaggregation, be easy to adapt to represent Mexico, be capable of representing a wide array of relevant policy options, and offer results that include a variety of policy-relevant outputs. More detail on using a computer model is available in the Technical Appendix.

2.1 Structure and Functionality of the Energy Policy Simulator

The Energy Policy Simulator assesses the effects of numerous energy and environmental policies on a variety of metrics, including the emissions of 12 pollutants;[11] cash flow changes for government, industry, and consumers; the composition of the electricity generation fleet; the use of various fuels; and lives saved from avoided particulate-caused mortality. The model is designed to operate at a national scale and focuses on five sectors: transportation, electricity supply, buildings, industry (including oil and gas), and land use. The model reports outputs at annual intervals with an initial year of 2015 and a final year of 2030.

A model user may freely specify the implementation schedule for any policy. In our scenarios, most policy effects are phased in linearly from 2017 through 2030.[12] For example, if the user selects a carbon tax of $\$10/tCO_2e$, then in 2016, the carbon tax is $\$0/tCO_2e$, halfway through the model run, the carbon tax will be $\$5/tCO_2e$, and in 2030, the carbon tax will be $\$10/tCO_2e$.

Unlike many energy and economic computer models, the Energy Policy Simulator does not construct a future baseline or reference scenario. Instead, it uses a reference scenario (based on the results of other scientists' studies and models) as input data. The model then modifies the reference scenario in response to the policy settings selected by the user. This approach enabled us to take advantage of the work[13] that has been done in this field, while providing novel capabilities to analyze policy options that are immediately useful to policymakers and suggest specific actions that could be undertaken.

2.2 System Dynamics

A variety of approaches exist for representing the economy and the energy system in a computer simulation. The Energy Policy Simulator is based on a theoretical framework called "system dynamics." As the name suggests, this approach views the processes of energy use and the economy as an open, ever-changing, nonequilibrium system. This may be contrasted with approaches such as computable general equilibrium models, which regard the economy as an equilibrium system subject to exogenous shocks, or disaggregated technology-based models, which focus on the potential efficiency gains or emissions reductions that could be achieved by upgrading specific types of equipment. For more information on system dynamics and on the Energy Policy Simulator's structure, please see the Technical Appendix.

2.3 Input Data

The model has significant input data requirements, necessitating the use of a variety of data sources. Whenever they are available, data from Mexican government sources were used. These data are often specific, such as the number of kilometers that passengers are traveling via different vehicle types or the quantity of fuel used by different industries. When future-year projections are not available from original sources, we often scaled present-day values by projections of Mexico's future GDP, population, or other relevant scaling factors.

When data were not available from Mexican government sources, we used published estimates specific to Mexico from reputable sources, such as the International Energy Agency and the U.S. Environmental Protection Agency. When no data specific to Mexico are available at all, we input United States data to represent Mexico, scaled by population, GDP, or other factors where applicable. This is most common for coefficients that relate certain (less commonly studied) policies or cost changes to their real-world responses, such as the elasticities of building component prices with respect to their energy efficiencies.

A table indicating the data and data sources for all relevant input data variables is in the Technical Appendix.

2.4 Model Limitations

Limitations of the Energy Policy Simulator are as follows:

- The Energy Policy Simulator relies on various scientific studies and modeling results to establish the effects of policies on physical quantities and costs. The studies typically investigated these relationships under a particular set of real-world conditions. These conditions cannot reflect all possible policy settings a user might select. Generally, the model's baseline case is likely to be closest to the conditions under which the various policies were studied by the creators of the input data. Therefore, the uncertainty of policy effects is likely smallest when policy levers are set at low values; uncertainty increases as the policy package includes a greater number of policies and the settings of those policies become more extreme.

- It is difficult to characterize uncertainty numerically. Almost all of the input data lacked numerical uncertainty information. Even if such bounds had been available, it would have been difficult to carry them through the model to establish uncertainty bounds on the final result. As a replacement, the Energy Policy Simulator supports Monte Carlo sensitivity analysis, which can highlight the sensitivity of the model results to changes in any particular input or set of inputs. A user who lacks confidence in a particular value may run a Monte Carlo simulation, varying the suspect value within the range that he/she believes is reasonable, to obtain a probability distribution for any output.

- Due to limits on available data that represent Mexico and the necessary use of scaled U.S. values for certain variables, certain policy responses may be larger or smaller in magnitude in the model than in reality. For example, because average household income is lower in Mexico than in the United States, many price elasticities might be lower in the United States than in Mexico (that is, wealthier consumers are less price-sensitive), causing the estimated effects of these policies for Mexico to be conservative.

3. MEXICO'S EMISSION TRENDS AND TRAJECTORY

Mexico's GHG emissions have continually increased between 1990 and 2010 (Instituto Nacional de Ecología y Cambio Climático 2012). In 2012, Mexico was the 13th highest GHG emitter in the world (Government of Mexico 2015) and, in 2013, the country's total GHG emissions were 665 $MtCO_2e$ (INECC/SEMARNAT 2015).

According to government projections, Mexico's emissions under a baseline scenario will increase by 46 percent by 2030 compared to 2013 levels, with total GHG emissions of 973 $MtCO_2e$ in 2030. However, the Mexican government has provided little information about how it constructed its baseline scenario. According to the government, the INDC baseline scenario was built using information from the National Inventory of Greenhouse Gas Emissions, with a 2013 base year (this was the first year after the 2012 General Law on Climate Change entered into force). The emissions were projected through 2030 based on economic growth, without the consideration of most climate policies adopted or implemented in 2012 or later.

For the purposes of this study, we constructed our own Baseline Emissions Scenario—one that mirrors the Mexican government's projections, but that is based on the country's 2014 data (e.g., energy, cost, energy use factors, emission factors). This was necessary because the Energy Policy Simulator requires detailed and disaggregated input data across many sectors, which are not available in published government scenarios. These input data must be compiled from a variety of sources, as no one source contains all the necessary data.

We attempted to mirror the government's official baseline scenario. However, in the model's Baseline Scenario, the total emissions are 4 percent larger than the official baseline scenario (this is likely due to different underlying assumptions and that the model's baseline was constructed using 2014 rather than 2012 data). Yet, the distribution of emissions by sector in the model's Baseline Scenario is similar to the official baseline scenario, although the model does group the oil and gas, waste, and agriculture and livestock sectors under the umbrella of "industry," which differs from Mexico's definition of industry. Table 1 presents the comparison of sector emission contributions in 2030 between the official baseline and the model's baseline.

Table 1 | **Comparison of Sector Emission Contributions between Mexico's Official Baseline and the Energy Policy Simulator Model Baseline Scenario**

SECTOR	OFFICIAL BASELINE[a] (PERCENT OF TOTAL EMISSIONS)	ENERGY POLICY SIMULATOR MODEL BASELINE (PERCENT OF TOTAL EMISSIONS)
Buildings	3	3
Electricity Sector	21	13
Industry Sector	46	59
Land Use, Land-Use Change and Forestry	3	3
Transport	27	24

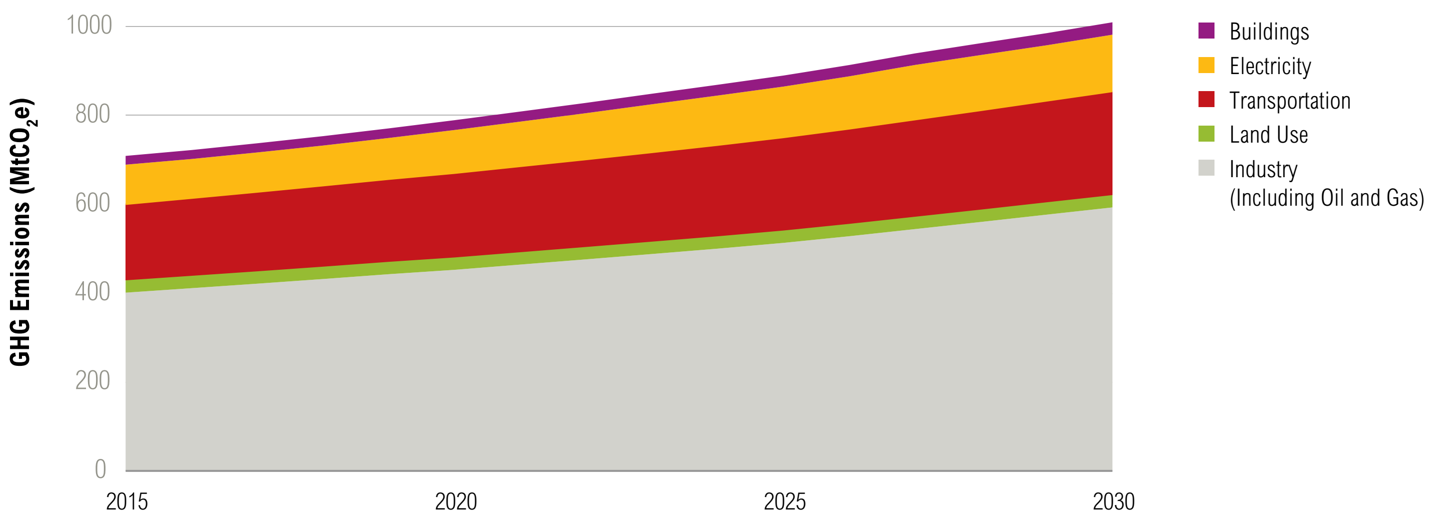
a. The emission contribution per sector in the official baseline is sourced from table 3 in "Mitigation and Adaptation Commitments to Climate Change for The Period 2020-2030" (in Spanish, "Compromisos de Mitigación y Adaptación ante el Cambio Climático para el Periodo 2020-2030;" (Government of Mexico 2014)). The differences between the official baseline and model baseline are predominantly due to different categorization of the sectors. For example, waste, agriculture, and oil and gas are categorized under "industry" in the model, which is in contrast to Intergovernmental Panel on Climate Change sector definitions.

The baseline scenario (2015–30) developed in this study is presented in Figure 1. In 2015, Mexico's GHG emissions were estimated at 709 $MtCO_2e$ and, in 2030, these emissions are anticipated to increase to 1,009 $MtCO_2e$. In 2015, the industry sector (including oil and gas) accounts for the largest share of Mexico's emissions, comprising 57 percent of the total GHG inventory. This is followed by the transport sector (24 percent), the electricity sector (13 percent),[14] land use (4 percent), and buildings (3 percent). The distribution of emissions by sector is similar to the Mexican government's projections considering that in our model the industry sector encompasses a broader set of activities than the traditional industry sector definition—it includes activities such as agro-industry, mining, oil and gas, and waste management.

In 2030, the industry sector (including oil and gas) remains the largest contributor to Mexico's GHG emissions profile, accounting for 59 percent of total emissions. This is followed by the transport sector (23 percent), the electricity sector (13 percent), land use (3 percent), and buildings (3 percent).

This Energy Policy Simulator baseline scenario is based on the climate and energy policies enacted in Mexico as of 2014. The Mexican government has implemented several new policies in the last two years that will impact GHG emissions (Box 3) but these policies are not modeled in a "revised baseline," mainly because the government has yet to announce the details for many of them. For example, the Energy Transition Law enacted in December 2015 mandates an energy efficiency target, but this target is yet to be established.

Figure 1 | **Mexico's Baseline Emissions Scenario by Sector (Energy Policy Simulator Model)**



Box 3 | **Recent Policies Implemented in Mexico**

Transport:

- According to the Federal Support Program for Mass Transportation, as of January 2016, there were 21 new bus rapid transit projects in two phases: thirteen projects were in preparation and eight were being evaluated for authorization.
- The Mexican Congress is working on a new Sustainable Mobility Law to facilitate the purchase of electric vehicles with larger federal and state government incentives, such as tax cuts and highway toll and parking exemptions.
- To improve air quality in the Mexico City megalopolis, the federal government enacted an emergency official standard (NOM-EM-167-SEMARNAT-2016) for the states of México, Hidalgo, Morelos, Puebla, Tlaxcala, and Mexico City. This emergency standard, which will take effect in 2016, aims for the compulsory verification of the private and public vehicular fleet and the measurement of emissions using the On Board Diagnostic.
- The Secretariat of Environment and Natural Resources (SEMARNAT) announced 168 policies and investments for 11 billion pesos (US$585 million) to renew the public transport fleet, improve urban mobility systems, and regulate emissions sources in industry and buildings.
- The National Strategy for Sustainable Urban Mobility has been announced, but there are no clear mechanisms for implementation, an action plan, targets, or indicators.
- A memorandum of understanding between The Netherlands and Mexico has been issued for cooperation on sustainable urban mobility.

Buildings:

- The Energy Efficiency and Sustainability Project in Municipalities is entering its second phase, where it will be implemented in four pilot cities with a total investment of US$156 million from the Government of Mexico and the World Bank. The first phase consisted of energy diagnostics in 32 municipalities using the Tool for Rapid Assessment of City Energy (TRACE) methodology.
- "Energy efficiency in inverter-type air conditioning" (NOM-026-ENER-2015) has been enacted.
- The Secretariat of Energy is developing the Incandescent Light Bulbs Replacement Program for residential buildings, best known as "Ahórrate una luz" (Save a light), after the Sustainable Light Program started by the former federal government. This program seeks to replace 32 million incandescent light bulbs with efficient bulbs in low-income localities with less than 100,000 inhabitants. About 3.5 million light bulbs were to be delivered by August 2015 in Oaxaca, Veracruz, and Chiapas.
- With the 2013 energy reform, the Secretariat of Energy launched the Clean Energy Auctions in April 2015. The result of the first auction was the assignment of 1,860 MW of capacity at US$50.7 million and 4 million Clean Energy Certificates to 11 projects from 7 developers. Seventy four percent of these certificates were awarded to photovoltaic projects, equivalent to 3.98 million megawatt-hours of energy in seven states. A second auction was planned for September 2016.

Electricity:

- The Energy Transition Law (enacted December 24, 2015) aims to regulate the sustainable use of energy and reduce emissions in the electric sector. It reiterates the goals of the Climate Change Law: to generate 25 percent of energy from clean energy sources by 2018; 30 percent by 2021; and, 35 percent by 2024. The law also mandates an energy efficiency goal, to be published in "Programa Nacional para el Aprovechamiento Sustentable de la Energía."
- The Electricity Sector Prospective 2015–2029 (Prospectiva del sector eléctrico 2015–2029) was issued in December 2015 as a planning instrument for the electricity sector.
- The Development Program for the National Electricity System 2016–2030 was issued on May 30, 2016 as a planning document for the national electric system with information about new and retirement capacity, generation by technology, and transmission and distribution programs.
- The National Strategy for Energy Transition and Sustainable Use of Energy (Estrategia Nacional de Transición Energética y Aprovechamiento Sustentable de la Energía) was issued on March 13, 2015 to promote public policies, programs, actions, and projects to increase the use of renewable sources and technologies, and to boost the energy efficiency and the diversification of the energy mix. The document has strategic goals and lines of action, but does not have emissions or energy reduction targets.

- To accelerate clean energy electricity generation, a notice requiring Clean Energy Certificates (Certificado de Energías Limpias; CER) was issued on March 31, 2015. The certificates were created in 2013 with the Energy Reform, and were built into the Electric Industry Act (enacted on August 11, 2014). They are applicable only to new capacity and a certificate is issued for each MWh.

