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WORKING PAPER

Technical Appendix

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

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WHY USE A COMPUTER MODEL?

Before considering the structure and uses of Mexico's Energy Policy Simulator, it is worthwhile to ask, "Why do we use a computer model at all?"

A policymaker seeking to reduce emissions faces a dizzying array of policy options that might advance this goal. Policies may be specific to one sector or type of technology (for instance, light-duty vehicle fuel economy standards) or might be 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. For instance, to improve the efficiency of home appliances, a government might offer rebates to buyers of efficient models, might mandate that the appliance manufacturers meet specific energy efficiency standards, or both. To navigate this field of options, policymakers require an objective, quantitative mechanism to determine which policies will meet their goals and at what cost.

Many studies have examined particular energy policies in isolation. However, it is of greater value to policymakers to understand the effects of a package of different policies because the policies may interact. This interaction can produce results different from the sum of the effects of the individual policies. For example, a policy that promotes energy efficiency and a policy that reduces the cost of wind energy, enacted together, are likely to reduce emissions by a smaller amount than the predicted sum of each of those two policies enacted separately. This is because some of the electricity demand that was eliminated via the efficiency policy would otherwise have been supplied by

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additional zero-emissions wind generation caused by the wind policy. In this case, the total effects are less than the sum of the individual effects. The opposite is also possible. For example, a policy that promotes the electrification of light-duty vehicles and a policy that makes wind energy cheaper are likely to do more together to reduce emissions than the sum of these policies' individual effects.

Thanks to the strength of computer models at simulating complex systems, a customized computer model is a crucial tool to help Mexican policymakers evaluate a wide array of policies. 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. Additionally, the model must capture the interactions of policies and other forces in a system whose parameters change dramatically over the course of the model run, as Mexico continues to grow and develop.

ABOUT SYSTEM DYNAMICS MODELING

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, non-equilibrium 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.

System dynamics models often include "stocks," or variables whose value is remembered from modeled year to modeled year, and which are affected by "flows" into and out of these variables. For example, a "stock" might be the total installed capacity of wind power plants, which can only grow or shrink gradually, due to construction of new turbines (an inflow) and retirement of old turbines (an outflow). In contrast, the amount of energy generated by wind turbines in a given year is calculated afresh every year (based on the installed capacity in that year) and is therefore a normal variable, not a "stock" variable. The Energy Policy Simulator uses stocks for two purposes: tracking quantities that grow or shrink over time (such as the total wind electricity generation capacity) and tracking differences from the baseline scenario input data that tend to grow over the course of the model run (for instance, the cumulative differences caused by enabled policies in the potential fuel consumption of the light-duty vehicle fleet).

System dynamics models often use the output of the previous timestep's calculations as input for the following timestep. The Energy Policy Simulator follows this convention, with stocks such as the electricity generation fleet, the types and efficiencies of building components, etc. remembered from one year to the next. Therefore, an efficiency improvement in an early year will result in fuel savings in all subsequent years, until the improved vehicle, building component, or other investment is retired from service.

The industry sector is handled differently. Because the available input data come in the form of potential reductions in fuel use and process-related emissions due to policy, we gradually implement these reductions (with corresponding implementation costs), rather than recursively tracking a fleet-wide efficiency. (Because of the diverse forms that input data can take in the sectors we model, one approach rarely works for all sectors. Accordingly, Mexico's Energy Policy Simulator attempts to use whichever approach makes the most sense in the context of a specific sector.)

STRUCTURE OF MEXICO'S ENERGY POLICY SIMULATOR

Mexico's Energy Policy Simulator structure can be envisioned along two dimensions: the visible structure that pertains to the equations that define relationships between variables (viewable as a flowchart) and a behind-the-scenes structure that consists of arrays (matrices) and their elements, which contain data and are acted on by the equations. For example, the transportation sector's visible structure consists of policies (such as a fuel economy standard), input data (such as the kilometers traveled by a passenger or a ton of freight), and calculated values, such as the quantity of fuel used by the vehicle fleet. The arrays in the transportation sector consist of vehicle categories (light-duty vehicles (LDVs), heavy-duty vehicles (HDVs), aircraft, rail, ships, and motorbikes), cargo types (passengers or freight), and fuel types (petroleum gasoline, petroleum diesel, electricity, etc.). The model generally performs a separate set of calculations, based on each set of input data, for every combination of array elements. For example, the model will calculate different fuel economies for passenger HDVs, freight HDVs, passenger aircraft, freight aircraft, and so forth.

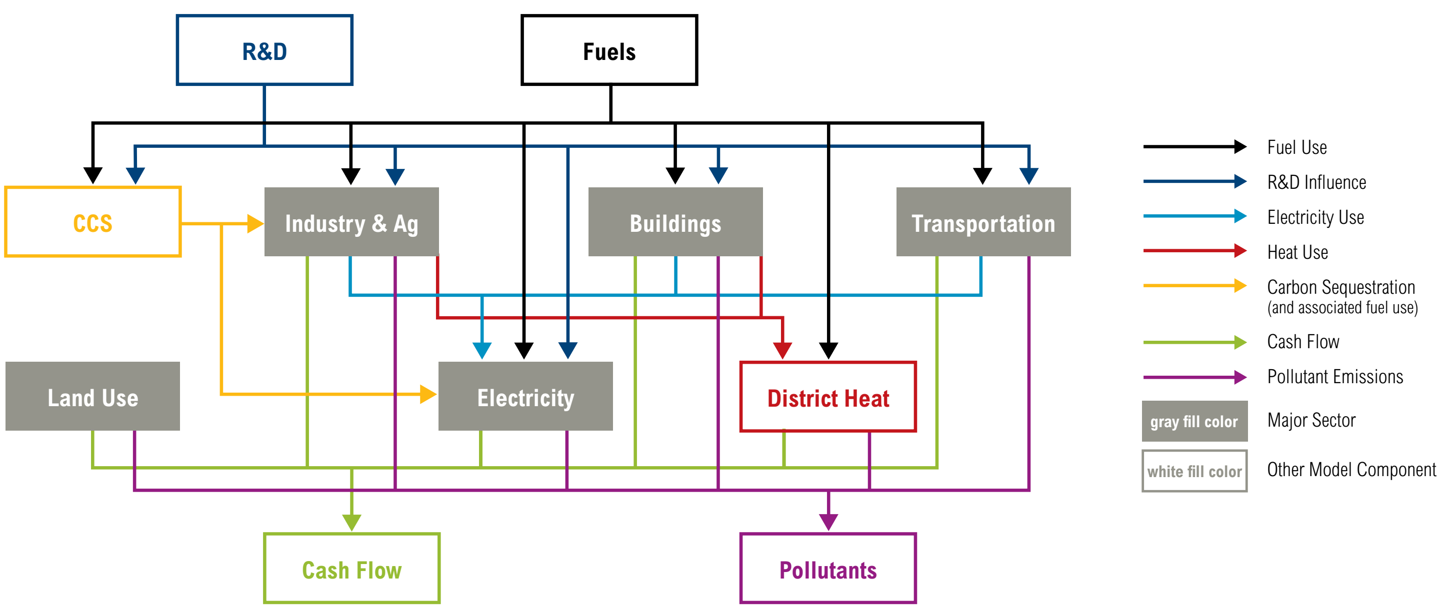
The model has five main sectors (industry and agriculture, buildings, transportation, electricity, and land use), plus a few supporting modules handling other functions, as depicted in Figure A1.

The model's calculation logic begins with the Fuels section, where basic properties of all fuels are set and policies that affect the price of fuels are applied. Information about the fuels is used in the three "demand sectors": transportation, buildings, and industry and agriculture. These sectors calculate their own emissions from direct fuel use (e.g., fossil fuels burned in vehicles, buildings, and industrial facilities). These sectors also specify a quantity of electricity or heat (energy carriers supplied by other parts of the model) required each year. The electricity sector and district heat module consume fuel to supply the energy needs of the three demand sectors. The fifth sector, land use, does not consume fuel or electricity.

All five sectors and the district heat module produce emissions of each pollutant, which are summed at the pollutants box at the end of Figure A1. The same is true for cash flow impacts, which are calculated separately for particular actors (government, industry, consumers, and several specific industries). Calculation of changes in spending (for example, on capital equipment, fuel, and operations and maintenance [O&M]), as well as monetized social benefits from avoided public health impacts and climate damages, are also carried out at this stage.

Two model components affect the operation of various sectors. A set of R&D levers allows the user to specify improvements in fuel economy and decreases in capital cost for technologies in each of the four sectors and in the carbon capture and sequestration (CCS) module. The CCS module alters the industry and electricity sectors by reducing their CO_2 emissions (representing sequestration), increasing their fuel usage (to power the energy-intensive CCS process), and affecting their cash flows.

Figure A1 | **Diagram of Mexico's Energy Policy Simulator Model Structure**



DATA SOURCES USED TO CONSTRUCT THE BASELINE SCENARIO IN THE ENERGY POLICY SIMULATOR

Table A1 shows the data sources used to construct the baseline scenario in this study.

BASIC INPUT DATA PROJECTIONS USED IN THE ENERGY POLICY SIMULATOR

For scaling some input variables, the Mexico Energy Policy Simulator uses projections based on GDP, population, or per capita GDP. GDP data come from the OECD's long-term GDP forecast (2016) and include a purchasing power

Table A1 | **Data Sources Used to Construct the Baseline Scenario in the Energy Policy Simulator**

SECTOR	MAIN DATA SOURCES
Transportation	▪ CTS Embarq's Modelo "Christopher" ▪ INEGI (National Institute of Statistics and Geography): Vehículos de motor registrados en circulación; Programa Integral de Transporte y Vialidad 2007–2012 ▪ Secretariat of Energy (SENER): Prospectiva de petrolíferos 2013–2027 ▪ Secretariat of Transport and Communications (SCT): Anuario Estadístico Ferroviario ▪ UN-HABITAT; North American Transportation Statistics; California State Controller's Office; U.S. Energy Information Administration (EIA); U.S. Environmental Protection Agency (EPA); U.S. National Highway Traffic Safety Administration (NHTSA); International Air Transportation Association; Center for Automotive Research; International Energy Agency (IEA); and Center for Automotive Research
Electricity	▪ SENER: PRODESEN 2015–2029; Inventario Nacional de Energías Renovables; Sistema de Información Energética; Prospectiva del Sector Eléctrico 2014–2028 ▪ Ley de la Industria Eléctrica ▪ Resources for the Future; Rocky Mountain Institute; Sandia National Laboratory; National Renewable Energy Laboratory (NREL); EIA; Federal Energy Regulatory Commission; Pacific Northwest National Laboratory; Western Electricity Coordinating Council; U.S. Department of Energy; and IEA
Buildings	▪ SENER: Balance Nacional de Energía 2014; Prospectiva del Sector Eléctrico 2015–2029; Prospectiva de Petróleo Crudo y Petrolíferos 2015–2029; Prospectiva de Gas Natural y Gas L.P. 2014–2028; and COPAR 2013 ▪ INEGI: Censo de Población 2010 ▪ NREL; Lawrence Berkeley National Laboratory; Resources for the Future; EIA; U.S. Department of Energy; Energy Star; and American Council for an Energy-Efficient Economy
Industry	▪ SENER: Balance Nacional de Energía 2014; Prospectiva del Sector Eléctrico 2015–2029; Prospectiva de Petróleo Crudo y Petrolíferos 2015–2029; Prospectiva de Gas Natural y Gas L.P. 2014-2028 ▪ Secretariat of Environment and Natural Resources (SEMARNAT): Inventario Nacional de Emisiones ▪ Resources for the Future; EPA; World Business Council for Sustainable Development; EIA; Rocky Mountain Institute
Land Use, Forestry, and Agriculture	▪ SEMARNAT-CONAFOR (National Forestry Commission): Inventario Nacional Forestal y de Suelos ▪ SEMARNAT-INECC: Marginal Abatement Cost Curves (MACC) for Mexico 2013 ▪ EPA

parity adjustment. Population projections come from Mexico's National Population Census (2014) (Table A2).

The model works internally in 2012 dollars, and some outputs are in billions of 2012 pesos. Consumer Price Index (CPI) information used to adjust the base year for U.S. dollars comes from the Bureau of Labor Statistics' CPI Detailed Report (2016). The conversion rate from 2012 dollars to 2012 pesos is from Oanda Historical Exchange Rates (2016) and has the value of 13.15 pesos per dollar.

Table A2 | **Input Data Projections Used in the Energy Policy Simulator**

YEAR	GDP (BILLION 2012 US$)	POPULATION	PER CAPITA GDP (2012 US$/PERSON)
2015	1,804.94	121,005,815	14,916
2016	1,858.96	122,273,473	15,203
2017	1,909.84	123,518,270	15,462
2018	1,961.32	124,737,789	15,724
2019	2,014.42	125,929,439	15,996
2020	2,069.40	127,091,642	16,283
2021	2,126.40	128,230,519	16,583
2022	2,185.60	129,351,846	16,897
2023	2,247.09	130,451,691	17,225
2024	2,310.88	131,529,468	17,569
2025	2,377.41	132,584,053	17,931
2026	2,447.17	133,614,190	18,315
2027	2,520.66	134,619,411	18,724
2028	2,598.33	135,599,641	19,162
2029	2,680.58	136,554,494	19,630
2030	2,767.76	137,481,336	20,132

Additionally, note that all uses of the word "billion" in this report refer to the short scale value (10^9) and not the long scale value (10^12) for that word.

UNCONDITIONAL AND CONDITIONAL SCENARIOS AND POLICY SETTINGS

In addition to the baseline scenario, we ran two other scenarios that achieve different GHG emissions targets for 2030. An unconditional scenario that targeted GHG emissions reductions at 22 percent below the baseline by 2030 could be achieved by Mexico acting alone with its own resources. A conditional scenario target to reduce GHG emissions by up to 36 percent below the baseline by 2030 would depend on a global agreement that addresses an international carbon price, carbon border adjustments, technical cooperation, and access to low-cost financial resources and technology transfer, among other things (all at a scale commensurate to the challenge of global climate change).

Similar policies were included in each scenario, but the policies had different "settings." A policy setting reflects the level of policy effort and of the related degree of abatement to be achieved by the policy. For example, a carbon tax of US$55 per tonne of CO_2e is more ambitious than a carbon tax of US$15 per tonne of CO_2e and would be expected to achieve a larger reduction in GHG emissions over time. Thus the conditional scenario policy package has policies with higher settings to bring about a greater reduction in GHG emissions.

The policy settings selected to reach Mexico's unconditional and conditional GHG reduction targets are presented in Table A3, along with the rationale for choosing these policy settings.

Table A3 | **Policy Settings for Reaching Mexico's Unconditional and Conditional GHG Emission Reduction Targets by 2030**

SECTOR	POLICY	DESCRIPTION	UNCONDITIONAL POLICY SETTING	CONDITIONAL POLICY SETTING	RATIONALE FOR SELECTING POLICY SETTINGS
Transportation	Transportation demand management (TDM)	Percentage of TDM package implemented	15	30	The unconditional and conditional policy settings are more modest than the implementation schedule recommended by the International Energy Agency in its 2009 report "Transport, Energy, and CO_2: Moving Toward Sustainability" (IEA 2009).
	Feebate on light-duty vehicles (LDVs)	Rate at which inefficient vehicles are taxed and efficient vehicles are subsidized	0	US$500/0.01 gallons per mile	Due to questionable political feasibility, no feebate is used in the unconditional policy package. However, stronger transportation policies will be required to meet Mexico's conditional GHG target. A feebate rate of US$500/0.01 gallons per mile is selected as the conditional policy setting, as per the proposal developed for the Institute of Ecology and Climate Change (INECC) in 2011 (Medina et al. 2011).
	Fuel economy standards	Percentage of additional improvement of fuel economy standards for LDVs	40	87	The conditional policy setting matches the fuel economy standards of the United States, since Mexican legislation is typically harmonized with the North American market. The unconditional policy setting matches the United States' 2016 fuel economy standards (GFEI 2016). Moreover, in a June 2016 announcement with the United States and Canada, Mexico committed to reduce GHG emissions from light- and heavy-duty vehicles by aligning fuel efficiency and/or GHG emission standards by 2025 and 2027, respectively.
		Percentage of additional improvement of fuel economy standards for heavy-duty vehicles (HDVs)	20	45	The conditional policy setting matches the United States' proposed 2030 fuel economy standards (since Mexican legislation is typically harmonized with the North American market). The unconditional policy setting matches the United States' 2016 fuel economy standards (GFEI 2016). Moreover, in a June 2016 announcement with the United States and Canada, Mexico committed to reduce GHG emissions from light- and heavy-duty vehicles by aligning fuel efficiency and/or GHG emission standards by 2025 and 2027, respectively.
	Vehicle electrification	Percentage of nonelectric passenger LDVs and HDVs shifted to electric	2	5	The inclusion of this policy is to put Mexico on a trajectory to complete decarbonization beyond 2050, which requires getting started on electrifying the transportation sector. Since Mexico does not yet have any policies related to electrifying passenger vehicles, fairly low policy settings are selected–2% in the unconditional policy package and 5% in the conditional policy package.