Industry:

- The Annual Work Plan 2016 (issued July 27, 2016) presents actions and guides for small and medium businesses to identify opportunity areas for potential energy and cost savings.
- The Five-Year Expansion Plan of the National Transportation System and National Natural Gas Storage 2015–2019 (Plan Quinquenal de Expansión del Sistema de Transporte y Almacenamiento Nacional Integrado de Gas Natural 2015–2019) of December 18, 2015 presents projects for the expansion of natural gas on the national grid. It includes 13 projects with information about the length, investment, and the dates for tender and operation.
- The Five-Year Plan, Bidding for Exploration and Extraction of Hydrocarbons 2015-2019 (Plan Quinquenal de Licitaciones para la Exploración y Extracción de Hidrocarburos 2015-2019), issued July 10, 2015 presents the exploration areas for the extraction of hydrocarbons and includes the results from the tenders in this sector.

Cross-Sector:

- The Pilot Emissions Trading Scheme was launched August 15, 2016. The Secretariat of Environment and Natural Resources, the Mexican stock exchange and MÉXICO2 (the voluntary carbon platform at the Mexican stock exchange) signed a cooperation agreement to implement a voluntary pilot emissions trading system. It is expected that 60 major emitters from the power generation, manufacturing, and transport sectors will participate. Mexico intends to implement a national carbon market by 2018 according to the Climate Change Law.

4. SCENARIO SET-UP

As noted in the Introduction, Mexico included two emission reduction targets in its INDC (Government of Mexico 2015):

- **An unconditional emission reduction target**, in which Mexico committed to reducing 25 percent of its GHG and short-lived climate pollutant emissions below the baseline by 2030. This unconditional target implies a GHG reduction of 22 percent and a black carbon reduction of 51 percent by 2030.
- **A conditional emission reduction target**, in which Mexico committed to reducing 40 percent of its GHG and short-lived climate pollutant emissions below the baseline by 2030, conditional on a global agreement that addresses, among other things, an international carbon price, carbon border adjustments, technical cooperation, access to low-cost financial resources and technology transfer (all at a scale commensurate to the challenge of global climate change). This conditional target implies a GHG reduction of 36 percent and a black carbon reduction of 70 percent by 2030.

While the policies identified in Box 3 have the potential to reduce Mexico's GHG emissions relative to the baseline scenario, a broader array of reforms is likely to be needed–particularly if Mexico is to position itself to achieve deep reductions over the longer term in line with the Paris Agreement. In this section, we focus on the factors considered in selecting appropriate climate and energy policies to include in such a policy package. Henceforth, an indicative set of policies that can reach Mexico's unconditional GHG emission reduction target will be referred to as the unconditional scenario policy package, and an indicative set of policies that can reach Mexico's conditional GHG emission reduction target will be referred to as the conditional scenario policy package.

4.1 Approach for Selecting Policies to be Included in Mexico's Unconditional and Conditional Scenario Policy Packages

As discussed in section 2, the Energy Policy Simulator model provides the functionality to adjust the settings for 56 different policies that affect energy use and emissions in various sectors of the economy (such as a carbon tax, fuel economy standards for vehicles, reducing methane leakage from industry, and accelerated research and development to advance various technologies). However, implementing all 56 policies may not be feasible or appropriate in the context of Mexico's sociological and political environment.[15] Therefore, a four-step policy screening process was adapted from the qualitative co-benefit assessment method proposed by Dubash et al. (2013).

Step 1: Assess each policy in terms of GHG abatement potential.

Mexico's baseline scenario emissions trajectory (see section 3) made it clear that the country will need to go beyond actions taken to date to reach its 2030 emission reduction targets. Policies that can deliver significant GHG reductions will be key for reaching the unconditional and conditional GHG reduction targets in Mexico's INDC. With this in mind, all 56 potential policies were ranked qualitatively in terms of GHG abatement potential based on Mexico's national circumstances. Each policy was tested in the Energy Policy Simulator at a range of values within technically feasible limits to see the effects on overall CO_2e emissions. Then policies were assigned a letter grade (A, B, C, D, or E) using the following definitions:

- A: Large overall abatement potential. Adjusting the policy through realistic ranges easily moves the national total CO_2e emissions curve.
- B: Moderate overall abatement potential. Movement on the national total CO_2e curve is small but observable. Often given to policies that are strong in a particular sector, but that sector is too small to make the policy strong from the perspective of national total emissions.
- C: Small abatement potential. Barely moves the national total abatement curve, if at all. Small movement even on sector-specific emissions graphs.
- D: Zero or minimal abatement potential.
- E: The policy increases CO_2e emissions.

The goal of this grading exercise was to provide a general or intuitive sense of which policies are effective at accomplishing particular goals, not to convey quantitative results. Policies that ranked either A, B, or C in terms of GHG abatement potential moved on to the next stage of screening. Policies ranking D or E were deemed inadequate for reaching Mexico's GHG emission reduction targets and were excluded from further analysis. This does not mean that such policies should not be pursued for other reasons – only that they are unlikely to deliver significant progress toward the INDC targets.

Mexico's INDC also includes a long-term climate change goal, which is to reduce the country's emissions by 50 percent by 2050, relative to 2000 emissions. This goal is also contained in the country's 2012 General Law on Climate Change. More recently, in June 2016, Mexico committed to developing mid-century, long-term low GHG emissions strategies by the end of 2016 (White House: Office of the Press Secretary 2016). Therefore, climate and energy policies that might not deliver significant emission reductions in the short term in Mexico (due to political feasibility or technology constraints), but that do show promising abatement potential over the longer term, also moved on to the next stage of screening. These policies—for example switching from nonelectric passenger vehicles to electric passenger vehicles—are consistent with long-term decarbonization.[16]

Step 2: Assess each policy in terms of cost effectiveness.

Mexico's response to climate change is driven by the 2012 General Law on Climate Change, which sets a clear obligation to give priority to the least costly mitigation actions. Therefore, to ensure that the policy packages proposed are in line with this obligation, the policies ranking either A, B, or C in terms of GHG abatement potential in Step 1 were then assessed in terms of cost effectiveness, again using a letter grade (A, B, C, or D). The following definitions apply:

- A: Financial savings from the policy are larger than its costs.
- B: Financial savings are smaller than costs, but net costs are much lower than monetized social

benefits from avoided climate and human health damages. Avoided climate damages are based on CO_2e abatement and the U.S. social cost of carbon estimate. Human health damages are based on reductions in particulate-driven mortality and the "value of a statistical life."

- C: Net costs are similar in magnitude to monetized social benefits.
- D: Net costs are significantly higher than monetized social benefits.

Policies scoring a cost-effectiveness grade of C or higher moved on to the third (and final) stage of policy screening. Policies receiving a D in terms of cost effectiveness were excluded from further analysis, due to the low likelihood of their implementation.[17]

Step 3: Screen each policy for co-benefits.

Mexico's 2012 General Law on Climate Change also emphasizes the importance of selecting mitigation actions that deliver co-benefits and that support improved health. Specifically, it mandates that Mexico's National Strategy "shall reflect the objectives of the climate change mitigation and adaptation policies established by this Law, and shall include, among other elements...an assessment of the country's emissions and of actions that prioritize those sectors with the greatest potential for reduction while simultaneously providing environmental, social, and economic benefits." The Mexican government cites the well-being of the Mexican people as the major driver for including short-lived climate pollutants in the 2013 National Strategy on Climate Change, the 2014-2018 Special Program on Climate Change, and its INDC. As such, it is important to screen policies that had successfully passed through both Steps 1 and 2 for co-benefits.

The co-benefits assessed include energy security and improved health. Energy security was assessed due to the importance of maintaining Mexico's high levels of energy security while developing an appropriate response to tackling climate change, and health was assessed due to the intrinsic linkages between the climate, air quality, and health concerns in Mexico. Note that this is not a comprehensive review of all co-benefits, but those that stood out as important in this context and that are able to be quantified by the Energy Policy Simulator model.

Using a similar letter grading system as in Steps 1 and 2, where A represents the most positive co-benefit and D represents the least positive co-benefit, policies were assessed in terms of the benefits they can deliver. All policies that had successfully moved through Steps 1 and 2 were found to have positive (or no less than neutral) impacts on energy security and human health. Thus, these policies were deemed suitable to be included in a package of policies for reaching Mexico's unconditional and conditional GHG reduction targets. The policies with the most broad-ranging co-benefits were mainly in the transport and energy sectors: feebates for light-duty vehicles, fuel economy standards, vehicle electrification, renewable portfolio standards, and subsidies for renewable electricity production.

Step 4: Develop a list of policies to be included in a policy package for reaching Mexico's unconditional and conditional GHG reduction targets.

Based on the stepwise policy screening process, a package of policies was developed. These policies were then checked for political and technical feasibility during a national consultation process with government officials and national experts. This consultation took place in June 2016 and involved representatives of the private, public, and social sectors, such as federal government officers, members of nongovernmental organizations, representatives of the private sector, and independent consultants.

The 21 policies that show significant abatement potential, are cost effective, can deliver sufficient co-benefits (policies scoring particularly well on GHG abatement also scored very well on at least two co-benefit indicators) in Mexico, and are deemed technically and politically feasible are presented in Table 2. Please refer to the Technical Appendix for the ratings earned by each policy.

The 21 policies in Table 2 form the core of Mexico's unconditional and conditional scenario policy packages. The difference between the two policy packages is not the policies (except for two policies used only in the conditional package: LDV feebates and livestock measures), but rather the settings (or level of abatement) applied to each policy lever. This is further discussed in section 4.2.

Table 2 | **Policies that Show Significant Abatement Potential, Are Relatively Cost Effective, and Can Deliver Co-Benefits in Mexico**

SECTOR	POLICIES INCLUDED IN THE UNCONDITIONAL AND CONDITIONAL POLICY PACKAGES
Transportation	▪ Transportation demand management ▪ Feebates on light-duty vehicles ▪ Fuel economy standards for light-duty vehicles and heavy-duty vehicles ▪ Vehicle electrification
Buildings	▪ Distributed solar carve-out ▪ Energy efficiency standards
Electricity	▪ Demand response ▪ Increase transmission capacity ▪ Avoid transmission and distribution losses
Industry (including oil and gas)	▪ Methane capture ▪ Reduced venting of high global warming potential gases (F-gases) ▪ Industry energy efficiency standards ▪ Cement clinker substitution ▪ Cogeneration and waste heat recovery ▪ Industrial fuel switching ▪ Early retirement of inefficient industrial facilities
Land Use and Agriculture	▪ Avoided deforestation ▪ Afforestation and reforestation ▪ Livestock measures
Cross-Sector	▪ Carbon tax ▪ End existing petroleum fuel subsidies

4.2 Choosing Policy Settings to Reach Mexico's Unconditional and Conditional GHG Reduction Targets

The next step was to select the level of abatement that can be achieved by each policy (see Table 2) from the standpoint of technical feasibility, referred to here as a "policy setting." Two settings are required for each policy: (1) a policy setting for reaching Mexico's unconditional GHG reduction target and (2) a (more ambitious) policy setting for reaching Mexico's conditional GHG reduction target. The choice of policy settings depends on existing and proposed laws and regulations, bilateral announcements, national targets, and technical and political feasibility.

An iterative process is required involving (1) choosing initial policy settings for reaching Mexico's unconditional and conditional GHG reduction targets based on the factors mentioned above; (2) inputting these settings into the model and running it; (3) checking how close the initial policy package is to reaching Mexico's stated goals; and (4) tweaking the policy settings to reach Mexico's goals, based on what is feasible in the context of the country's national circumstances.

The policy settings selected to reach Mexico's unconditional and conditional GHG reduction targets—as a result of this iterative process—are presented in the Technical Appendix, along with the rationale for selection. A summary is presented in Table 3.

Table 3 | **Summary of Policy Settings Used in Baseline, Unconditional, and Conditional Policy Packages, 2017–30**

SECTOR	POLICY	BASELINE POLICY SETTING	UNCONDITIONAL POLICY SETTING	CONDITIONAL POLICY SETTING
Cross-Sector	Carbon tax	$0/t$CO_2$e	$15/t$CO_2$e	$55/t$CO_2$e
Cross-Sector	Reduce petroleum subsidies	Average petroleum subsidy per unit ($/BTU) is 3.15E-06	All petroleum subsidies are removed	All petroleum subsidies are removed
Transportation	Light-duty vehicle (LDV) fuel economy standards	14.9 km per liter	40% improvement above the baseline	87% improvement above the baseline
Transportation	Heavy-duty vehicle (HDV) fuel economy standards	No standard currently enacted. Baseline is the calculated current average fuel economy of Mexico's HDVs (51.02 - 56.43 freight tonne-km/l)	20% improvement above the baseline	45% improvement above the baseline
Transportation	Passenger LDV electrification	<1% of passenger LDVs electrified	2% of passenger LDVs electrified	5% of passenger LDVs electrified
Transportation	Passenger HDV electrification	<1% of passenger HDVs electrified	2% of passenger HDVs electrified	5% of passenger HDVs electrified
Transportation	Transport demand management measures	No additional transport demand management measures enacted above the efforts in place in 2014	4% reduction in passenger-km traveled in LDVs, 9.3% increase in HDVs, 4.5% decrease in aircraft, 16% increase in rail, 7.5% decrease in motorbikes (no effects on freight transport)	8% reduction in passenger-km traveled in LDVs, 18.6% increase in HDVs, 9% decrease in aircraft, 32% increase in rail, 15% decrease in motorbikes (no effects on freight transport)
Transportation	Passenger LDV feebate	None	None	$210/.01 liters per km
Electricity	Transmission growth	16,655,698 kilovolt kilometer (kV-km) increase above 2014 levels	30% above the baseline	60% above the baseline
Electricity	Reduce transmission and distribution losses	13.9% reduction relative to 2014 levels	22% reduction relative to baseline	43% reduction relative to baseline
Electricity	Demand response	4,248 MW capacity is on the grid by 2030 to improve flexibility	12,340 MW capacity is on the grid	12,340 MW capacity is on the grid
Electricity/Buildings	Distributed solar carve-out	<1% of total electricity generated from distributed solar (on residential and commercial buildings)	1% of total electricity generated from distributed solar	2% of total electricity generated from distributed solar
Buildings	Standards for cooling equipment	Based on the National Commission for Energy Efficient Uses (CONUEE's) estimations on energy use reductions derived from the levels enforced	30% reduction in energy use relative to baseline	50% reduction in energy use relative to baseline

Buildings	Standards for building envelope	Based on CONUEE's estimations on energy use reductions derived from the levels enforced by existing regulations in 2014	20% reduction in leakage relative to baseline	40% reduction in leakage relative to baseline
Buildings	Standards for lighting	Based on CONUEE's estimations on energy use reductions derived from the levels enforced by existing regulations in 2014	10% reduction of energy use relative to baseline	20% reduction of energy use relative to baseline
Industry	Cement clinker substitution	No change in clinker percentage from 2014 levels	15% reduction from 2014 levels	15% reduction from 2014 levels
Industry	Reduce fluorinated gas (F-gas) emissions	F-gas emissions are 37.7 $MtCO_2e$ in 2030	50% reduction relative to baseline	98% reduction relative to baseline
Industry	Convert natural gas to electric equipment	No additional equipment is converted from natural gas to electricity	2% of the natural gas used in industry is replaced by electricity	5% of the natural gas used in industry is replaced by electricity
Industry	Early facility retirement	Industrial facilities are used for the duration of their expected useful economic lifetimes	Early retirement affects 6.3% of cement facilities, 4.5% of natural gas and petroleum facilities, 8.5% of iron and steel facilities, 2.0% of chemical facilities, and 1.6% of other industrial facilities	Early retirement affects 6.3% of cement facilities, 4.5% of natural gas and petroleum facilities, 8.5% of iron and steel facilities, 2.0% of chemical facilities, and 1.6% of other industrial facilities
Industry	Methane capture	Methane leakage and venting from industry is 9.4 $MtCO_2e$ in 2030	16% reduction relative to baseline	36% reduction relative to baseline
Industry	Cogeneration and waste heat recovery	No increase in rate of usage of cogeneration and waste heat recovery in industrial facilities	All identified opportunities are realized, resulting in a 3.9% reduction in fuel use for non-agriculture industries	All identified opportunities are realized, resulting in a 3.9% reduction in fuel use for non-agriculture industries
Industry	Equipment efficiency standards	8% improvement relative to 2014 levels	30% improvement relative to baseline	30% improvement relative to baseline
Land Use	Avoid deforestation[a]	No additional avoided deforestation measures are implemented, above those already in place in 2014	CO_2 emissions from Land Use Land-Use Change and Forestry (LULUCF) are reduced by 16% relative to baseline	CO_2 emissions from LULUCF are reduced by 43% relative to baseline
Land Use	Afforestation/ reforestation[a]	No additional afforestation/ reforestation measures are implemented above those already in place in 2014	CO_2 emissions from LULUCF are reduced by 21% relative to baseline	CO_2 emissions from LULUCF are reduced by 58% relative to baseline
Agriculture	Livestock measures	None	None	GHG emissions are reduced by 3.5 $MtCO_2e$/yr (2.3% of Agriculture Sector emissions)

Note: Values given for unconditional and conditional targets are for 2030; policies are phased in linearly from baseline level beginning in 2017.

a. The combined effect of the two Land Use policies in the Conditional Scenario achieve Mexico's objective of net zero anthropogenic CO_2 emissions from forests, which is in line with current consolidation of Reduced Emissions from Deforestation and Forest Degradation (REDD++) strategies.

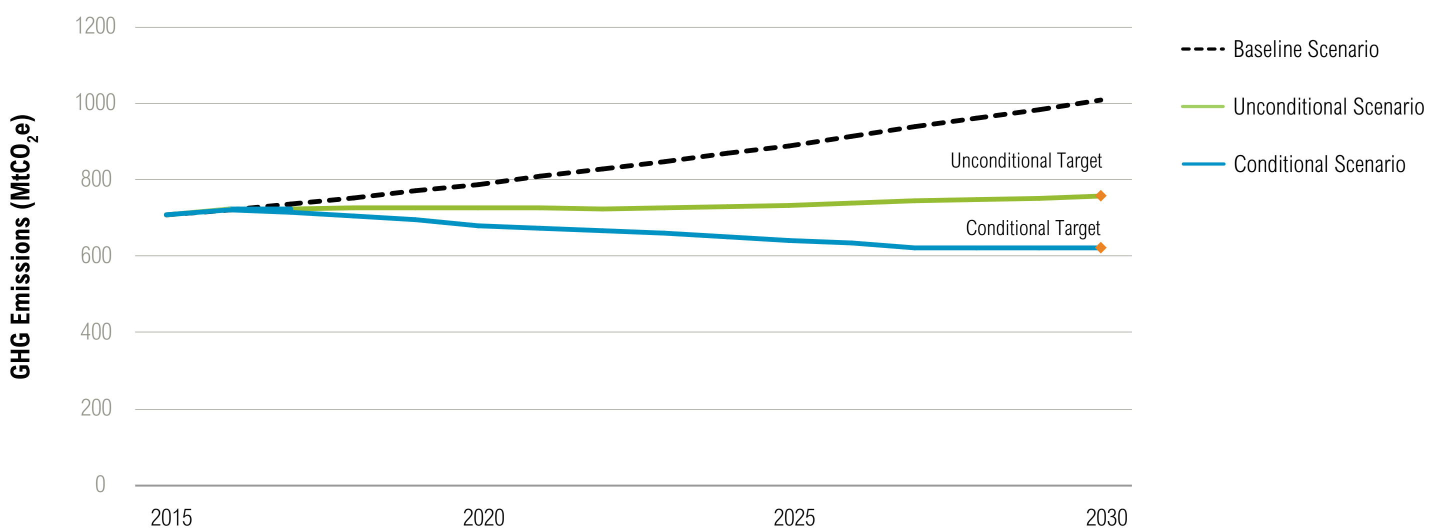
The combinations of policies and settings represented by the unconditional and conditional policy packages are not the only such combinations capable of achieving the INDC mitigation targets; rather, they are indicative sets of policies selected on the basis of the criteria and process outlined above to illustrate robust options for how Mexico can achieve its targets in a cost-effective, feasible manner alongside other co-benefits.

5. FINDINGS

5.1 Emission Trajectories

The emission trajectories required to meet Mexico's unconditional and conditional GHG reduction targets are presented in Figure 2 along with Mexico's emissions trajectory under a Baseline Scenario. Under the Baseline Scenario, Mexico's total emissions are 1,009 $MtCO_2e$ in 2030. To meet the country's unconditional and conditional GHG reduction targets, emission levels of 758 $MtCO_2e$ and 623 $MtCO_2e$, respectively, are required in 2030. In both the Unconditional and Conditional Policy Scenarios, about 50 percent of the emission reductions are achieved by three policies: (1) improving industrial efficiency standards; (2) implementing a carbon tax; and (3) improving methane capture. This gives an indication of the type of policies that Mexico needs to focus on; the government should improve GHG reduction measures in industry (including the oil and gas sector) and implement policies that increase the efficiency of the economy.

Figure 2 | **Mexico's Emissions Trajectory under the Baseline Scenario, along with the Emissions Trajectories Required to Meet the Unconditional and Conditional GHG Reduction Targets**



5.2 Policy Contributions to Meet Mexico's Unconditional and Conditional GHG Reduction Targets

The policy contributions to GHG emissions abatement in the unconditional and conditional policy packages are shown in Figures 3 and 4.

In the unconditional policy package, the industrial efficiency standards policy delivers the largest level of GHG abatement in 2030 (contributing to 24 percent of the emission reductions required to meet the unconditional GHG reduction target). This is followed by methane capture (contributing to 15 percent of emission reductions) and carbon tax (contributing to 12 percent of emission reductions at a level of $15/tCO_2e$).

In the conditional policy package, the same three policies deliver the highest levels of GHG abatement, just with differing levels of magnitude. Carbon tax is shown to be the strongest policy (contributing, at a level of $55/tCO_2e$,[18] 19 percent of the emission reduction required to meet the conditional GHG reduction target), followed by methane capture (18 percent) and industrial efficiency standards (15 percent).

These results highlight the importance of taking strong action to tackle GHG emissions in Mexico's industrial activities and the need for new legislation on carbon tax. Pricing carbon to reflect its true external costs to society is an economically efficient way to drive emissions reductions and provide incentives to undertake the lowest-cost abatement opportunities (Energy Innovation 2015; Kennedy, Obeiter, and Kaufman 2015).

Figure 3 | **Policy Contributions to GHG Abatement to Meet Mexico's Unconditional GHG Reduction Target**

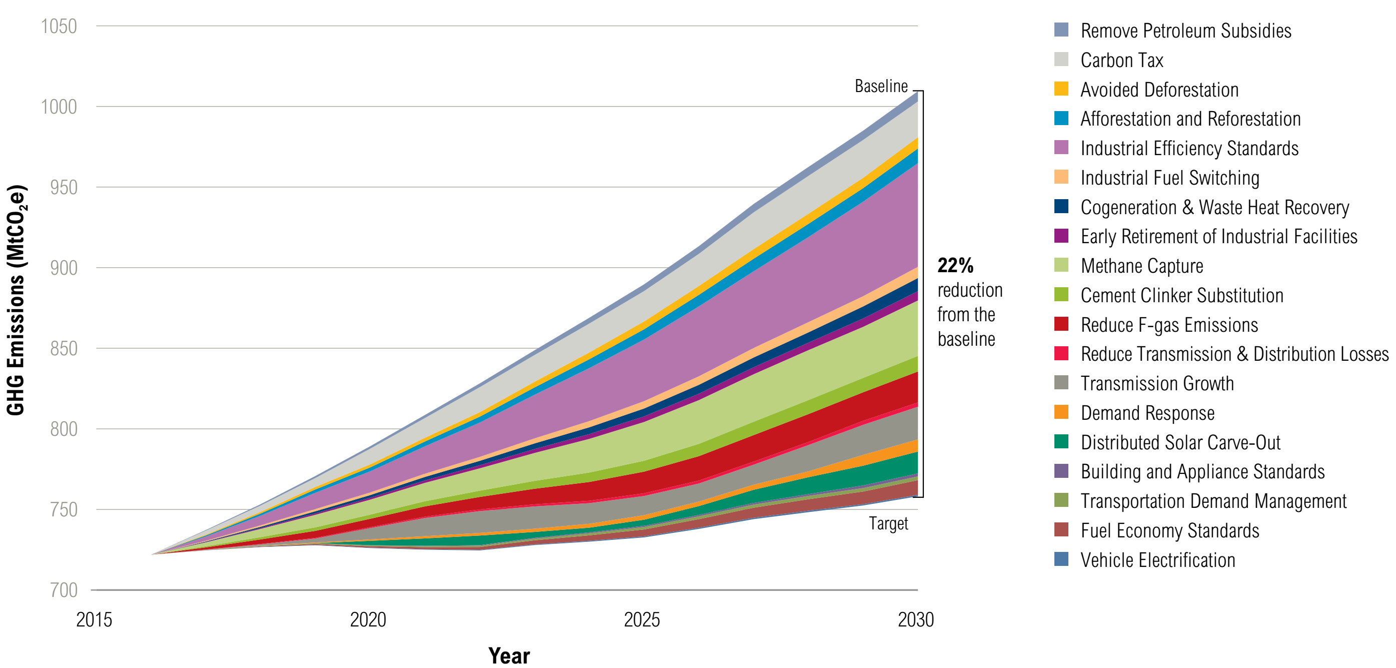
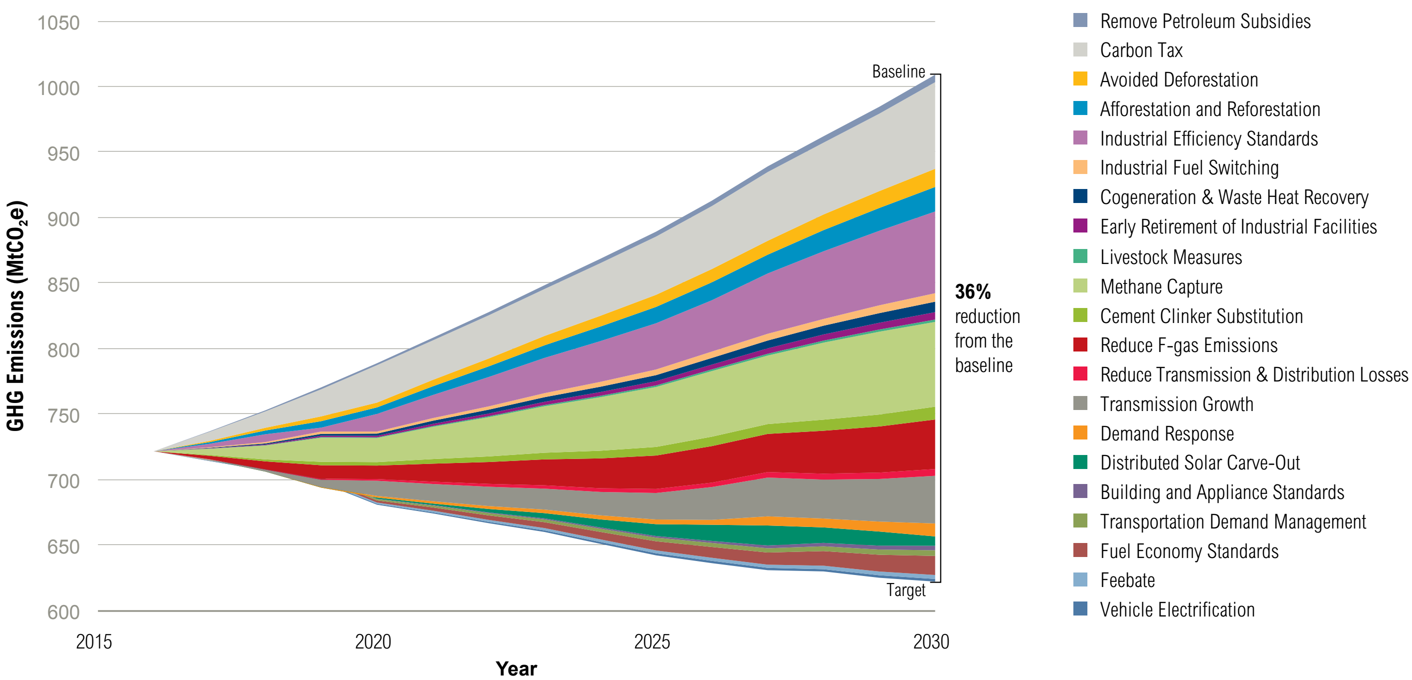


Figure 4 | **Policy Contributions to GHG Abatement to Meet Mexico's Conditional GHG Reduction Target**

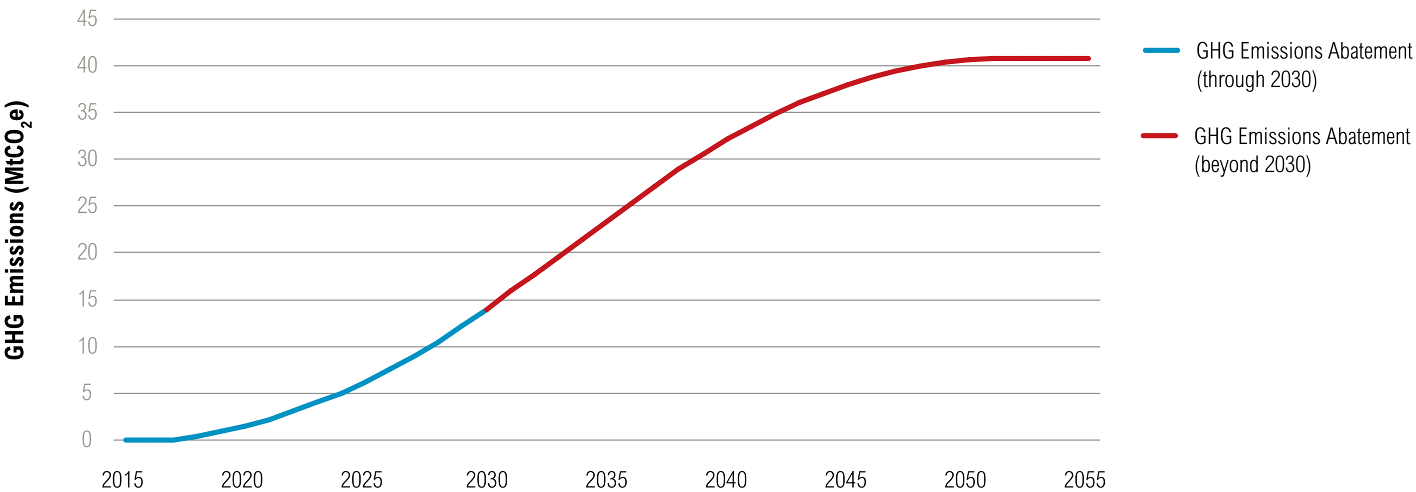


5.3 Policies Showing Significant GHG Abatement Post-2030

The Energy Policy Simulator model runs only until 2030, but some policies show significant abatement potential post-2030 and therefore are also included in Mexico's unconditional and conditional policy packages. This is especially true for vehicle fuel economy standards and building component energy efficiency standards.