Table A3 | **Policy Settings for Reaching Mexico's Unconditional and Conditional GHG Emission Reduction Targets by 2030 (continued)**

SECTOR	POLICY	DESCRIPTION	UNCONDITIONAL POLICY SETTING	CONDITIONAL POLICY SETTING	RATIONALE FOR SELECTING POLICY SETTINGS
Buildings	Distributed solar carve-out	Minimum percentage of total electricity demand to be met by distributed solar photovoltaic (PV)	1	2	Unconditional and conditional policy settings are based on the 2015 report from the Mexican Institute for Competitiveness on transforming the Mexican electricity market (Gallegos and Rodríguez 2015).
	Energy efficiency standards	Percentage reduction in energy use allowed for cooling and ventilation in the residential (urban and rural) and commercial sectors	30	50	Unconditional and conditional policy settings are based on the U.S. Agency for International Development (USAID) 2015 report, which assessed the feasibility for reducing Mexico's GHG emissions through energy efficiency, as well as Mexico's National Commission for the Efficient Use of Energy (CONUEE) 2016 report, which accessed the impacts of energy saving measures by national policies (USAID 2016 and CONUEE 2016).
		Percentage reduction in energy use allowed for the building envelope in the residential (urban and rural) and commercial sectors	20	40	Unconditional and conditional policy settings are based on USAID's 2015 report, which assessed the feasibility for reducing Mexico's GHG emissions through energy efficiency, as well as CONUEE's 2016 report, which accessed the impacts of national policies on energy saving measures (USAID 2016 and CONUEE 2016).
		Percentage reduction in energy use allowed for lighting in the residential (urban and rural) and commercial sectors	10	20	Unconditional and conditional policy settings are based on USAID's 2015 report, which assessed the feasibility for reducing Mexico's GHG emissions through energy efficiency, as well as CONUEE's 2016 report, which accessed the impacts of energy saving measures by national policies (USAID 2016 and CONUEE 2016).
Electricity	Additional demand response	Percentage of demand response potential achieved	50	50	No study of demand response potential in Mexico has been conducted. However, the U.S. Federal Energy Regulatory Commission completed an assessment of U.S. demand response potential. As most demand response is provided by industrial and commercial facilities, particularly in the early years of demand-response implementation, Mexico's potential was estimated by scaling the U.S. potential by GDP ratio. We conservatively use only 50% of this potential in the policy packages.

Table A3 | **Policy Settings for Reaching Mexico's Unconditional and Conditional GHG Emission Reduction Targets by 2030 (continued)**

SECTOR	POLICY	DESCRIPTION	UNCONDITIONAL POLICY SETTING	CONDITIONAL POLICY SETTING	RATIONALE FOR SELECTING POLICY SETTINGS
	Increase transmission capacity	Percentage increase in transmission capacity above baseline scenario	30	60	Mexico has a portfolio of projects that could double the electricity grid's transmission capacity over the next 20 years (Secretaría de Energía 2014). This is equivalent to increasing transmission capacity by 75% by 2030 (15 years). Since these projects are classified as "possible," a more conservative setting of 60% is selected for the conditional policy package. Half of this value (30%) is chosen for the unconditional policy package.
	Avoid transmission and distribution (T&D) losses	Percentage of T&D losses avoided	22	43	Mexico's PRODESEN (the Development Program for the National Electricity System) for 2015–2029 includes goals to reduce T&D losses of the electricity grid to 10% by 2018, which currently stand at 13.9%. However the Electric Sector Outlook (Prospectiva del Sector Eléctrico 2015-2029) set the goal for T&D losses at 8%. Reducing these T&D losses to 8% (which translates to a policy setting of 43%) is seen as feasible in the conditional policy package, and half that (22%) is selected in the unconditional policy package.
Industry	Methane capture	Percentage of opportunities achieved	38	75	In June 2016, Mexico announced a target to reduce methane emissions from the oil and gas industry by 40–45% below 2005 levels by 2025 (White House: Office of the Press Secretary 2016). The achievement of this target (at the lower end, i.e., 40%) is equivalent to a reduction of 75% of GHG emissions from the oil and gas industry below the baseline scenario. This is chosen as the conditional policy setting. Half of this value (38%) is chosen for the unconditional policy package, to reflect less-than-full achievement of this goal.
	Reduced venting of high global warming potential (GWP) gases	Percentage of CO_2e abatement achieved	38	75	In July 2015, Mexico, Canada, and the United States submitted a joint proposed amendment to the Montreal Protocol to phase down HFC emissions (UNEP 2015). Then, in June 2016, Mexico, along with Canada and the United States, affirmed its commitment to adopt an ambitious and comprehensive Montreal Protocol HFCs phase-down amendment in 2016, and to reduce use of HFCs, including through domestic actions (White House: Office of the Press Secretary 2016). As such, it is politically feasible for Mexico to reduce the venting of its high GWP gases by up to 75% by 2030. 75% is chosen as the policy setting in the conditional policy package. Half of this value (38%) is chosen for the unconditional policy package.
	Industry energy efficiency standards	Percentage improvement in standards relative to baseline scenario	30	30	A policy setting of 30% by 2030 is chosen for both the unconditional and conditional policy packages, to reflect continued improvement but at a more modest pace from 2021-2030.

Table A3 | **Policy Settings for Reaching Mexico's Unconditional and Conditional GHG Emission Reduction Targets by 2030 (continued)**

SECTOR	POLICY	DESCRIPTION	UNCONDITIONAL POLICY SETTING	CONDITIONAL POLICY SETTING	RATIONALE FOR SELECTING POLICY SETTINGS
	Cement clinker substitution	Percentage of technically feasible cement clinker substitution made	90	90	The Government of Mexico, through SEMARNAT and Mexico's National Chamber of Cement (CANACEM), is implementing a nationally appropriate mitigation action (NAMA) in the cement sector to reduce GHG emissions. The NAMA will be achieved through the use of clinker substitutes in cement production (cement blending) and the replacement of fossil fuels with alternative fuels (generated from the recycling of tires, municipal solid waste, sewage sludge, and biomass) (International Partnership on Mitigation and MRV 2013). In addition, cement clinker substitution is a fairly cost effective policy. Therefore, the percentage of cement clinker substitution that can be made by 2030 is fairly high. 90% of the potential is selected as the setting for both the unconditional and conditional policy packages, which represents a reduction of roughly 15% clinker from 2014 levels.
	Cogeneration and waste heat recovery	Percentage of potential cogeneration and waste heat recovery adopted	100	100	Mexico's PRODESEN (the Development Program for the National Electricity System) for 2015–2019 estimates that, in order to meet expected electricity demand growth for the period 2015–2029 in Mexico, 60 gigawatts (GW) of additional capacity will be required.12% of this additional power capacity is expected to come from efficient cogeneration systems (Secretaría de Energía 2014) (which is already included in the baseline scenario). This means that additional investments will be required in cogeneration and waste heat recovery. In addition, this is a strongly cost effective policy. As such, this policy is set at full strength for both the unconditional and conditional policy packages.
	Industrial fuel switching	Percentage of coal use converted to natural gas	100	100	A major pillar of Mexico's Special Climate Change Program (PECC) (2014–2018) is a strategy to accelerate the transition to less intensive carbon energy sources (SEMARNAT 2013). Under this strategy, Mexico will give priority to, among others, natural gas, which is considered a "clean" fuel in Mexico. Due to the current low price of natural gas and the ability to sometimes retrofit coal-burning equipment to burn natural gas, it is feasible that industrial facilities can switch from coal to natural gas. This is also a fairly cost-effective policy. As such, this policy is set at full strength for both the unconditional and conditional policy packages.
		Percentage of natural gas use converted to electricity	2	5	This is a policy that achieves emission reductions over the long term, and only when the power sector has been decarbonized. As such, the policy settings applied to this lever are fairly low–2% in the unconditional policy package and 5% in the conditional policy package.

Table A3 | **Policy Settings for Reaching Mexico's Unconditional and Conditional GHG Emission Reduction Targets by 2030 (continued)**