To illustrate this, we can examine light-duty vehicle fuel economy standards. Due to the time it takes for the fleet to turn over, and the fact that the policy is implemented on a theoretically linear basis in the model (so it covers 100 percent of vehicles in 2030), much of the GHG abatement for vehicle fuel economy standards is achieved after 2030, as shown in Figure 5. The abatement from the light-duty vehicle fuel economy standard shows a logistic growth. Increases are gradual at first, when the standard begins to be enforced. Growth accelerates through 2030, where it reaches an inflection point, as the standard continues to increase in stringency. Thereafter, growth slows down, as the standard remains fixed and the fleet gradually turns over, first replacing the oldest (and least-efficient) vehicles, then replacing the newer vehicles. By 2055, essentially all vehicles on the road were purchased after the standard reached its full strength in 2030. (Figure 5 was produced using a special model run through 2055, and shows the increase in GHG abatement post-2030, even as fuel economy standards remain fixed after 2030.)

Figure 5 | **Charting Light-Duty Vehicle Fuel Economy Standards to 2050 Illustrates the Delay Caused by Fleet Turnover**



5.4 Policy Package Costs

What do we Mean by the "Costs" and "Savings" of a Policy Package?

In addition to the effects a policy package will have on pollutant emissions, policymakers are often concerned about the financial costs that would result from the policies. A policy package's cost can be examined in several ways, depending on the audience and purpose. Ideally, to understand the potential net economic impacts of undertaking a given policy package, a full benefit-cost analysis should be undertaken to look at the monetary and nonmonetized costs and benefits across various actors, including for example, the health or employment impacts. Specific groups of actors may be interested in the specific net benefits or costs that may accrue to them; whereas those who would need to implement the actions in the policy package will be interested in the financial costs and the returns on investment, and the time-scale in which they accrue.

The model used in this analysis calculates cash flow changes, which represent the direct (first-order) transfers of money from one entity to another as a result of the active policy package.[19] These can be useful for understanding who benefits and who has to pay for an action. The total of all transfers sums to zero, thus, summing all cash flow changes is not a useful metric of policy cost.

The Energy Policy Simulator Model provides several policy cost metrics. The one we focus on in this report is "total change in capital, fuel, and operations and maintenance expenditures." We exclude all changes in spending that are not on capital, fuel, or operations and maintenance. The most important type of spending related to climate action that is excluded by this definition is the payment of subsidies. A couple other minor types of spending are excluded as well, such as carbon tax payments on process emissions and payment of a carbon tax rebate (a reduction in carbon taxes paid) to reward sequestration of CO_2. Another metric in the Energy Policy Simulator, Total Change in Outlays, includes all spending, even transfer payments such as subsidies.

The cost metric that we report looks at a subset of direct (first-order) cash flow changes caused by the policy package. The model does not attempt to estimate higher-order impacts, for example, how government might spend increased tax revenues and what that would do for the economy. In our analysis we follow the assumption that some policies such as the carbon tax and feebates are revenue-neutral (i.e., they are used to offset reductions in other taxes). Hence, we assume that the government does not use the carbon tax to raise revenues but to change the behavior of people. The neutrality in tax outlays helps to remove taxes on things that society wants to encourage (for example, employment or income) and increases taxes on things it wants to discourage (for example, GHG emissions). A carbon tax may help to reduce payroll, personal income, or corporate income taxes and could provide broader tax reform (Kaufman, Obeiter, and Krause 2016).

Policy Package: The Costs and Savings Assessed by the Model

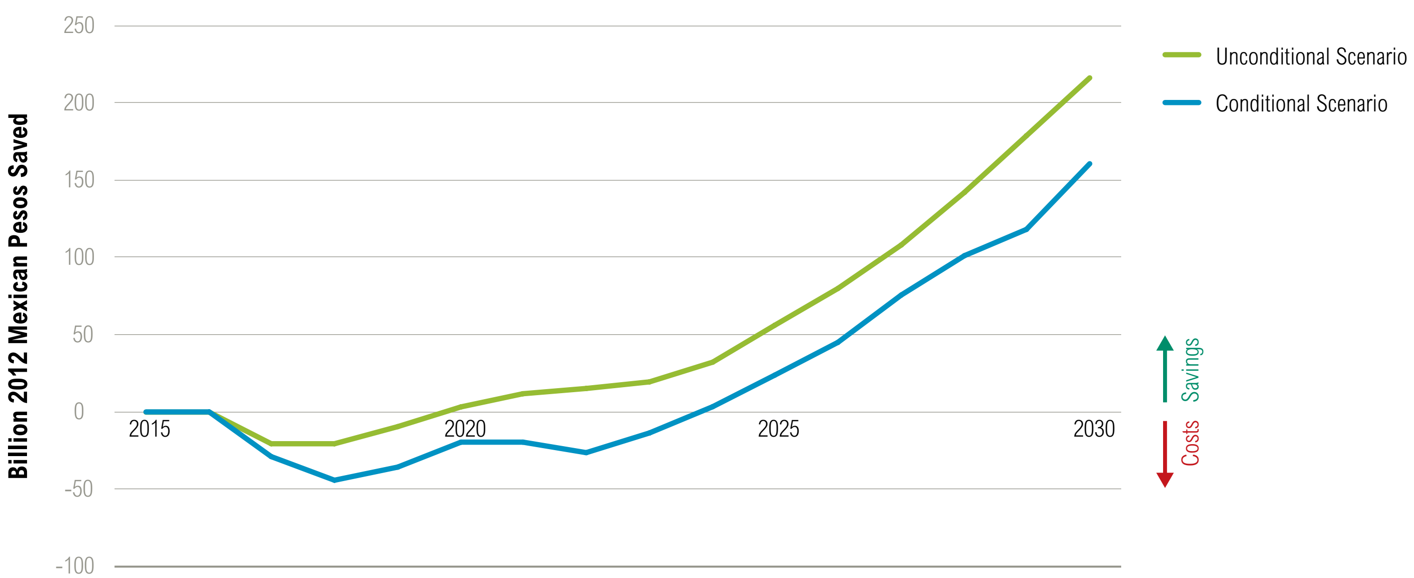
Figure 6 shows the total change in capital, fuel, and operational expenditures for the Unconditional and Conditional Scenarios using the revenue-neutral carbon tax assumption. In general, costs are highest in the early years of the model run, as equipment is upgraded and purchasing decisions are shifted toward more efficient (and generally more capital-intensive) options. Fuel savings at this point are minimal, because only a small portion of the entire capital stock has been replaced.

In later years of the model run, costs decline and turn into net savings. This is the point at which fuel savings from the accumulated quantity of improved equipment in the economy outweighs the ongoing, increased capital investments.

Under these assumptions, the Unconditional Policy Scenario begins achieving net savings by 2020 and the Conditional Scenario by 2024.

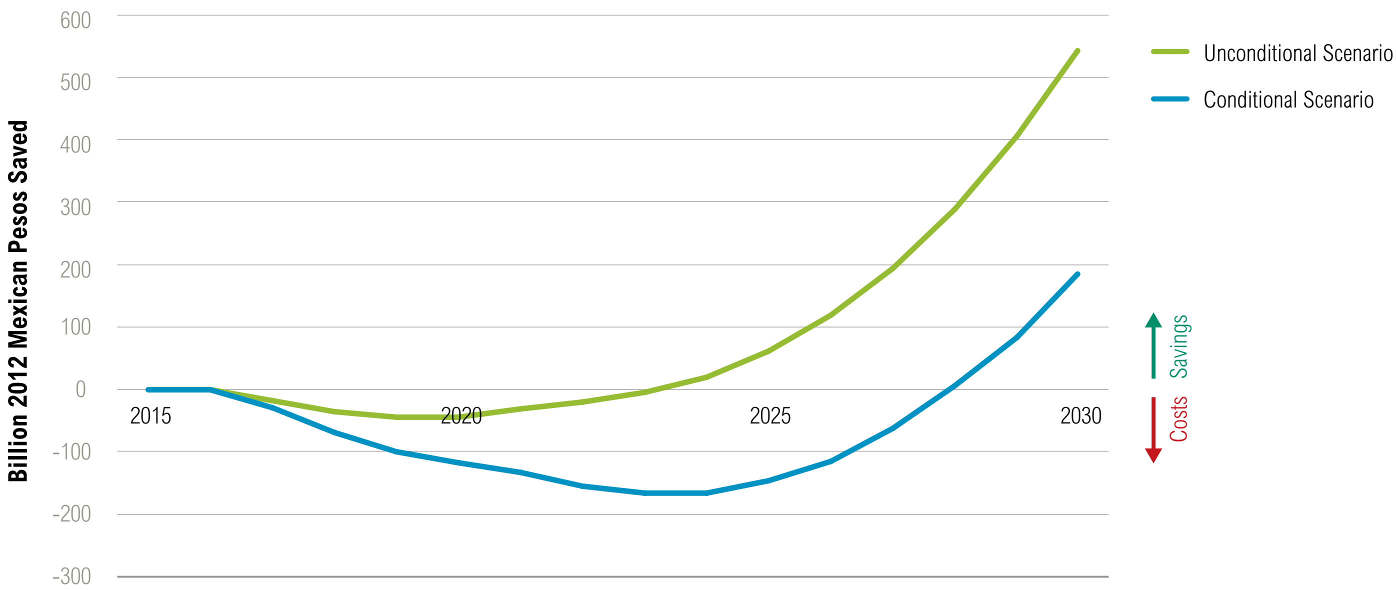
Policymakers often wish to make policy decisions by looking at the cumulative effects of policies over time, with future cash flows properly discounted. This is similar to the way an investor would consider a prospect when making an investment decision. Figure 7 shows the costs and savings limited to the selection of the policy packages chosen, cumulated across time, using a 3 percent discount rate. We choose a 3 percent discount rate because it is preferred by the U.S. government in its Social Cost of Carbon calculations.[20] Moreover, in the United States, many agencies use traditionally constant discount rates of either 3 or 7 percent in their cost-benefit

Figure 6 | **Annual Costs and Savings of Unconditional and Conditional Scenario Policy Packages**



Note: Assumes carbon tax is revenue neutral.

Figure 7 | **Cumulative Costs and Savings of Unconditional and Conditional Scenario Policy Packages**



Note: Discounted at 3 percent from a base year of 2015. Assumes carbon tax is revenue neutral.

analyses. For analysis involving climate change, recent estimates (Greenstone, Kopitsy, and Wolverton 2013) have recommended use of three constant discount rates: 2.5 percent, 3 percent, and 5 percent. However, there is an ongoing debate on how the uncertainty surrounding climate change may require use of a nonconstant, declining discount rate.[21]

As shown in Figure 7, our modeling analysis concludes that the unconditional scenario policy package has paid for itself by 2023 and the conditional scenario policy package has paid for itself by 2028 under these assumptions. By the model's end year of 2030, the unconditional scenario policy package has achieved over 500 billion pesos of net savings (about 2 percent of the 2015 GDP), and the conditional scenario policy package has achieved nearly 200 billion pesos of net savings (about 0.8 percent of the 2015 GDP) on the direct expenditures. Beyond 2030, savings would continue to accumulate.

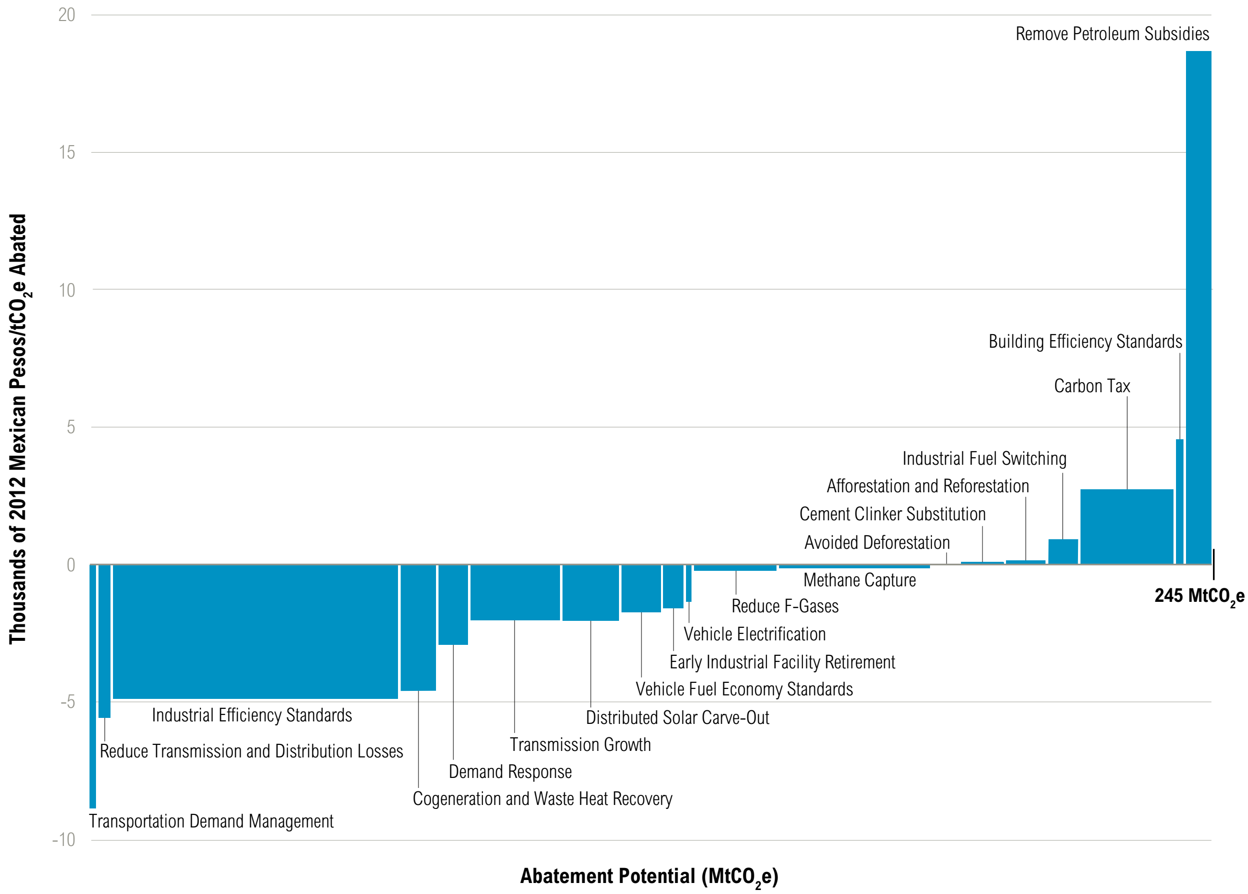
As mentioned above, this cost metric includes only selected changes in expenditures–in this case only costs and savings from the change in capital, fuel, and operations and maintenance expenditures. It does not capture many other benefits, including the expected benefits of reduced risks of climate impacts, nor lower health costs and mortality from reduced particulate emissions. Once these other benefits are taken into consideration, it is likely that the policy packages would achieve net benefits much sooner.

Cost-Effectiveness of Individual Policies

Previously, we considered the cost-effectiveness of policy packages as a whole. It is also possible to analyze the cost-effectiveness of specific policies that make up the policy packages. To do this, we start with the complete policy package and disable each policy in turn, recording the change in emissions and in costs/savings. This provides insight into which aspects of our policy packages achieve the most cost-effective abatement.

Results can be displayed as a cost curve in which each policy is represented as a box. The width of each box (along the X-axis) represents its CO_2e abatement. The height of each box (along the Y-axis) represents its cost-effectiveness in thousands of pesos per ton of CO_2e abated. Policies that appear below the X-axis (0) have net savings, while policies that appear above the X-axis have net costs.

Figure 8 | **Cost Curve for the Unconditional Scenario Policy Package**



Note: Policies that appear below the X-axis (0) have net savings, while policies that appear above the X-axis have net costs. The width of the box indicates the amount of CO_2e abatement.

Figure 8 shows the cost curve for the unconditional scenario policy package in year 2030.

The policy that achieves the greatest CO_2e abatement is improved industrial efficiency standards. This policy is set to a very aggressive setting (30 percent reduction in energy use over baseline improvements), so it achieves substantial emissions reductions. Policies such as industrial efficiency standards and vehicle fuel economy standards are not only relatively cost-efficient but also result in high levels of co-benefits. Fuel savings outweigh capital equipment costs by 2030, making them strongly cost-saving.

The policy with the most cost savings is transportation demand management, partly because of the size of the population benefitted. The mode shifting caused by this policy leads to a net reduction in fuel consumption, because recipient modes (particularly passenger buses) are more fuel-efficient on a passenger-kilometer basis than individual cars. Additionally, some trips are shifted to nonmotorized modes, such as walking and biking, which do not entail fuel costs. Note that the model calculates only changes in the amount spent on fuel and vehicles, not on infrastructure such as highways or subway lines. Therefore, the costs of buying more public transit infrastructure, or building biking and walking paths are not included. However, the costs of building or expanding highways and other roadways, in the absence of the transport demand management package, are not included either. Were both sorts of infrastructure investments factored in, it is not clear whether the transport demand management package would increase or decrease total infrastructure costs.

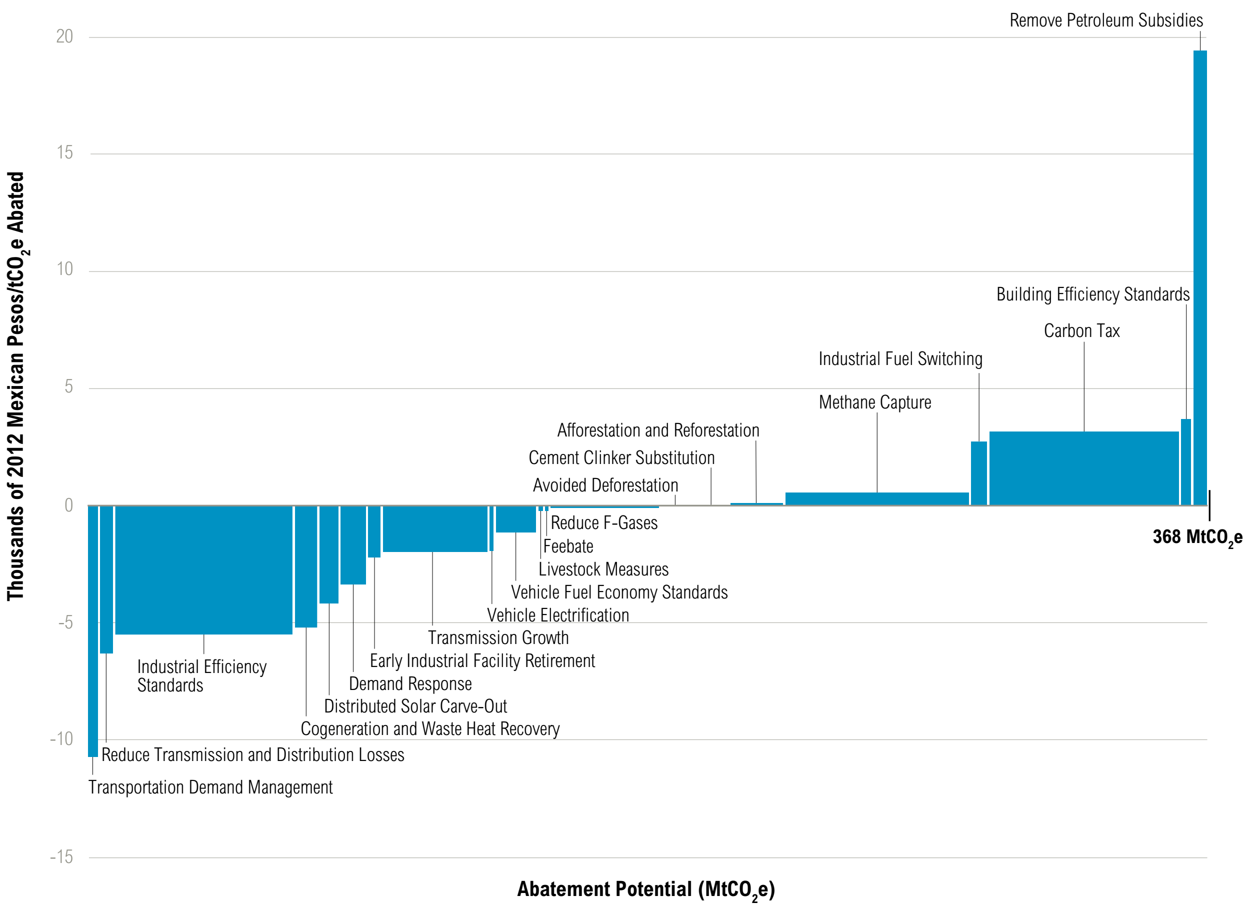
It has been shown that increased investment in infrastructure, if done well, can lead to growth (IMF 2014). Also, the development of greener infrastructure would have environmental co-benefits for Mexico.

The carbon tax has the second-highest abatement of the policies included in the unconditional scenario package (at US$15/t$CO_2$e). Carbon taxes are often thought of as an efficient way to monetize externality costs and allocate them across society to minimize economic burden. A carbon tax is a powerful and relatively cost-effective policy. There are some concerns about potential competitiveness losses when a carbon tax is raised. However, studies (Landa-Rivera, et al. 2016) show that for Mexico, this loss may be small and it will depend on very restrictive assumptions such as high prices for renewables and a lack of further commitment from the international community regarding carbon pricing.

Efficiency standards for buildings appear to have positive costs partly because buildings and building components generally have long lifetimes, and the policy is ramped in linearly only through 2030 when most improvements in the efficiency of the building stock would not yet be realized. Additionally, the elasticity of building component price with respect to efficiency tends to be high, resulting in longer payback periods than with some other types of equipment. Nonetheless, building efficiency standards are a valuable and worthwhile policy, in part because they will provide incentives to developers to invest in efficiency even though they will not directly benefit partly because the tenants pay the energy bills. Thus, this is one of the few ways to avoid the split incentives problem, which is acute in the buildings sector.[22]

The cost curve for the conditional scenario policy package is shown in Figure 9.

Figure 9 | **Cost Curve for the Conditional Scenario Policy Package**



Note: Policies that appear below the X-axis (0) have net savings, while policies that appear above the X-axis have net costs. The width of the box indicates the amount of CO_2e abatement.

The total emission reductions in the conditional scenario policy package is 387 $MtCO_2e$, 54 percent more than the 251 $MtCO_2e$ reduction in the unconditional scenario policy package. The carbon tax, industrial efficiency standards, and methane capture remain the three most important policies in terms of abatement. Though there are some small differences (such as an increase in the cost of the methane capture policy), policies generally have the same order of cost-effectiveness at their stronger conditional scenario policy package settings as they did at the settings used in the unconditional scenario.

5.5 Co-Benefits Achieved through the Implementation of Mexico's Unconditional and Conditional Scenario Policy Packages

The implementation of Mexico's unconditional and conditional scenario policy packages can also deliver significant co-benefits. This is discussed further in this section, from the perspective of the health and well-being of Mexico's population.

Health Benefits Associated with Taking Climate Action

The health benefits associated with implementing climate and energy policies are understood in terms of reducing both the mortality (registered deaths) and the morbidity (nonfatal diseases) associated with the change of exposure to pollutants in the population. In practice, only data on pollutant effects on mortality, not morbidity, are available, so only mortality was considered in this analysis. The main criteria pollutants with implications for public health are: sulfur oxides (SO_x), nitrogen oxides (NO_x), volatile organic compounds (VOCs), carbon monoxide (CO), and particulate matter (PM). Particulate matter with a diameter of less than 10 micrometers (PM_{10}) poses a special health risk because these particulates can accumulate in the respiratory system. Even more dangerous are fine particles of less than 2.5 micrometers in diameter ($PM_{2.5}$) which are believed to pose the greatest health risks because they can embed deeply into the lungs due to their small size. To provide some perspective on the size of particulate matter, the average human hair is about 70 micrometers in diameter – making it 30 times larger than the largest fine particle (EPA 2016).

Maximum permissible limits of particulate pollution have been established for several countries, including Mexico. Table 4 shows the World Health Organization and the Mexican regulatory standards (NOM-025-SSA1-2014) for maximum particulate pollutant concentration and related time exposure. Mexican standards have higher allowed levels for 24-hour and annual periods for exposure on both PM_{10} and $PM_{2.5}$. While Mexico's standards are less stringent than those of the World Health Organization, they are stricter than they were previously.[23]

Table 4 | **Particulate Matter Emissions and Recommendations by the World Health Organization and the Mexican Regulatory Standards for Health Protection**

POLLUTING AGENT	WORLD HEALTH ORGANIZATION CONCENTRATION (TIME)	MEXICAN REGULATORY STANDARDS CONCENTRATION (TIME)
PM_{10}	50 μg/m^3 (24-hour average) 20 μg/m^3 (annual average)	75 μg/m^3 (24-hour average) 40 μg/m^3 (annual average)
$PM_{2.5}$	25 μg/m^3 (24-hour average) 10 μg/m^3 (annual average)	45 μg/m^3 (24-hour average) 12 μg/m^3 (annual average)

Source: (WHO 2000), NOM-025-SSA1-2014.

Note: PM_{10} = particulate matter less than 10 micrometers in diameter. $PM_{2.5}$ = particulate matter less than 2.5 micrometers in diameter. μg = micrograms.

Short-term exposure[24] to $PM_{2.5}$ emissions poses health risks such as premature mortality, increases in hospital admissions, heart and lung disease, increases in symptoms of the lower respiratory tract, reductions of lung function, and changes in heart rhythm. Furthermore, long-term exposure to particulate matter "increases total premature mortality due to cardiovascular and respiratory causes, lung cancer in adults and respiratory causes in children" (Rojas 2014). Robust epidemiological studies regarding health and air pollution indicate that reducing the concentration of $PM_{2.5}$ in the air reduces deaths caused by at least three specific illnesses: cardiovascular disease, lung cancer and chronic obstructive pulmonary diseases (INE 2011).

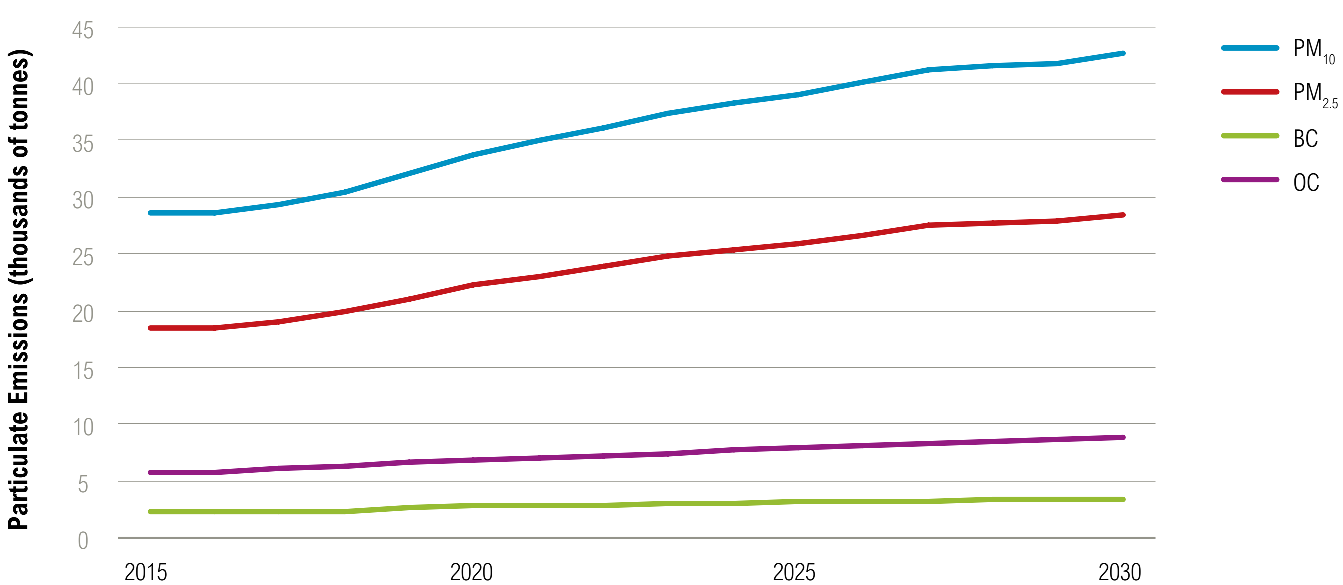
Particulate emissions also include black and organic carbon, which are short-lived pollutants. Black carbon, formed by the incomplete combustion of fossil fuels, biofuels, and biomass, is a major component of soot. Although research is not conclusive, some studies show black carbon is particularly harmful to health because it represents a mixture of carcinogenic particles, small enough to enter the bloodstream and affect certain body organs (European Environment Agency 2013). Organic carbon, also a component of soot but in a smaller proportion, is a complex mixture of many groups of compounds originating from primary sources and secondary formation processes; its major anthropogenic emission sources are biomass and fossil fuel combustion.

Health Benefits Associated with Mexico's Unconditional and Conditional Scenario Policy Packages

According to the results of the Energy Policy Simulator model, 28,700 tonnes of PM_{10} were emitted in Mexico in 2015. In addition, 18,500 tonnes of $PM_{2.5}$ 2,300 tonnes of black carbon, and 5,700 tonnes of organic carbon were emitted in the same year.

Figure 10 presents Mexico's particulate emissions under the baseline scenario, showing that by 2030, PM_{10} emissions may rise by up to 49 percent between 2015 and 2030, while $PM_{2.5}$ emissions could increase by around 53 percent. Over the same period, the increase in black and organic carbon emissions could be up to 47 percent and 54 percent, respectively. This would increase exposure of the Mexican population to particulate emissions, which would have a direct effect on health (also increasing the associated economic and social costs of healthcare). These increases are driven by increased fuel consumption.

Figure 10 | **Particulate Emissions in the Baseline Scenario**



Note: PM_{10} = particulate matter under 10 micrometers in diameter. $PM_{2.5}$ = particulate matter under 2.5 micrometers in diameter. BC = black carbon. OC = organic carbon.

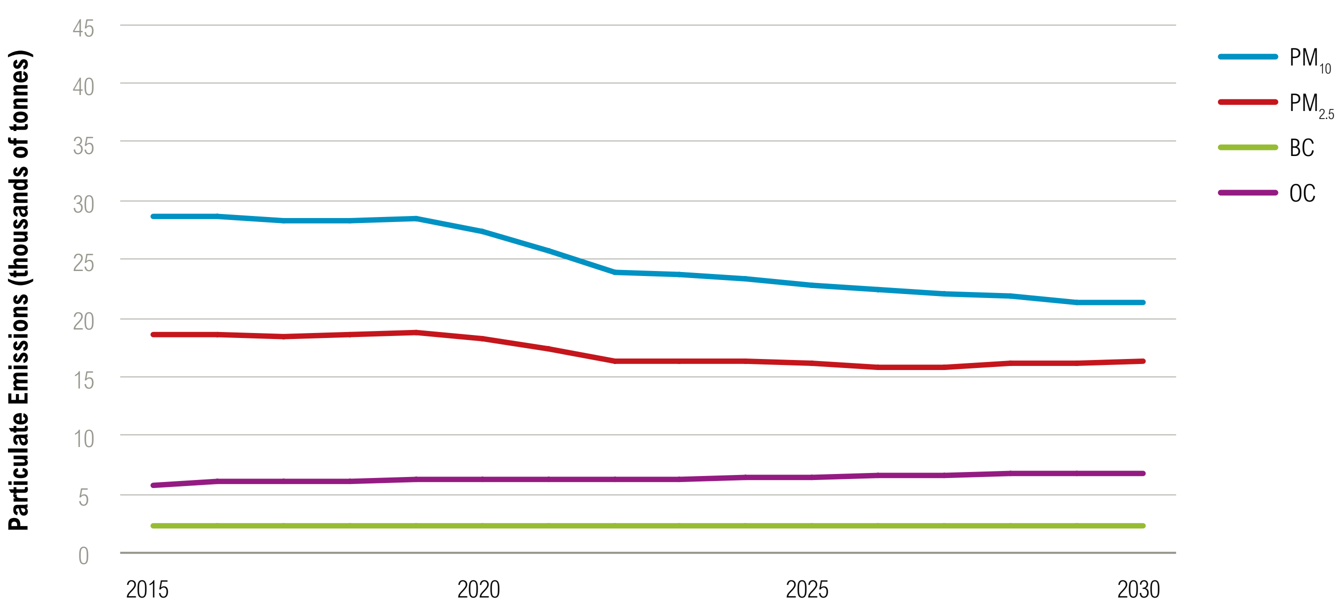
Figure 11 shows that, with the implementation of the policy package proposed for the unconditional scenario policy package, PM_{10} and $PM_{2.5}$ emissions could decrease by 25 and 13 percent by 2030, respectively (relative to 2015 levels). On the one hand, compared with the Baseline Scenario, the unconditional scenario policy package would decrease PM_{10} emissions by 50 percent and $PM_{2.5}$ emissions by 43 percent. On the other hand, black and organic carbon emissions are still anticipated to increase during that timeframe, but at a much smaller rate than in the baseline scenario: 6 and 17 percent by 2030, respectively (relative to 2015 levels). However, compared with the baseline scenario, these emissions would effectively decrease by 27 and 23 percent, respectively, by 2030.