SECTOR	POLICY	DESCRIPTION	UNCONDITIONAL POLICY SETTING	CONDITIONAL POLICY SETTING	RATIONALE FOR SELECTING POLICY SETTINGS
	Early retirement of inefficient industrial facilities	Percentage of energy savings achieved	100	100	Due to the existence of old PEMEX plants in Mexico, the early retirement of inefficient industrial facilities is highly feasible and fairly cost effective. As such, this policy is set at full strength for both the unconditional and conditional policy packages.
Land Use and Agriculture	Avoided deforestation	Percentage of abatement achieved	14	27	Mexico has announced a goal to achieve net zero carbon emissions from forests by 2030. Assuming that Mexico's afforestation and reforestation targets are achieved (see the row below), the conditional scenario avoided deforestation settings are equivalent to the additional abatement that would be required to meet Mexico's forestry goals. The unconditional policy setting is half that of the conditional policy setting, to reflect less-than-full achievement of this goal.
	Afforestation and reforestation	Percentage of abatement achieved	50	100	The conditional policy setting is based on the achievement of Mexico's afforestation and reforestation targets submitted as part of the Bonn Challenge (Government of Mexico 2014). The unconditional policy setting is half that of the conditional policy setting, to reflect less-than-full achievement of this goal.
	Livestock measures	Percentage of abatement achieved	None	50	Manure management measures are feasible and commercially viable in Mexico. The Global Methane Initiative recognizes that, for Mexico, livestock and agro-industrial subsectors are deemed to have the greatest potential for methane emission reduction or methane capture. We select a 50% setting rather than a 100% setting, as some of the more expensive livestock measures (such as dietary supplements or anti-methanogen vaccines) are either too expensive or not yet commercially viable.
Cross-Sector	Carbon tax	Rate	US\$15/tCO_2e	US\$55/tCO_2e	According to the United States Environmental Protection Agency (EPA), the social cost of carbon in 2030 is US\$55/tCO_2e (at 3% discount rate, converted to 2012 US\$). This is chosen as the carbon tax rate to meet Mexico's conditional GHG reduction target. A weaker carbon tax rate of US\$15/tCO_2e is selected for Mexico's unconditional policy package, which is below the true externality cost of carbon.
	End existing fossil fuel subsidies	Percentage reduction in gasoline, diesel, and jet fuel subsidies relative to baseline scenario	100	100	In June 2016, as part of a joint announcement with Canada and the United States, Mexico committed to phase out inefficient fossil fuel subsidies by 2025 in keeping with the G20's 2009 commitment to phase out inefficient fossil fuel subsidies in the medium term (White House: Office of the Press Secretary 2016). It is assumed that this target is achieved in both the unconditional and conditional policy packages.

SECTOR-LEVEL EMISSIONS TO MEET MEXICO'S UNCONDITIONAL AND CONDITIONAL GHG REDUCTION TARGETS BY 2030

Figures A2, A3, and A4 present the sector-level emissions profile in Mexico's baseline scenario and the sector-level emissions profiles that result from the unconditional and conditional policy package scenarios.

Figure A2 | **GHG Emissions by Sector under Mexico's Baseline Scenario, 2015–2030**

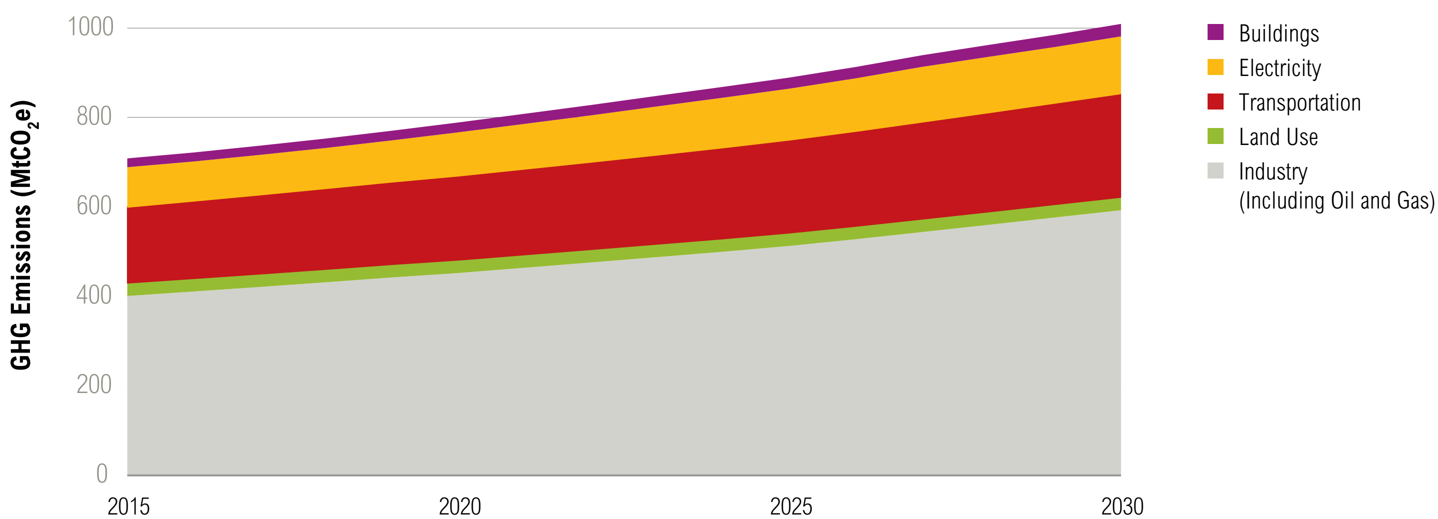


Figure A3 | **GHG Emissions by Sector to Reach Mexico's Unconditional GHG Reduction Target, 2015–2030**

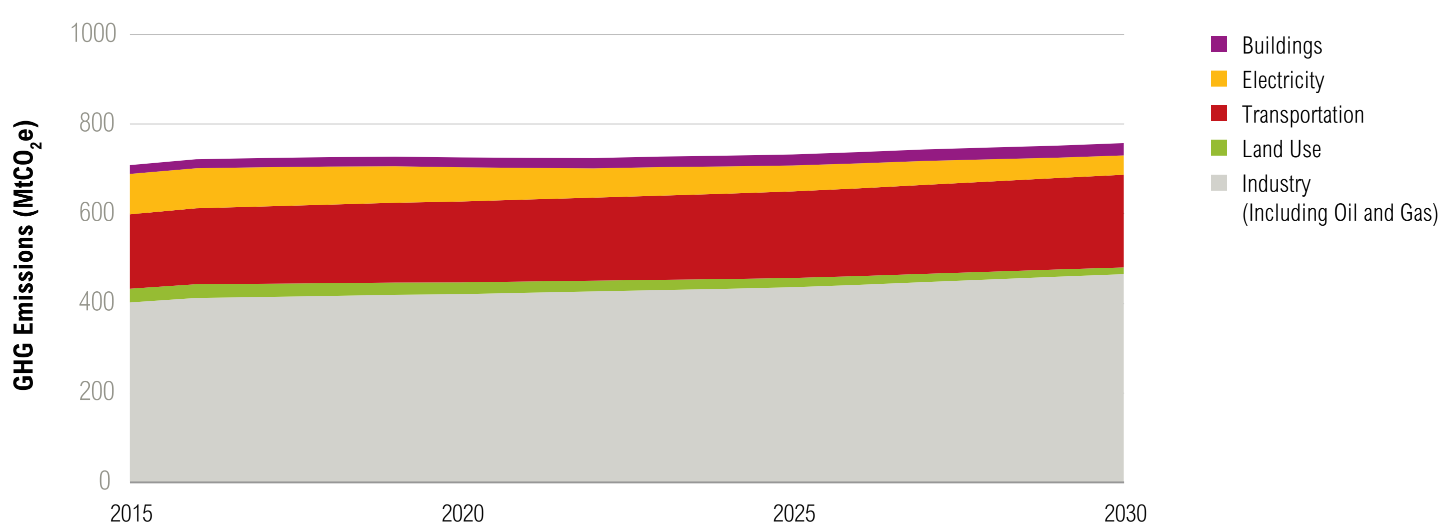


Figure A4 | **GHG Emissions by Sector to Reach Mexico's Conditional GHG Reduction Target, 2015–2030**

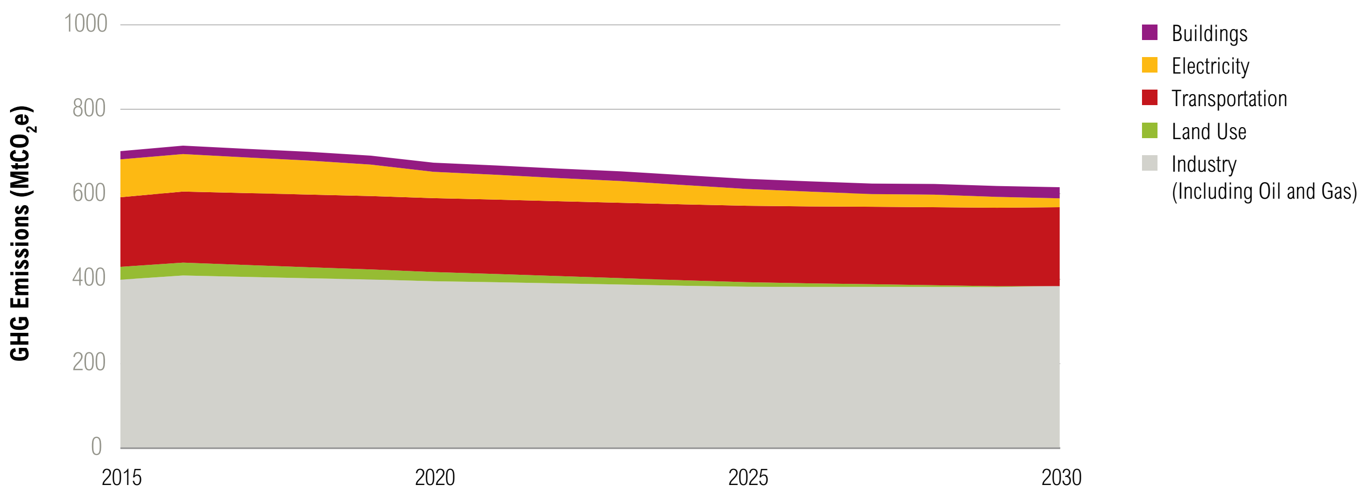
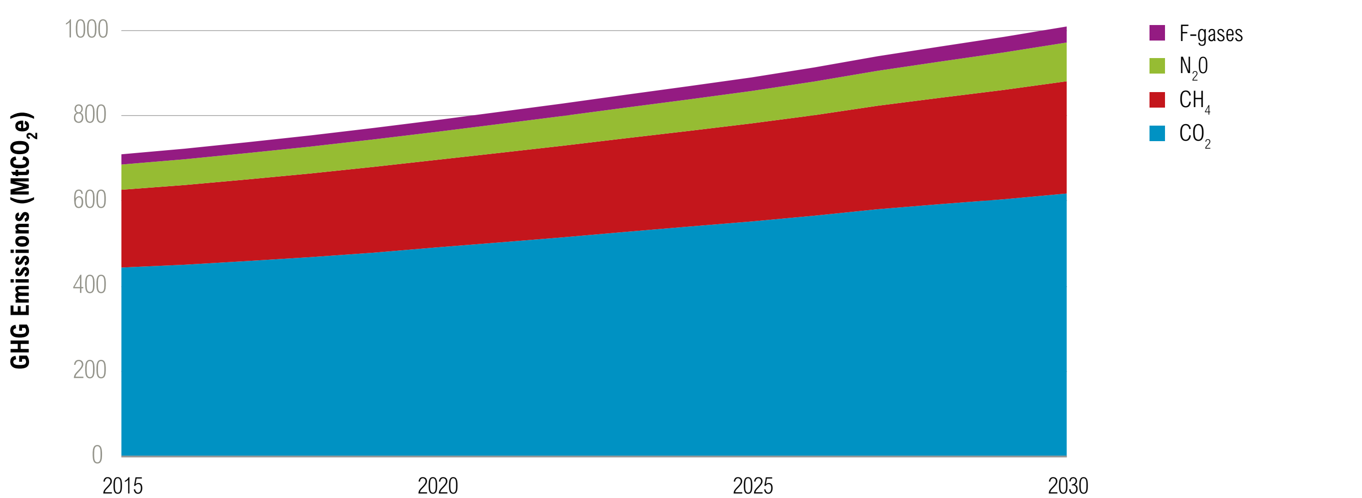


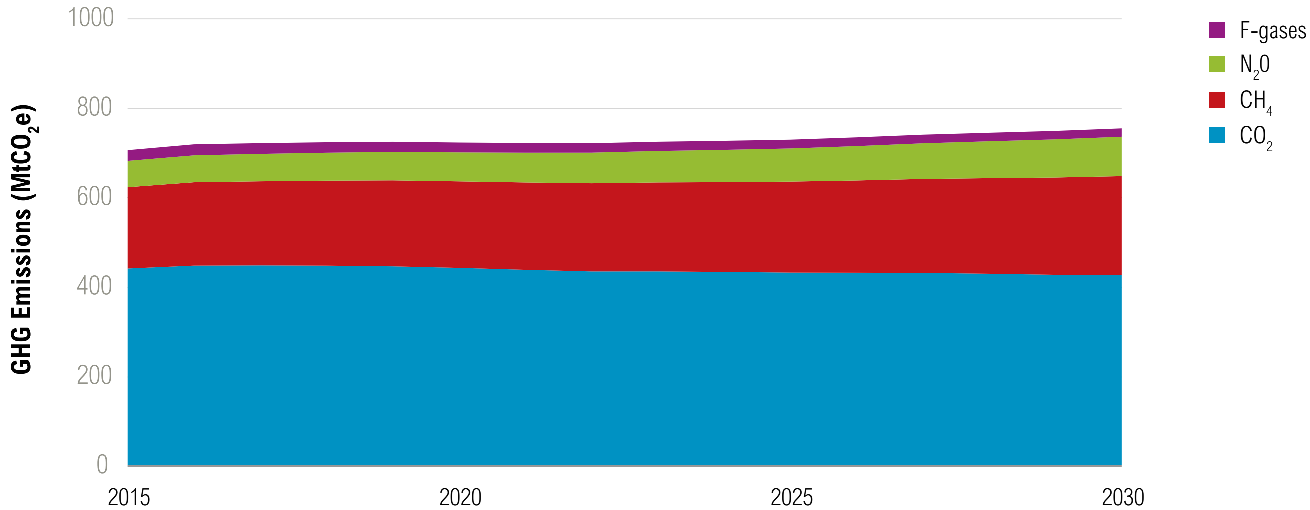
Figure A5, A6, and A7 present the emissions by gas in Mexico's baseline scenario and the sector-level emissions profiles that result from the unconditional and conditional policy package scenarios.

Figure A5 | **Emissions by Greenhouse Gas in the Baseline Scenario, 2015–2030**



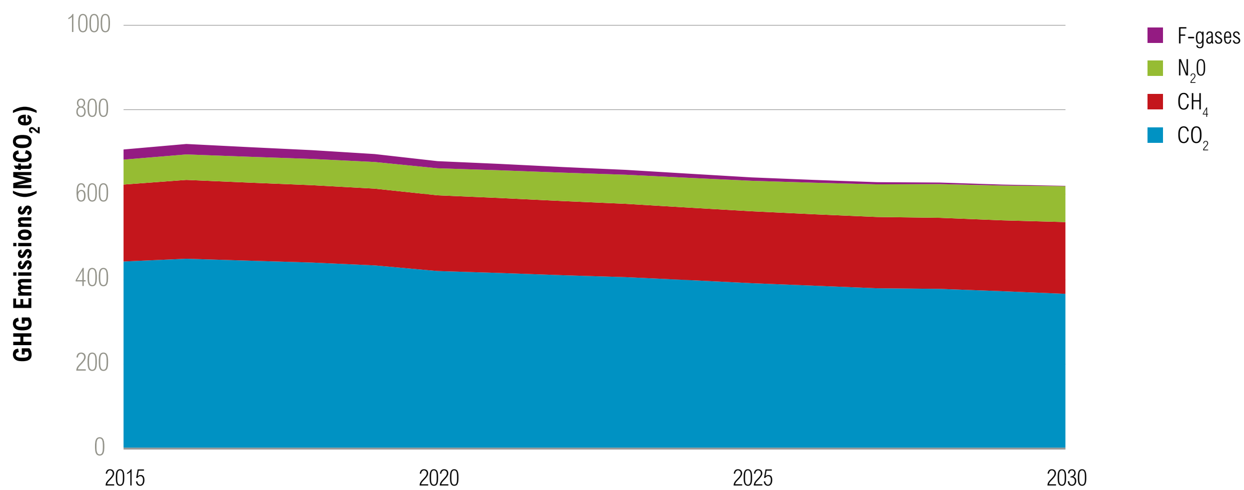
Note: F-gases = fluorinated gases. N_2O = nitrous oxide. CH_4 = methane. CO_2 = carbon dioxide.

Figure A6 | **Emissions by Greenhouse Gas in the Unconditional Scenario Policy Package**



Note: F-gases = fluorinated gases. N_2O = nitrous oxide. CH_4 = methane. CO_2 = carbon dioxide.

Figure A7 | **Emissions Required by Greenhouse Gas in the Conditional Scenario Policy Package**



Note: F-gases = fluorinated gases. N_2O = nitrous oxide. CH_4 = methane. CO_2 = carbon dioxide.

ELECTRICITY SYSTEM STRUCTURE FOR BASELINE, UNCONDITIONAL, AND CONDITIONAL POLICY SCENARIOS

The policy packages developed to meet Mexico's unconditional and conditional GHG reduction targets include two grid transmission-related policies: increase grid transmission capacity and reduce transmission and distribution losses. Both policies relate to improving the grid infrastructure, which will allow for more clean energy on the grid, the incorporation of new-generation technologies, and increases in efficiency in the transmission and distribution of electricity in Mexico. These infrastructure improvements also reduce energy losses, which, in turn, save operational costs. This allows electricity to be sold at more competitive prices.

Both the unconditional and conditional scenario policy packages lead to increases in the share of clean energy technologies[1] over time.