Furthermore, if the policies proposed in this working paper for the conditional scenario policy package are implemented, the reduction of particulate pollution would be even higher. Figure 12 shows PM_{10} emissions would decrease by 31 percent and $PM_{2.5}$ by 18 percent by 2030 (relative to 2015 levels). These levels represent a 53 and 47 percent fraction of the baseline scenario, respectively, which translates to large improvements in health effects.

In the conditional scenario policy package, black carbon emissions would decrease by 1.5 percent from 2015 to 2030, while organic carbon pollution would increase by 11 percent in the same period, a smaller rate than in the unconditional and baseline scenarios. Compared to the baseline scenario, these levels imply total reductions in black and organic carbon of 33 and 28 percent, respectively.

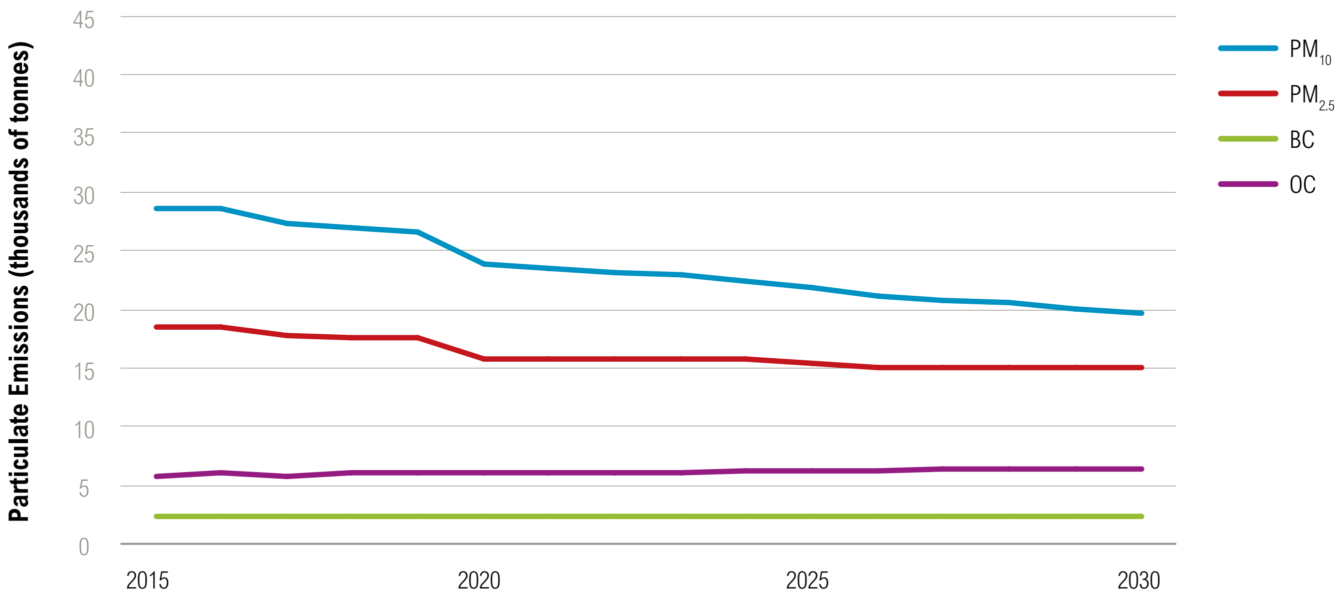
These particulate pollution reductions can be translated in terms of human lives saved per year, calculated using the monetized benefit from avoided mortality impacts and the value of a statistical life. The results show that, during the period 2015–30, 15,228 human lives could be saved in the unconditional scenario policy package, as shown in Figure 13. Moreover, if the policies for the conditional scenario policy package take place as suggested, 1,072 additional lives would be saved during that timeframe, reaching a total of 16,300 lives saved by 2030, almost nine times the number of people who died prematurely in the Mexico City Metropolitan Area due to air pollution in 2015 (CEMDA 2016).

Figure 11 | **Particulate Emissions in the Unconditional Scenario Policy Package**



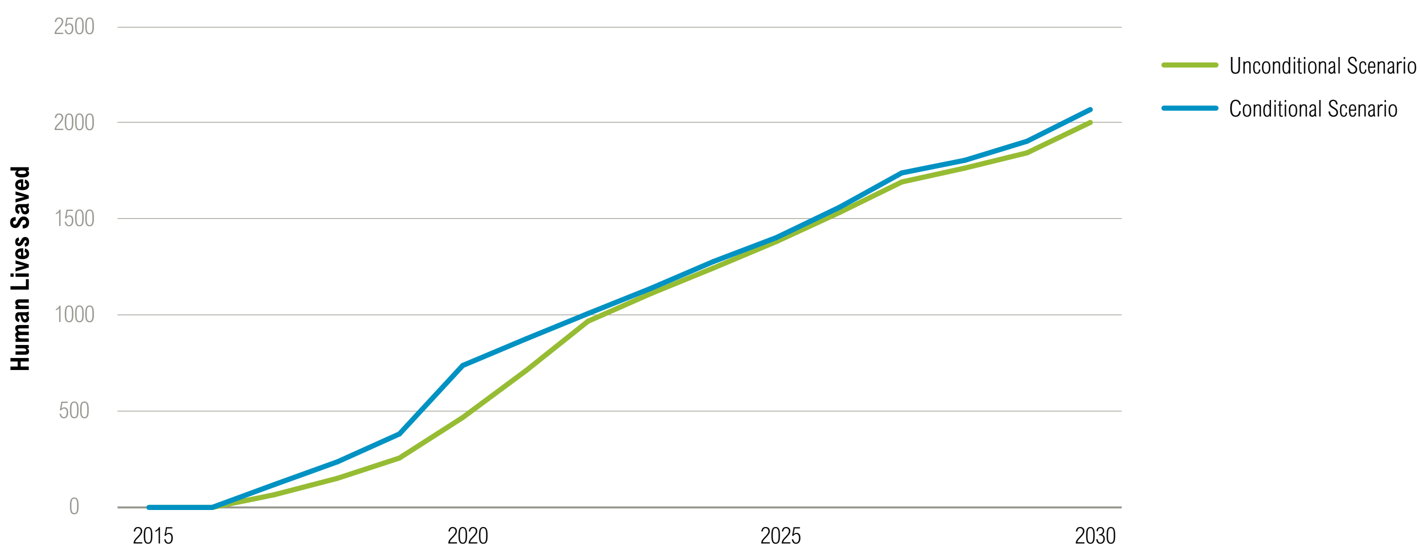
Note: PM_{10} = particulate matter under 10 micrometers in diameter. $PM_{2.5}$ = particulate matter under 2.5 micrometers in diameter. BC = black carbon. OC = organic carbon.

Figure 12 | **Particulate Emissions in the Conditional Scenario Policy Package**



Note: PM_{10} = particulate matter under 10 micrometers in diameter. $PM_{2.5}$ = particulate matter under 2.5 micrometers in diameter. BC = black carbon. OC = organic carbon.

Figure 13 | **Human Lives Saved from Reduced Particulate Pollution, 2015–30**



Note: Relies on U.S. pollutant emissions indices and likely underestimates lives saved.

6. RECOMMENDATIONS

We have identified and evaluated policy options available to Mexico to support the implementation of its Intended Nationally Determined Contribution (INDC) GHG mitigation targets, focusing primarily on technically feasible policy solutions that provide high abatement potential, with joint consideration of cost-effectiveness, political feasibility, and health co-benefits. These options were identified by testing through the Energy Policy Simulator model and expert feedback. In this working paper, we provide a roadmap for meeting Mexico's INDC objectives; we recognize that this is a first step toward attaining such goals.

Our analysis shows that Mexico has the opportunity to achieve its INDC targets while saving at least 200 billion pesos (around US$11 billion) and 15,000 lives by 2030. To reap these benefits, we propose an eight-point policy action plan:

- Improve fuel efficiency and promote the switch to clean fuels in industrial activities
- Maintain and develop cost-efficient policies to reduce emissions of non-CO_2 gases
- Reduce distortions in the economy through carbon pricing and fossil fuel subsidies reduction
- Increase efficiency in the electricity sector
- Promote synergies with adaptation objectives (deforestation and reforestation) and other sectorial actions (agriculture)
- Prompt the transition to clean and well-designed transport options
- Increase energy efficiency in commercial and residential buildings
- Develop a comprehensive, long-term strategy for achieving net zero GHG emissions in line with the long-term goals in the Paris Agreement

I. Improve fuel efficiency and promote the switch to clean fuels in industrial activities

In Mexico, industrial activities (including oil and gas)[25] provide significant opportunities to reduce process emissions through improving process efficiency and switching to less polluting and/or cleaner fuels. In our analysis, the combined policies for this sector represent 36 percent of the total emissions reductions in the unconditional scenario policy package and 22 percent of the reductions in the conditional scenario policy package. Collectively, these activities have the largest potential for achieving Mexico's INDC objectives.

In the area of improving efficiency (in particular in the use of energy), our analysis shows that three policies are particularly promising: industry energy efficiency standards, cogeneration and waste heat recovery, and early retirement of inefficient facilities. Cement clinker substitution, which affects process emissions rather than energy efficiency, is also a promising industry sector policy. These measures have not only strong political support but also high potential uptake from the private sector. Mexico is showing important progress in this field, for example, the improvement of industrial efficiency standards is one of the key issues highlighted in the North American Leaders Summit declaration. The declaration promotes the alignment and improvement of efficiency standards, for instance through the adoption of the voluntary ISO 50001 energy performance standard, and commits to set a common target date of 2017 for ISO 50001 uptake. However, Mexico's National Program for the Sustainable Use of Energy for 2014–2018 (Programa Nacional para el Aprovechamiento Sustentable de la Energía 2014–2018) sets only a relatively modest goal to at least maintain the rate of energy intensity at 2012 levels; therefore, a new national goal on energy efficiency, which should be ready at the end of 2016, would play an important role in improving performance. The Secretariats of Economics and Energy (SE and SENER) should align the Official Mexican Standard with the industrial efficiency standards highlighted in the North American Leaders Summit declaration.

Additionally, the Secretariats of Economics and Energy should enhance industrial energy efficiency through promoting early retirement of inefficient facilities (for instance of old PEMEX facilities) and ensuring that the Mexican Official Standards will be further developed into the areas of energy efficiency equipment, devices and systems, and others, and promoted through the three levels of government.

Joint work with the private sector will be crucial in policies related to the cement sector as well as in cogeneration and heat recovery. Cement clinker substitution is already at the forefront of existing plans that have been put forward by the representatives of the industry and the government–in the form of a nationally appropriate mitigation action (NAMA). The Secretariat of Environment and Natural Resources (SEMARNAT) and Mexico's National Chamber of Cement are implementing a NAMA in the cement sector to reduce GHG emissions by increasing energy efficiency and replacing fossil fuels with alternative fuels. If the implementation of the NAMA is successful, the cement industry expects to reduce GHG emissions about 9 percent below the cement sector's baseline emissions by 2020, and 15 percent by 2030 (International Partnership on Mitigation and MRV 2013). It is important to note that the NAMA is still in the design phase and no proposals are yet in place to scale up this action. Mexico's NAMA is, however, backed by the largest cement producer in Mexico (and one of the 10 largest producers in the world), CEMEX, which recognizes the challenge posed by climate change and the need to transition to a low-carbon economy.[26]

On the cogeneration side, the Development Program for the National Electricity System estimates that in order to meet Mexico's expected electricity demand growth for the period 2015-29, 60 GW of additional capacity will be required, with an investment of 653 billion pesos. It is expected that 12 percent of this additional power capacity will come from efficient cogeneration systems. Rules included in Mexico's recent energy reform incentivize the development of clean energy sources by allowing private companies that have cogeneration projects to produce power and connect to the grid. This incentive should be further developed through the Secretariat of Energy, the Federal Commission of Electricity, and the Secretariat of Finance and Public Credit providing extra support and information for the industry. This could include, for instance, highlighting the provisions in Mexico's Income Tax Law that provide a 100 percent deduction incentive for taxpayers who carry out investments in cogeneration systems.

Fuel switching provides an additional opportunity for lowering emissions and it is potentially cost saving. Switching from natural gas to electricity is particularly important in light of the Paris Agreement goals, which underscore the need to achieve net zero emissions globally by around mid-century (Tovilla and Buira 2015). This policy should take advantage of the plans drafted under the North American Leaders Summit. This may be possible, because renewable/clean energy represents around 70 percent of future installed capacity in 2030 in the unconditional scenario policy package and 85 percent in the conditional scenario policy package.

II. Strengthen actions to reduce emissions of non-CO_2 gases

Non-CO_2 GHG emissions contribute significantly to climate change. These GHGs have a greater ability to trap heat (expressed as global warming potential [GWP]), and many have greater short-term impacts than CO_2. In 2013, non-CO_2 emissions comprised 24 percent of Mexico's national GHG inventory (INECC & SEMARNAT 2015), highlighting the importance of taking action to reduce these emissions. Mitigating non-CO_2 emissions can also deliver development benefits. For instance, a variety of approaches to mitigating CH_4 emissions from landfill and wastewater systems can contribute to job creation, health benefits, cost savings due to reduced need for landfilling, and improved crop yields (Santucci, et al. 2015).

In Mexico, two strong policies, if implemented fully, will be effective in tackling these emissions: (1) methane capture and (2) avoiding venting of byproduct gases with high global warming potential.