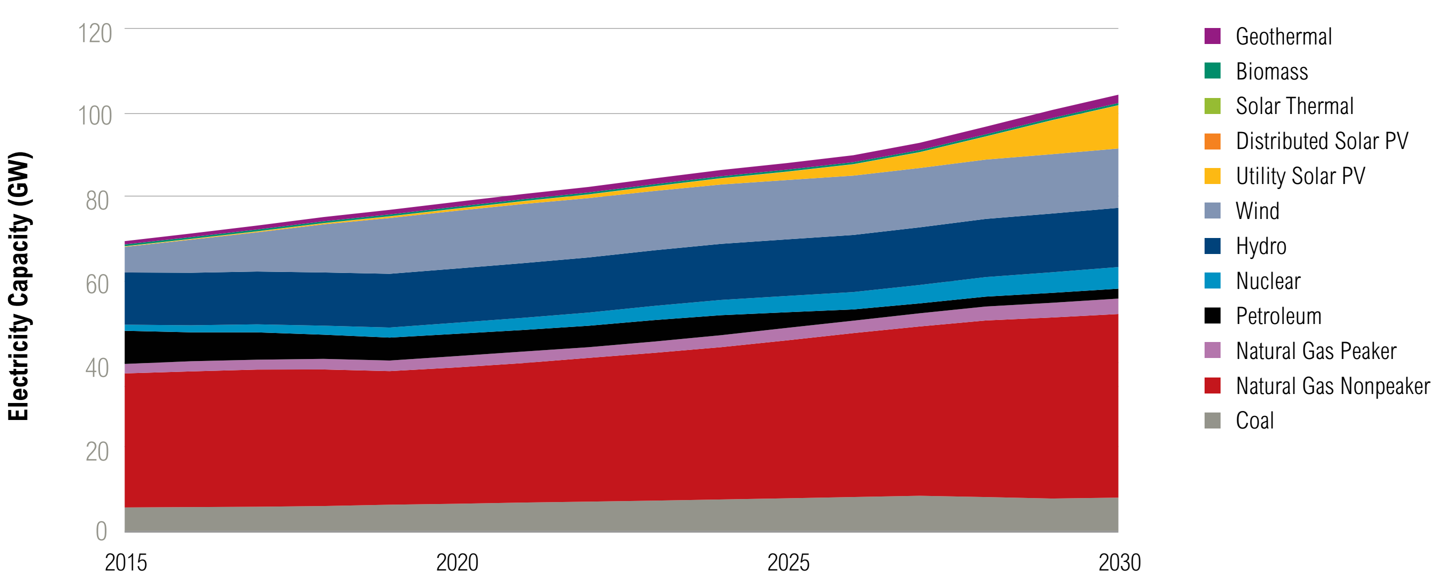
To develop the electricity system structure in the Energy Policy Simulator, we consulted several documents published by Mexico's Secretariat of Energy (SENER): *the Development Program for the National Electricity System 2014–2029 (Programa de Desarrollo del Sistema Eléctrico Nacional; PRODESEN), Electric Sector Outlook 2014–2029 (Prospectiva del Sector Eléctrico 2014–2029), the Energy Information System Database (Sistema de Información Energética; SIE) and Costs and Reference Parameters for Formulating Investment Projects in the Electricity Sector (Costos y Parámetros de Referencia para la Formulación de Proyectos de Inversión del Sector Eléctrico, 2015).*

PRODESEN, 2014–2029, contains the most recent information about the country's electricity system. Therefore, the projections in this document were used to construct the electricity system structure in the baseline scenario. The Energy Policy Simulator assesses how much electricity will be required in Mexico through 2030, adds power plants over the years depending on the demand, and finally chooses which power plants to dispatch to meet the demand. The model then sums the fuel usage by these power plants to calculate GHG emissions.[2]

Baseline Scenario: Electricity System Structure

This section describes the electric system capacity and electricity generation in the baseline scenario policy package, 2015–2030.

Figure A8 | **Total Installed Electric Capacity in the Baseline Scenario, 2015–2030**



Note: Natural gas peaker plants are those run only for a small fraction of the year (typically less than 10 percent), when additional, fast-ramping electricity capacity is needed to meet a sudden increase in demand or to help integrate variable renewables onto the grid. All other natural gas plants are categorized as natural gas nonpeaker plants.

Electric Capacity in the Baseline Scenario

In the baseline scenario, Mexico's total electric capacity increases from 60 gigawatts (GW) in 2015 to 105 GW in 2030 (increasing 75 percent over 15 years). In 2015, in the baseline scenario, the energy sources that make up the total installed capacity include 50 percent natural gas, 18 percent hydropower, 11 percent petroleum, 9 percent wind, and 8 percent coal, with the remaining 4 percent distributed between biomass, geothermal, nuclear, and solar. In 2030, in the baseline scenario, the energy sources that make up the total installed capacity include 46 percent natural gas, 14 percent hydropower, 14 percent wind, 10 percent solar, 8 percent coal, and 5 percent nuclear, with the remaining 5 percent distributed between biomass, geothermal, and petroleum (see Figure A8).

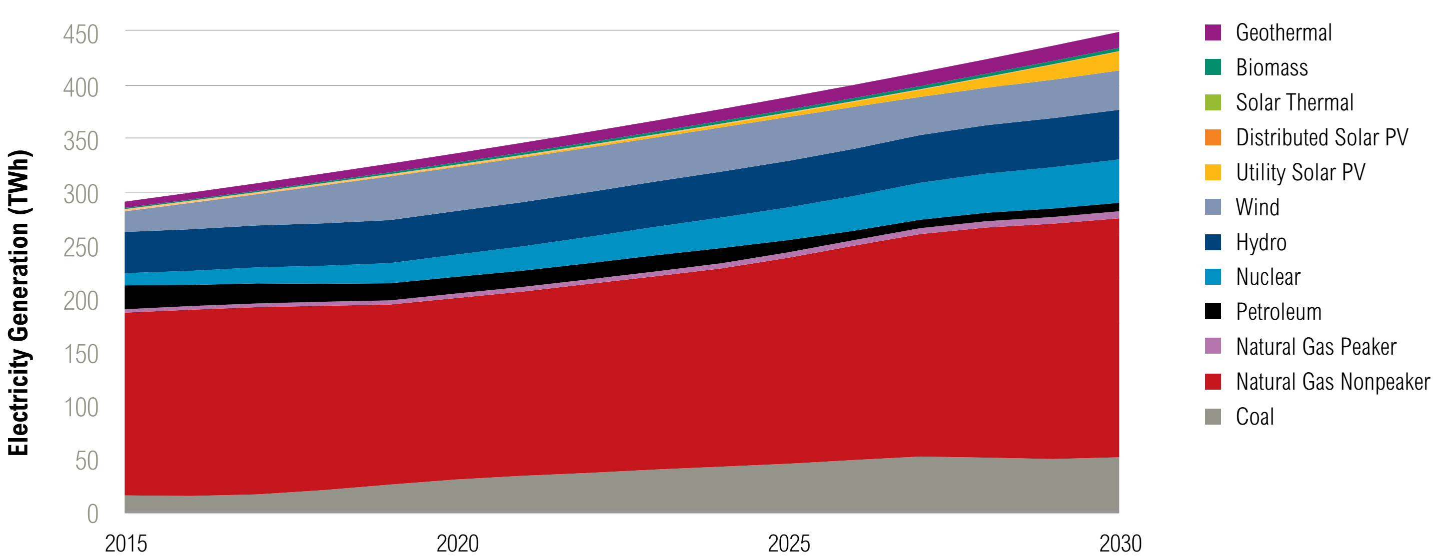
In 2015, in the baseline scenario, clean energy sources comprise 31 percent of the total installed capacity, and increase to 40 percent in 2020 and to 44 percent in 2030.

Electricity Generation in the Baseline Scenario

In the baseline scenario, Mexico's total electricity generation increases from 292 terrawatt-hours per year (TWh/year) in 2015 to 452 TWh/year in 2030. In 2015, 60 percent of the total electricity generation is from natural gas, followed by hydropower (13 percent), petroleum (8 percent), wind (7 percent), and coal (5 percent). The remaining 7 percent includes biomass, solar, geothermal, and nuclear. In 2030, electricity generation from natural gas decreases to a 51 percent share of the total generation, followed by coal (11 percent), hydropower (10 percent), nuclear (9 percent), and wind (8 percent). The remaining 11 percent comprises biomass, geothermal, solar, and petroleum (see Figure A9).

As mentioned earlier in this section, Mexico's electricity system structure was modelled based on information contained in PRODESEN, 2014–2029. According to this document, Mexico has a goal of generating 35 percent of its electricity from clean energy sources by 2024. PRODESEN references the "Indicative Program of Installation and Retirement of Power Plants" (PIIERCE in Spanish), which reflects the long-term electricity system planning to meet demand and clean energy targets. As such, the baseline scenario results reflect Mexico meeting this target—in 2015, clean energy sources would comprise 27 percent of the total electricity generation mix, increasing to 34 percent in 2020, 35 percent in 2024, and 36 percent in 2030.

Figure A9 | **Electricity Generation in the Baseline Scenario, 2015–2030**



Note: Natural gas peaker plants are those run only for a small fraction of the year (typically less than 10 percent), when additional, fast-ramping electricity capacity is needed to meet a sudden increase in demand or to help integrate variable renewables onto the grid. All other natural gas plants are categorized as natural gas nonpeaker plants.

Unconditional Scenario Electric System Structure

This section describes the electric system capacity and electricity generation in the unconditional scenario policy package, 2015–2030.