Mexico recognizes the importance of reducing methane emissions and has a history of setting quantitative methane reduction targets. In 2014, the government set a target for reducing methane emissions from the country's wastewater treatment plants, landfills, oil and gas sector, and agricultural sector as part of its Program for Energy Transition 2014–18.[30] The achievement of this target requires coordination among several government departments such as the Secretariat of Energy, SEMARNAT, the National Water Commission, and the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food. In June 2016, Mexico committed to reducing methane emissions from the oil and gas sector by 40–45 percent by 2025, relative to 2005 levels (White House: Office of the Press Secretary 2016). This target will be supported by Mexico's participation in mechanisms such as the Climate and Clean Air Coalition Oil and Gas Methane Partnership.[28]

With the political will already in place to strengthen action on methane emissions, we recommend the Mexican government further reduce methane leaks and gas venting from oil and natural gas exploration, production, processing and distribution processes by setting performance standards for oil and natural gas extraction, mandating leak detection and repair, and providing specific guidance for the management of flaring and venting methane volumes under National Hydrocarbon Commission's ruling CNH.06.001/09,[29] along with penalties if these volumes are exceeded. Mexico, through SEMARNAT and the National Hydrocarbon Commission, should also implement methane capture and utilization projects at solid waste disposal sites and wastewater treatment plants. The Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food could promote methane reduction technologies in the agriculture sector, following the lead of the United States' AgSTAR program,[30] which promotes the use of biogas recovery systems to reduce methane emissions from livestock waste. Mexico can also follow the overall approach of the United States, which, in recent years, has taken several steps to proactively tackle methane emissions. For example, methane emissions are a key pillar of the U.S. Climate Action Plan, and the country also has methane emissions standards in place for new and modified equipment used in the development of natural gas and petroleum.

Another strong policy to reduce non-CO_2 GHG emissions in Mexico is to avoid venting byproduct gases with high GWPs. Some of the highest GWP gases are hydrofluorocarbons (HFCs). Their use is on the rise as a result of the phase-out of their ozone-depleting predecessors under the Montreal Protocol: chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). In July 2015, Mexico, Canada, and the United States submitted a joint proposed amendment to the Montreal Protocol to phase down HFC emissions. This was reinforced by the North American Leaders Summit statement, where Canada, the United States, and Mexico affirmed their commitments to adopt an ambitious and comprehensive Montreal Protocol HFCs phase-down amendment in 2016, and to reduce the use of HFCs, including through domestic actions. As part of this statement, Mexico stated its intention to "initiate new actions to authorize the use of low global warming potential SNAP-approved HFC alternatives as well as promote their use as alternatives to high global warming potential HFCs and remove barriers to deployment."

To continue taking action on HFCs, we suggest that SEMARNAT and the Trust for Energy Efficiency contain and destroy HFCs under a new coolant substitution program, or develop a new program with similar objectives under the umbrella of the North American Climate, Clean Energy, and Environment Partnership Action Plan.

III. Reduce distortions in the economy through introducing carbon pricing and phasing out fossil fuel subsidies

To avoid an increase in the negative effects of climate change, governments need to eliminate the distortions in the economy resulting from not including the effect of the use of fossil fuels on the environment. Hence, governments need to make emissions progressively costlier by charging an explicit price on the carbon content of the different fuels used in their economies. In Mexico, two promising policies in this respect are carbon pricing (through carbon taxes and emissions trading) and reduction of subsidies to fossil fuels. Carbon pricing provides the incentives to transform the economy into a low-carbon economy. As Kaufman, Obeiter, and Krause (2016) explain, a strong carbon price will induce the electricity sector to shift away from high-carbon fuels and, to a more gradual extent, the transportation sector to shift toward cost-effective alternatives. Additionally, it may provide enough incentives to reduce emissions in other sectors of the economy by shifting investments to more cost-effective, low-carbon alternatives. In Mexico, carbon pricing is a recent instrument that has been applied rather modestly. The 2013 fiscal reform introduced an excise tax on fossil fuels for their potential CO_2 emissions and, after deliberation in the government, the tax was fixed at a level of about US$3.5 per tonne of CO_2e. The tax rate was capped at 3 percent of the sales price of fuel and is expected to collect approximately US$1 billion a year.

In terms of emissions trading, recently SEMARNAT and Mexico's Stock Exchange signed an agreement to green light a pilot system for GHG permit trading. This pilot will start in 2017 with the assessment and definition of emissions' limits and allocations for several energy-intensive industries. It is planned that the system will be fully operational in 2018 (Santiago 2016).

Our analysis shows that a carbon tax is a key instrument to attaining the INDC objectives. This tax is responsible for about 12 percent of the emissions reduction in the unconditional scenario (at a rate of US$15 per tCO_2e) and almost 19 percent in the conditional scenario (at a rate of US$55 per tCO_2e). Thus, SEMARNAT, the Secretariats of Energy and of Finance and Public Credit must provide support for stepping up efforts toward an effective carbon tax in Mexico. The implementation of this policy is complicated by political and social barriers and uncertainty about its economic impacts in different sectors.

Mexico is exploring the possibility of linking up with the emerging North American carbon market (California, Quebec, Ontario). It has signed a memorandum of understanding with California to explore possible linking. The Secretariat of Finance and Public Credit, SEMARNAT, and the Secretariat of Foreign Affairs might leave options open for future partnerships, for example a broader North American cap-and-trade scheme. Moreover, the country could profit from the actions put forward at the North American Leaders Summit, in which North American countries would encourage subnational governments to share lessons learned about the design of effective carbon pricing systems and supportive policies and measures. We propose that the Secretariat of Finance and Public Credit and SEMARNAT explore the collaboration and experience of the United States and Canada, and make funds available for additional research to explore the economic implications of a carbon tax.

In the case of fossil fuel subsidies, energy reform provides a key opportunity by introducing market competition to the sector, which will require the fuel price to depend on market conditions, not price setting by the government. The Organisation for Economic Co-operation and Development, the G20, and the International Energy Agency are launching initiatives for governments, Mexico included, to withdraw all energy subsidies on both consumption and production. In 2014, fossil fuel subsidies in Mexico represented an expenditure of US$42 per capita (IEA 2015). The difference between the domestic and the international fuel prices is charged as a tax, which becomes a subsidy when international prices are higher than domestic. Currently, high fuel consumer domestic prices are used to replace public income losses due to low international oil prices. As long as the federal government depends on this unusual income, there are no economic incentives to switch this policy. However, the increase in the number of competitors in the market will pressure the Mexican government to liberalize fuel price.

The Secretariats of Finance and Public Credit, Economics, and Energy should build on recent progress to develop a plan to phase out the remaining subsidies to fossil fuel production and use in Mexico, while ensuring protection for the poor.

IV. Increase capacity and efficiency in the electricity sector (transmission and distribution)

Mexico's electricity sector has important potential to help the country reach its INDC commitments. Our analysis shows that the potential for emissions reductions in this sector is about 14 percent of the total required to reach both the unconditional and conditional targets. This potential stems in particular from the increase of transmission lines and improvements in the distribution, the increase in the amount of energy from distributed solar, and demand-response actions. These measures are effective in reducing emissions and cost efficient.

Mexico has plans to increase its transmission capacity and reduce losses in transmission and capacity. Feedback from experts suggests that losses can be moderately reduced and that there are plans for doubling transmission capacity in 20 years. The Clean Energy Auctions launched by the Secretariat of Energy in April 2015 and the Energy Transition Law provide strong legislative and financial support to these policies, since a large investment is needed to build substations and make improvements on distribution and transmission lines. Social barriers related to land use ought to be addressed and considered as mandated on the Electric Industry Law. Transmission lines may pass across indigenous lands, creating potential conflict. We propose increased collaboration between the Secretariat of Energy, the Federal Commission of Electricity, the Energy Regulatory Commission, the Centre for Energy Control, and the Federal Regulatory Improvement Commission to avoid land disputes and ensure the auction process is competitive.

Mexico has one of the most promising solar markets in Latin America, but its development has been hindered by regulatory barriers, the fall in the exchange rate of the peso/dollar, and especially the high import tax

(15 percent) on solar panels. However, recent studies from Green Technology Media (GTM 2016) show that the market could improve by increasing the tariffs for residential solar. Thus, we recommend that the Secretariat of Finance and Public Credit, the Secretariat of Energy, the Federal Commission of Electricity, the Centre for Energy Control, and the Federal Regulatory Improvement Commission, work together to provide further economic incentives, such as removing the import taxes on solar panels, to meet demand for distributed solar photovoltaics.

Demand-response operates by calling on utility customers—typically large commercial or industrial users—to temporarily reduce loads, thus reducing peak system demand. Demand-response can also be used to provide "up-regulation," which means that loads can be called into action during times of excess electricity supply. Typically, utilities will contract with large customers using interruptible load rates coupled with payments for load curtailment. During a peak load event, utilities can call demand-response customers and ask them to reduce load or, alternatively, can remotely disable systems that will reduce demand. Spread across multiple large customers—or many smaller customers—demand-response can reduce peak demand, mitigate the need for new capacity, and build a more flexible power system. Because the cost of paying utility customers to curtail load in certain hours is significantly less than the marginal cost of building and operating a new plant, demand-response can often meet demand requirements at much lower cost than expanding capacity. We did not identify any study of demand-response potential in Mexico, so we recommend the government commission such a study, as a preliminary step toward implementing a demand-response program.

V. Promote synergies with adaptation objectives (deforestation and reforestation) and other sectorial actions (agriculture)

Mexico would benefit from increasing the interaction and synergies of its mitigation and adaptation objectives, particularly those related to the forest sector where important emissions reduction may be achieved through avoiding deforestation and increasing reforestation activities. The recent North American Leaders Summit declaration encourages sharing best practices and technical solutions to improve accounting effectiveness, including for the land sector and carbon market-related approaches. Additionally, it looks to enhance the conservation and restoration of wetlands, which increase mitigation (blue carbon[31]), preserve coastal ecosystem services, and reduce the potential impacts of more frequent or intense severe weather events under climate change projections. The main problem in this sector is the lack of coordination and the apparent contradictory policies among and even within government agencies. For instance, the National Forestry Commission wants to incentivize forest exploitation as a tool for development and conservation, but it privileges passive conservation schemes. Additionally, although there is a formal objective in the INDC to "reach a rate of 0 percent deforestation by the year 2030" there is no clarity on what actions are additional to what is already included in the government's baseline scenario. We recommend that SEMARNAT, Institute of Environment and Climate Change, the National Forestry Commission, and the Intersecretarial Commission on Climate Change work to harmonize the different laws and plans[32] to make clear and measurable targets for the sector.

The agriculture sector is also crucial for attaining the required abatements in the INDC, especially the level needed to meet the conditional target. Our analysis shows that abatement from livestock measures is a potential cost-effective policy that can be implemented to this end. In particular, we encourage Mexico to strengthen its actions around improved manure management, which is feasible and commercially viable. Mexico could benefit from its membership to the Global Methane Initiative,[33] where it participates actively in identifying actions (especially in the livestock and agro-industrial sectors) with the greatest cost-effective methane reduction potential as well as developing country market opportunities (Global Methane Initiative 2015). The initiative recognizes that, for Mexico, livestock and agro-industrial subsectors have a substantial potential for methane emission reduction or methane capture. However, barriers that may hinder the introduction of these actions are social (resistance to changing traditional livestock management techniques), financial (high upfront capital costs to implement actions, e.g., to buy biodigesters), lack of capacity (no trained personnel to manage effectively the operations and promote technology uptake), and biological (resistance to introducing new species of livestock and feeding inputs) (MCE2-INECC

2013). To overcome these barriers the activities need the support of diverse Secretariats like Rural Development Fisheries and Food, SEMARNAT, and the Secretariat of Energy. We recommend that Mexico implement and explore further its Global Methane Initiative membership to achieve the true potential in emissions reduction from these sources.

VI. Prompt the transition to clean and well-designed transport options

Policies in the transport sector can help Mexico achieve its INDC goals while providing co-benefits (see section 5.5) and opportunities to contribute to long-term decarbonization. Our analysis suggests that Mexico's transport policy agenda should focus on an electrified and/or cleaner fleet, transportation demand management, and improving fuel economy through measures such as fuel economy standards and feebates. Transport emissions must be considered alongside the need to address air pollution. Recent actions by the Mexico City Megalopolitan Area, which sped up the disbursement of more than 11 billion pesos (US$595.9 million) for infrastructure projects and modernization of public transit units, along with the Guadalajara Metropolitan Zone, which took aggressive steps to improve air quality and reduce private vehicle use, have improved the outlook for the kinds of policies analyzed in our scenarios.

With regard to fuel economy, Mexico can profit from its partnership with Canada and the United States under the North American Leaders Summit, whose trilateral statement proposes "strengthening and aligning efficiency standards across all three countries" to commit "to reduce greenhouse gas (GHG) emissions from light- and heavy-duty vehicles by aligning fuel efficiency and/or GHG emission standards out to 2025 and 2027, respectively" across the three countries. This may provide incentives to the National Commission on Energy Efficient Uses, the National Institute of Environment and Climate Change, the Secretariat of Energy, and SEMARNAT to overcome political obstacles and put forward stronger standards in line with the General Law on Climate Change.[34] Likewise, the air pollution crisis and the North American Leaders Summit declaration may facilitate compensation of efficient-vehicle buyers and improve the political incentives for local and national governments to become more active in strategies and policies that reduce emissions. This is especially true for the light-duty vehicle feebate proposed in the conditional scenario policy package, which requires the coordination of Institute of Environment and Climate Change and state governments due to its political and technical obstacles.

The Secretariat of Transport and Communications and the Federal Support Program for Mass Transportation should focus efforts on an electrified and/or cleaner passenger and freight fleet, transport-demand management, and improved fuel efficiency through stronger light-duty vehicle and heavy-duty vehicle standards and feebates.[35] The Secretariats of Economics, Energy, and Transport and Communications should harmonize fuel economy and emissions-related standards with the United States and Canada for passenger and freight vehicles.

While solutions like fuel economy standards and feebates can be part of the solution during the transition to a low-carbon transportation sector, Mexico will ultimately need to electrify its vehicle fleet and reduce its reliance on single-occupancy transport (Tovilla and Buira 2015). As of October 2015, there were only 200 electric light-duty private vehicles in Mexico, which represented 0.0007 percent of the national fleet of private light-duty vehicles (Alavez 2015), compared to more than 200,000 such vehicles (or 1 percent of the vehicular fleet) in the United States.[36] One of the main barriers to scaling up electric vehicle use is their high price, which renders them unaffordable for most Mexican households. However, costs are expected to fall rapidly (Bloomberg New Energy Finance 2016). In the meantime, the Mexican government has taken steps to speed up their adoption, including an exemption from the tax on new vehicle sales (Impuesto sobre Automóviles Nuevos), from the tax on vehicular tenure in most states, and from the environmental vehicular verification; support from the Federal Electricity Commission to install new domestic meters that do not affect the household's current electric bill because of the subsidy scheme for low electricity consumption; and the installation of electric charging stations, with an expected growth of 66 percent in 2016 (Obras Web 2016). As it does for fuel economy standards, the North American Leaders Summit declaration also proposes a range of collaboration on clean and electric vehicles, including: accelerating deployment of clean vehicles in government fleets; working collaboratively with industry to encourage the adoption of clean vehicles by identifying initiatives to support consumer choice; and encouraging public and private infrastructure investments to establish North American refueling corridors for clean vehicles.

In terms of transport demand management, authorities at all levels of government need to strengthen and improve local planning and metropolitan authorities, and widen collaboration between the Secretariat of Energy and the automotive industry. Also, an increased collaboration and funding to properly elaborate the Integral Plan for Sustainable Urban Mobility and the development and implementation of the Secretariat of Rural, Territorial and Urban Development's Urban Mobility National Strategy with appropriate resources allocation are needed; along with an increase in the collaborative work of the Federal Support Program for Mass Transportation, the National Infrastructure Fund, the Secretariat of Rural, Territorial and Urban Development, the National Housing Commission, the private sector, urban mobility start-ups for enterprises, local and state governments, and metropolitan governance institutions. To implement this policy, federal and local governments should: (1) increase metropolitan coordination, (2) reform land-use ordinances, (3) change the rules of operation of federal funds for urban mobility and housing, and (4) change the rules of operation of federal funds to guarantee that a majority of resources are focused on sustainable mobility, especially public and nonmotorized transport with support to metropolitan governance bodies. Transport demand management measures provide important co-benefits (see section 5.5), particularly in bus rapid transit systems in cities like Mexico City, Leon, and Guadalajara, which are currently planned to be scaled and replicated in 36 projects throughout the country within integrated transport systems (PROTRAM 2016).