Electric Capacity in the Unconditional Scenario Policy Package

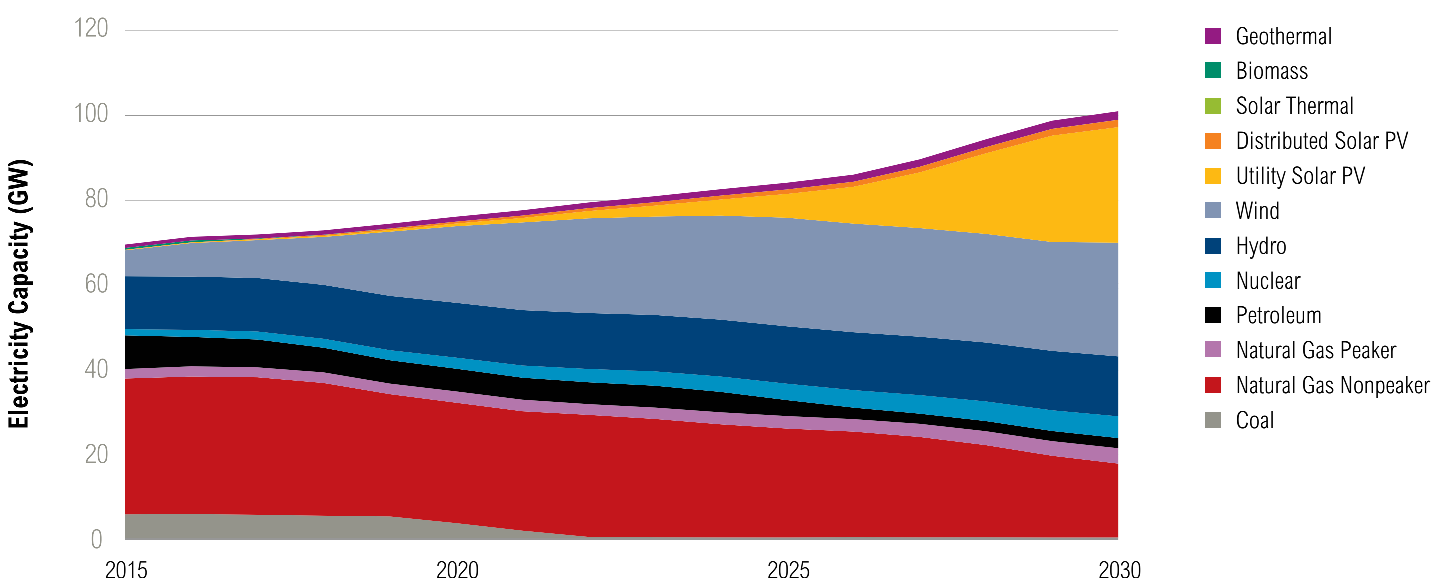
In the unconditional scenario policy package, by 2030, the electricity sector is expected to have around 101 GW of total installed capacity (which is 4 GW lower than the baseline scenario). In 2030, clean energy sources will comprise 77 percent (77 GW) of the installed total capacity, with fossil fuels accounting for a considerably lesser share, 23 percent (24 GW). With regards to the composition of energy sources in the electricity sector, the unconditional scenario has 7 percent more clean energy installed than the baseline scenario in 2020, 18 percent more in 2024, and 32 percent more in 2030.

As shown in Figure A10, the technologies showing the biggest increase in capacity in the unconditional scenario policy package are utility solar PV and wind. The total utility solar PV installed capacity increases from around 0.1 GW in 2015 to around 27 GW in 2030. The total wind installed capacity increases from around 6 GW in 2015 to nearly 27 GW in 2030—a more than fourfold increase over 15 years. Fossil fuels in the electricity mix show a substantial decrease in the unconditional scenario policy package. The installed capacity of coal power plants decreases by 97 percent to almost 0 GW in 2030, while the installed capacity of natural gas plants decreases from around 32 GW in 2015 to 17 GW in 2030 (a decline of 45 percent). The carbon tax is a major driver of these shifts.

Generation capacity construction costs in the unconditional scenario policy package are slightly lower than baseline costs from 2018 to 2020 (due to electricity demand reduction), but capacity construction costs exceed baseline construction costs in all remaining years of the model run (2021–2030), peaking in 2023 at US$1.3 billion above the baseline, then gradually declining to US$162 million above the baseline in 2030. The main driver of increased capacity construction costs is wind power throughout most of the model run, but solar PV becomes the main cost driver by 2030.

The changes in the composition of the electricity mix in the unconditional scenario policy package result in a 66 percent drop in emissions from this sector by 2030, relative to the baseline.

Figure A10 | **Installed Power Capacity in the Unconditional Scenario Policy Package, 2015–2030**



Note: Natural gas peaker plants are those run only for a small fraction of the year (typically less than 10 percent), when additional, fast-ramping electricity capacity is needed to meet a sudden increase in demand or to help integrate variable renewables onto the grid. All other natural gas plants are categorized as natural gas nonpeaker plants.

Electricity Generation in the Unconditional Scenario Policy Package

In the unconditional scenario policy package, Mexico's total electricity generation increases from 292 TWh in 2015 to 342 TWh in 2030 (110 TWh less than the baseline scenario) (see Figure A11). The share of clean energy in the unconditional scenario policy package is also higher than in the baseline scenario. As mentioned in the previous section, Mexico has a goal to generate 35 percent of its electricity from clean energy sources by 2024. The baseline scenario reflects Mexico achieving this goal. The unconditional scenario policy package shows Mexico achieving this goal sooner: by 2020 the country will generate 41 percent (129 TWh) of its electricity from clean energy sources and this percentage will increase to 51 percent (166 TWh) in 2024 and 67 percent (231 TWh) in 2030 due to increases in electricity generation from sources such as utility solar PV, wind, and nuclear.

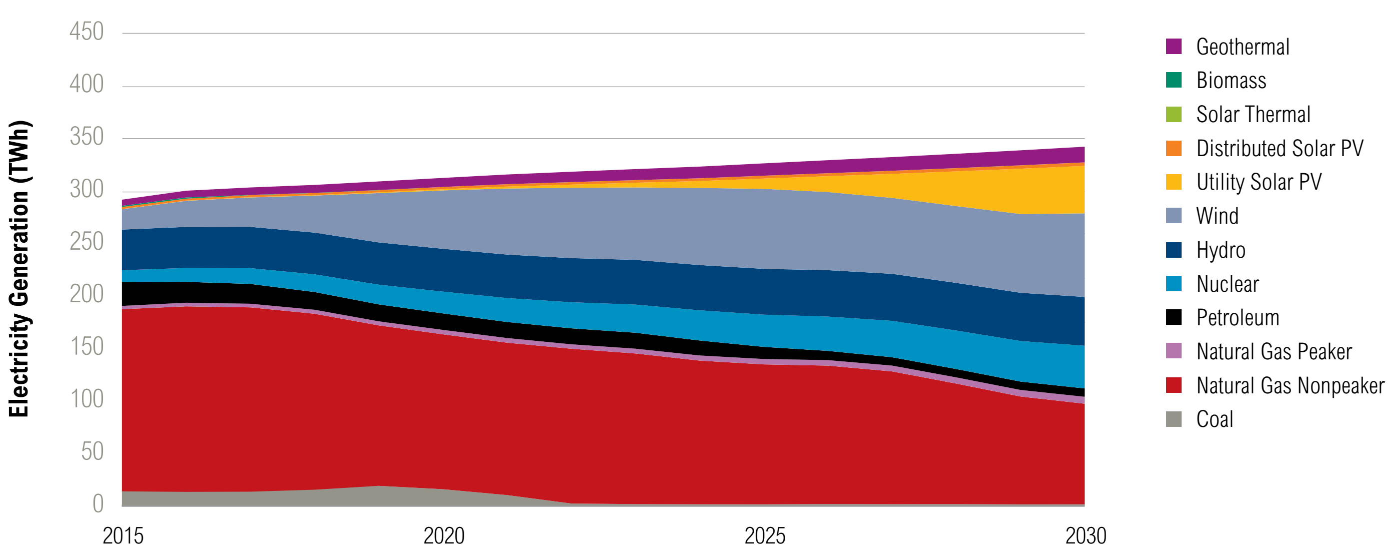
Conditional Scenario: Electric System Structure

This section describes the electric system capacity and electricity generation in the unconditional scenario policy package, 2015–2030.