VII. Increase energy efficiency in commercial and residential buildings

Although emissions from the buildings sector are not that high in Mexico, this sector represents an opportunity to help achieve INDC objectives given that there is strong political will to improve standards in cooling and ventilation, building envelope, and lighting. However, these measures, although cost-effective and easy to implement upstream, would take a reasonably long time to become cost-saving. Currently the topic of energy efficiency is included in many policy discussions and plans in Mexico. For instance, energy efficiency in buildings is a priority area of the Mission Innovation project (Mission Innovation 2016) which can be broadened through international bilateral and multilateral collaboration, like the Sustainable Energy for All (SE4ALL) program launched by the United Nations.[37] The major challenges with these policies are the diffusion of the official standards and the verification processes and institutions that enforce compliance, as well as some lobbying efforts to enact less ambitious official standards. We recommend that the National Commission for Energy Efficient Uses, the Secretariat of Energy, and private component and building developers work together to strengthen the feasibility of these measures and highlight the economic gains of having better efficiency standards in the sector. For instance, by strengthening political will around Article 18 of the Energy Transition Law and Article 1 of the "Agreement that is delegated from the Director General of the National Commission for Energy Conservation," which entitles the Director of National Commission for Energy Efficient Uses to issue regulations within its competency and to preside over the National Consultation Committee of Normalization for the Preservation and Rational Use of Energy Resources, respectively.

The Secretariats and Economics and Foreign Affairs should broaden international learning and capacity development under bilateral and multilateral energy efficiency programs, such as Mission Innovation and Sustainable Energy for All.

VIII. Develop a comprehensive, long-term strategy for achieving net zero GHG emissions in line with the long-term goals in the Paris Agreement

As Mexico develops its plans for implementing its INDC goals, it should consider the risk that some pathways toward meeting its unconditional target–and even its conditional target–may lock in post-2030 emissions that would hinder achievement of net zero emissions on the timeframe implied by the Paris Agreement. To have a medium chance (greater than 50 percent) of limiting warming to 1.5°C, global carbon dioxide emissions must reach net zero by 2045–50, and global total GHG emissions must reach net zero by 2060–80 (UNEP 2015b). For a likely chance (greater than 66 percent) of limiting warming to 2°C, the same milestones must be met no more than 15 to 20 years later.

Of relevance to Mexico, natural gas-fired power generation and fossil-fueled vehicles are particularly vulnerable to lock-in (Erickson, et al. 2015). While our conditional scenario policy package implies significantly less investment in both of these technologies than our unconditional scenario package, which in turn implies lower investment than under the baseline, both policy packages nevertheless rely on such technologies to a certain extent through 2030. Based on the lifespans assumed in the Energy Policy Simulator Model—45 years for non-peaker natural gas, 22 years for light-duty vehicles, and 29 years for heavy-duty vehicles–Mexico would either have to retire such technology before the end of its lifespan or offset emissions from such technology with negative emissions to reach net zero emissions on a timeline consistent with the Paris Agreement temperature goals. Globally, the International Energy Agency has found that continued near-term investment in conventional technologies instead of low-carbon alternatives would increase investment costs fourfold in the longer term (IEA 2013).

As such, the Mexican government—with the Intersecretarial Commission on Climate Change and SEMARNAT taking the lead—should prioritize developing a comprehensive, long-term strategy for aligning its emissions pathways with the Paris goals. Such a strategy may ultimately require strengthening actions in certain areas relative to the policy packages discussed in this report–for example, phasing out fossil-fueled infrastructure earlier, electrifying the vehicle fleet faster, and enhancing transportation demand management more significantly. To develop its long-term strategy, we recommend that the government review (and if necessary revise) its existing target to reduce GHG emissions 50 percent from 2000 by 2050 in light of the Paris Agreement goals (particularly the goal to pursue efforts to limit the global temperature increase to 1.5°C), develop sectoral milestones for implementing the 2050 target, undertake a full analysis of lock-in risk for key infrastructure, and refine its plans to achieve its INDC targets in a manner that ensures consistency with such milestones in a cost-effective manner. The Institute of Environment and Climate Change should undertake the analysis of carbon lock-in risk for key infrastructure, including in particular coal- and natural-gas-fired power generation and fossil-fueled vehicles. SEMARNAT could develop sectorial pathways and associated milestones for implementing the (potentially revised) target.

Implementing this eight-point plan has the potential to put Mexico on a path toward achieving its INDC targets, while at the same time improving economic competitiveness, energy security, and the health and well-being of its people.

ACRONYMS AND ABBREVIATIONS

BC	Black Carbon
CANACEM	National Chamber of Cement
CENACE	National Center for Energy Control
CFE	Federal Commission of Electricity
CICC	Intersecretarial Commission on Climate Change
CNH	National Hydrocarbon Commission
CO	Carbon Monoxide
CO_2e	Carbon Dioxide Equivalent
COFEMER	Federal Regulatory Improvement Commission
CONANP	National Commission for Protected Areas
CONUEE	National Commission for Energy Efficient Uses
CRE	Energy Regulatory Commission
EPS	Energy Policy Simulator
FIDE	Trust for Energy Efficiency
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWP	Global Warming Potential
HDV	Heavy-Duty Vehicle
HFCs	Hydrofluorocarbons
INDC	Intended Nationally Determined Contribution
INECC	National Institute of Environment and Climate Change
LDV	Light-Duty Vehicle
LGCC	General Law on Climate Change
LULUCF	Land Use, Land-Use Change and Forestry
NAMA	Nationally Appropriate Mitigation Action
NOM	Norma Oficial Mexicana (Official Mexican Standard)
NO_x	Nitrogen Oxides
OC	Organic Carbon
PEMEX	Mexican Petroleum, a state-owned petroleum company
PM	Particulate Matter
PROTRAM	Federal Support Program for Mass Transportation
R&D	Research and Development
SAGARPA	Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food
SCT	Secretariat of Transport and Communications
SE	Secretariat of Economics
SEMARNAT	Secretariat of Environment and Natural Resources
SENER	Secretariat of Energy
SHCP	Secretariat of Finance and Public Credit
SLCP	Short-Lived Climate Pollutant
SO_x	Sulfur Oxides
SRE	Secretariat of Foreign Affairs
UNFCCC	United Nations Framework Convention on Climate Change
VOCs	Volatile Organic Compounds

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ENDNOTES

1. Energy Innovation: Policy and Technology LLC., is an energy and environmental policy firm that develops research and original analysis for policymakers to help them make informed choices on energy policy.
2. In this paper, we follow the characterization of industry as a collective of activities modeled within the Energy Policy Simulator model. These activities include a broader set than those from the traditional industry sector definition (e.g., from National Accounting Systems). We account for activities associated with industrial process emissions, either public or private, in sectors beyond the manufacturing sector such as agriculture, mining, oil and gas as well as waste management.
3. The United States AgSTAR program promotes the use of biogas recovery systems to reduce methane emissions from livestock waste by identifying project benefits, risks, options and opportunities. https://www.epa.gov/agstar/what-epa-doing-agstar
4. This commitment was made as part of an unconditional target to reduce 25 percent of Mexico's GHG emissions and SLCPs (below the baseline) by 2030. Mexico also includes a conditional target in its INDC: to reduce 40 percent of Mexico's GHG emissions and SLCPs (below the baseline) by 2030.
5. The core elements of National Communications include relevant information on national circumstances, GHG inventories, a vulnerability and adaptation assessment, mitigation assessment, financial resources and transfer of technology, and education, training, and public awareness.
6. According to North American Climate, Clean Energy, and Environment Partnership Action Plan clean energy includes renewable, nuclear, and carbon capture and storage technologies.
7. This was the first time that a goal in energy efficiency was set by law. Before that, it was only established in national programs like Programa Nacional para el Aprovechamiento Sustentable de la Energía and Programa Sectorial de Energía.
8. The Energy Policy Simulator includes non-energy policies, such as those affecting land use and industrial processes, as well as energy policies.
9. The Energy Policy Simulator was developed by Energy Innovation LLC, with help from the Massachusetts Institute of Technology and Stanford University. The model has been peer reviewed by individuals associated with Argonne National Laboratory, the National Renewable Energy Laboratory, Lawrence Berkeley National Laboratory, Stanford University, China's National Center for Climate Change Strategy and International Cooperation, China's Energy Research Institute, and Climate Interactive. The adaptation of the model to Mexico was carried out jointly by Energy Innovation LLC, Centro Mario Molina, World Resources Institute, and WRI Mexico.
10. Additional documentation on the Energy Policy Simulator, beyond the scope of this report, can be found on the model's website, at http://energypolicy.solutions.
11. They are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), high-GWP fluorinated gases (F-gases), particulate matter with aerodynamic diameter 10 microns or less (PM_{10}), particulate matter with aerodynamic diameter 2.5 microns or less ($PM_{2.5}$), black carbon (BC), organic carbon (OC), carbon monoxide (CO), volatile organic compounds (VOCs), nitrogen oxides (NO_x), and sulfur oxides (SO_x).
12. The implementation of some policies will take more time, some less. For simplicity, it was assumed that all policies are phased in linearly between 2017 and 2030.
13. The Energy Policy Simulator model has been reviewed by academics at Stanford University, the Massachusetts Institute of Technology, the University of Chicago, Argonne National Laboratory, the National Renewable Energy Laboratory, and Lawrence Berkeley National Laboratory, among others.
14. Note that we report the total GHG emissions, which includes process emissions from industry and agriculture; waste; and land use, land-use change and forestry. Here electricity emissions may seem low but Mexico's power sector is not coal intensive, which is the most emissions-intensive source. Additionally, often models focus only on energy-related emissions, of which the electric sector is a greater portion.
15. Technological feasibility is already implicit in the design of the model and input data.
16. These policies were selected with reference to (Tovilla and Buira 2015).
17. There was, however, one policy that scored a D and did move on to final screening stage: vehicle electrification. This is due to the significantly high long-term abatement potential, and the fact that the policy may prove to be cost-effective post-2030.
18. The current carbon tax in Mexico is lower (around $US3.5/t$CO_2$e) (Landa-Rivera, et al. 2016).
19. The Energy Policy Simulator also produces estimates of the cost of avoided climate damages (based on the social cost of carbon), but avoided climate damages are not factored into the policy package cost metrics we use here.
20. As the Global Commission on the Economy and Climate (Global Comission on the Economy and Climate 2014) explained "The social cost of carbon (SCC) is a theoretical measure which attempts to value the full social cost of damage from an additional tonne of greenhouse gas emissions… It signals what society should, in theory, be willing to pay now to avoid the future damage caused by incremental greenhouse gas emissions."
21. The interested reader may look further into this discussion at (Global Comission on the Economy and Climate 2014) and (Hepburn 2007).
22. Split incentives occur when the party responsible for paying energy bills (typically the tenant) is not the same as the party responsible for capital investments (typically the owner). Since the benefits from efficiency improvements would accrue to the tenant, but the cost of the capital improvement to generate those benefits would be borne by the owner, the owner may lack the incentive to make the improvements.
23. http://www.cemda.org.mx/wp-content/uploads/2016/05/Los-Derechos-Humanos-y-la-calidad-dei-aire-en-Me%CC%81xico.pdf
24. Short-term exposure refers to hours and days, while long-term exposure implies months and years.

25. The Energy Policy Simulator Model's industry sector encompasses a broader set of activities than the traditional industry sector definition (e.g., from National Accounting Systems). We group activities associated with industrial process emissions, either public or private, in sectors beyond the manufacturing industry sector such as agro-industry, mining, oil and gas, and waste management.
26. Since 1990, CEMEX has been replacing clinker with substitutes such as blast furnace slag, fly ash, and pozzolanic minerals to reduce the GHG emissions of its cementitious products (the average clinker content in all of their cementitious products now stands at 78.6%, down from 85.5% in 1990).
27. To reduce 161,724 tonnes of methane per year by 2018 (against a 2014 baseline where 0 tonnes of methane is mitigated per year). This is equivalent to 9% reduction below the baseline by 2030 (linearly extrapolating the same rate of reduction through 2030).
28. The CCAC Oil & Gas Methane Partnership provides companies with a mechanism to address their methane emissions, and demonstrate this systematic approach and its results to stakeholders. A company joining the CCAC Oil & Gas Methane Partnership voluntarily commits itself to the following in its participating operations: (1) survey for nine core sources that account for the bulk of methane emissions in typical upstream operations; (2) evaluate cost-effective technology options to address uncontrolled sources; and (3) report progress on surveys, project evaluations and project implementation in a transparent, credible manner that demonstrates results (CCAC 2016)
29. National Hydrocarbon Commission (CNH.06.001/09) – Performance criteria and application for the calculation of flaring and venting of natural gas. http://www.cnh.gob.mx/_docs/QuemaVto/DT_QyV.pdf
30. The United States AgSTAR program promotes the use of biogas recovery systems to reduce methane emissions from livestock waste by identifying project benefits, risks, options and opportunities. https://www.epa.gov/agstar/what-epa-doing-agstar
31. Blue carbon is the carbon stored and sequestered in coastal ecosystems such as mangrove forests, seagrass meadows or intertidal saltmarshes. These valuable ecosystems hold vast carbon reservoirs; they sequester atmospheric CO_2 through primary production, and then deposit it in their sediments. http://bluecarbonportal.org/the-new-blue-carbon-homepage-2/about-2/what-is-blue-carbon/
32. The forestry sector in Mexico has a relatively complex legal framework, where almost 30 federal laws and at least 15 national regulations interact. Government's institutions must at least make compatible provisions under the Ley General de Cambio Climatico (General Climate Change Law), Programa Sectorial de Medio Ambiente y Recursos Naturales 2013-2018 (PROMARNAT, Sectorial Program for the Environment and Natural Resources 2013=2018), Programa Especial de Cambio Climático 2014-2018 (Special Climate Change Program 2014-2018), Programa Nacional Forestal (2103-2018) (National Forestry Program 2013-2018), Estrategia Nacional REDD+ (National REDD+ Strategy).
33. The Global Methane Initiative is "an international public-private initiative that advances cost effective, near-term methane abatement and recovery and use of methane as a clean energy source in four sectors: agriculture, coal mines, municipal solid waste, oil and gas systems, and wastewater… The Initiative reduces the informational, institutional, and other market barriers to project development through the development of tools and resources, training and capacity building, technology demonstration, and direct project support (Global Methane Initiative 2015)."
34. Article 102, V of the General Law on Climate Change.
35. A feebate is a fee on inefficient technology and a rebate on efficient vehicles.
36. This may account for skepticism expressed during the consultative process followed for this report regarding the cost-effectiveness and political feasibility of vehicle electrification policies, the result of which was that our unconditional and conditional scenarios model only 2 percent and 5 percent fleet electrification in 2030, respectively. This might be seen as conservative in the global context; other projections foresee that the global fleet will be over 25 percent electric as soon as 2040 (Bloomberg New Energy Finance 2016).
37. For instance, WRI's Building Efficiency Accelerator was used to develop the "Mexican Energy Conservation Code for Buildings" by EMBARQ Mexico, the National Commission for Energy Efficient Uses (CONUEE) and Calidad y Sustentabilidad en la Edificación (CASEDI), with the support of the British Embassy in Mexico and its future implementation in Mexican cities.

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The Open Climate Network (OCN) brings together independent research institutes and stakeholder groups to monitor countries' progress on climate change. We seek to accelerate the transition to a low-emission, climate-resilient future by providing consistent, credible information that enhances accountability both among and within countries. www.openclimatenetwork.org.

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