Electric Capacity in the Conditional Scenario Policy Package

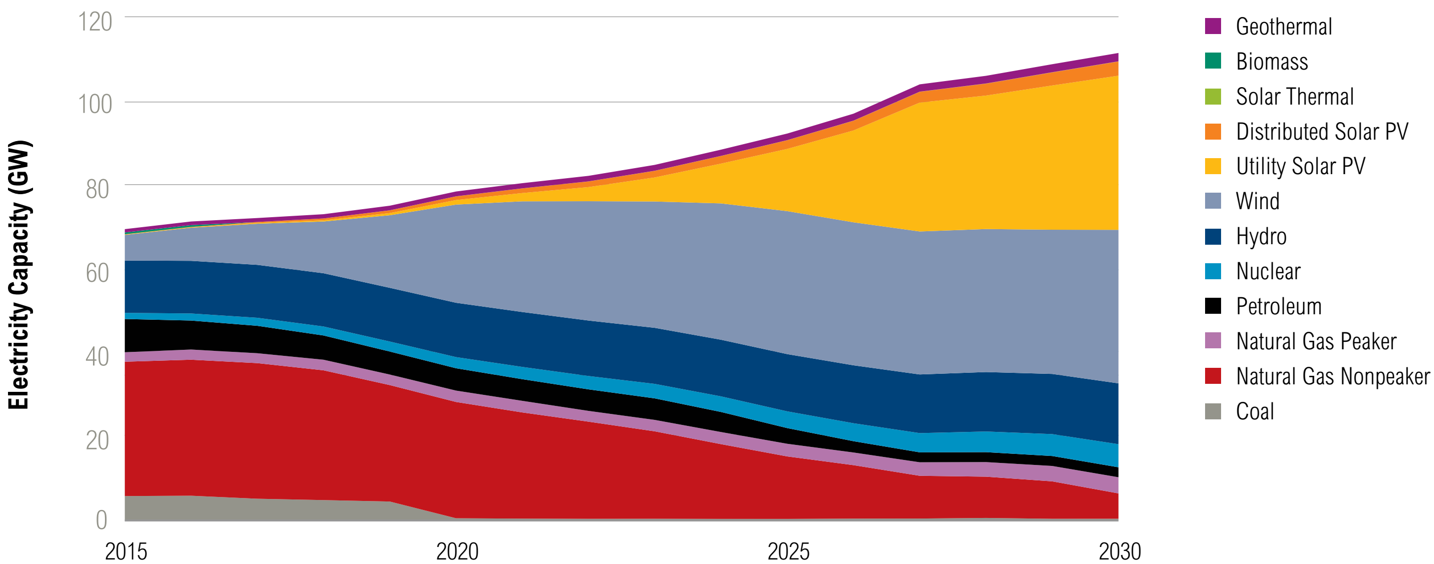
In the conditional scenario policy package, by 2030, the electricity sector is expected to have around 112 GW of total installed capacity (which is 7 GW higher than the baseline scenario). In 2020, clean energy sources will comprise 54 percent (42 GW) of the installed total capacity, increasing to 71 percent (63 GW) in 2024, and 89 percent (100 GW) in 2030. With regards to the composition of energy sources in the electricity sector, the conditional scenario policy package has 14 percent more clean energy installed than the baseline scenario in 2020, 31 percent more in 2024, and 45 percent more in 2030. Moreover, by 2030, the share of fossil fuels in the electricity sector is 11 percent, compared with the baseline scenario of 56 percent.

Figure A11 | **Electricity Generation in the Unconditional Scenario Policy Package, 2015–2030**



Note: Natural gas peaker plants are those run only for a small fraction of the year (typically less than 10 percent), when additional, fast-ramping electricity capacity is needed to meet a sudden increase in demand or to help integrate variable renewables onto the grid. All other natural gas plants are categorized as natural gas nonpeaker plants.

Figure A12 | **Installed Power Capacity in the Conditional Scenario Policy Package, 2015–2030**



Note: Natural gas peaker plants are those run only for a small fraction of the year (typically less than 10 percent), when additional, fast-ramping electricity capacity is needed to meet a sudden increase in demand or to help integrate variable renewables onto the grid. All other natural gas plants are categorized as natural gas nonpeaker plants.

As shown in Figure A12, the technologies showing the biggest increase in capacity in the conditional scenario are utility solar PV and wind. The total installed capacity of utility solar PV increases from around 0.1 GW in 2015 to around 37 GW in 2030. The total installed wind capacity increases from around 6 GW in 2015 to nearly 37 GW in 2030—a more than sixfold increase over 15 years. The share of fossil fuels in the electricity mix also shows a substantial decrease in the conditional scenario policy package. The installed capacity of natural gas plants decreases from around 32 GW in 2015 to 6 GW in 2030 (a decline of 81 percent).[3]

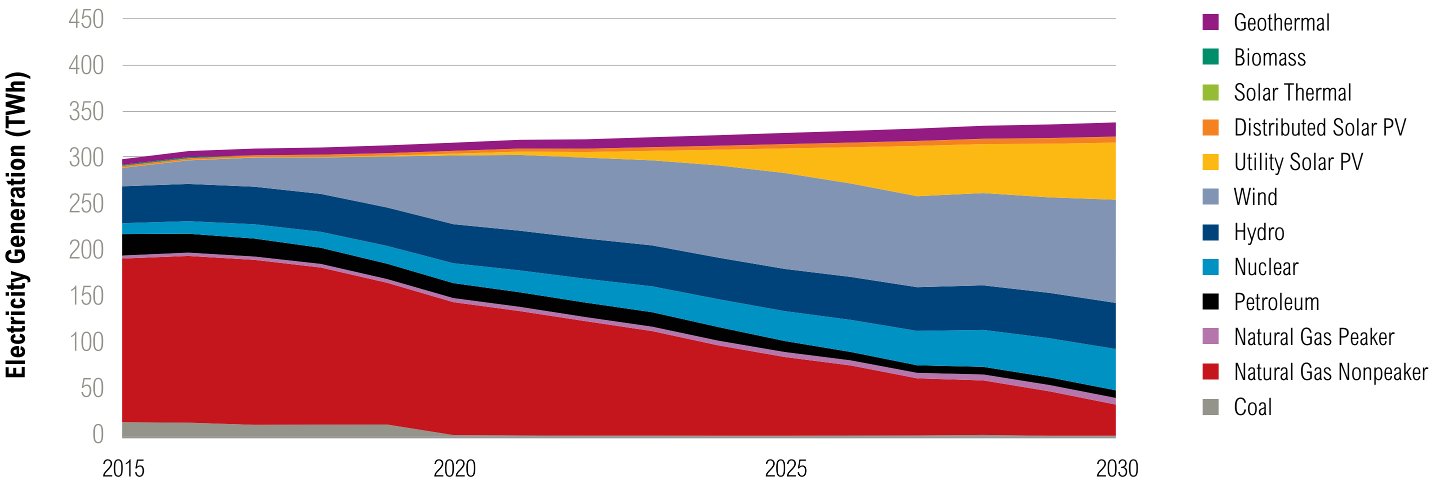
Generation capacity construction costs in the conditional scenario policy package are similar to the baseline costs from 2018 to 2019, but capacity construction costs significantly exceed the baseline construction costs in all remaining years of the model run (2020–2030). Costs rise to US$1.8 billion above the baseline in 2022, then remain in the range of roughly US$1.7–US$2.1 billion above the baseline for the remainder of the model run. The main driver of increased capacity construction costs is wind power throughout most of the model run, but solar PV becomes nearly as large by 2030.

The changes in the composition of the electricity mix in the unconditional scenario policy package results in an 84 percent drop in emissions of this sector by 2030 relative to the baseline.

Electricity Generation in the Conditional Scenario Policy Package

In the conditional scenario policy package, Mexico's total electricity generation increases from 292 TWh/year in 2015 to 330 TWh/year in 2030 (122 TWh/year less than the baseline scenario, see Figure A13). The share of clean energy in the conditional scenario policy package is higher than in the baseline scenario and the unconditional scenario policy package: by 2030, the country would generate 85 percent of its electricity from clean energy sources. This is due to dramatic changes in the electricity composition mix between 2015 and 2030. Natural gas electricity generation will decrease from 172 TWh/year in 2015 to 32 TWh/year in 2030, coal from 14 TWh/year to less than 1 TWh/year, and petroleum from 22 TWh/year to 8 TWh/year. Conversely, there will be drastic increase in clean energy generation: wind energy generation

Figure A13 | **Electricity Generation in the Conditional Scenario Policy Package, 2015–2030**



Note: Natural gas peaker plants are those run only for a small fraction of the year (typically less than 10%), when additional, fast-ramping electricity capacity is needed to meet a sudden increase in demand or to help integrate variable renewables onto the grid. All other natural gas plants are categorized as natural gas nonpeaker plants.

increases from 19 TWh/year in 2015 to 108 TWh/year in 2030, utility solar PV increases from 0.1 TWh/year to 60 TWh/year, and nuclear increases from 11 TWh/year to 43 TWh/year.

In both the unconditional and conditional scenario policy packages, the largest changes in the electricity composition mix are caused by increases in solar and wind energy (and decreases in the capacity of natural gas plants). These results are consistent with the effects of increasing the transmission capacity of the power grid and reducing energy losses through efficiency improvements. As mentioned earlier, increased transmission capacity allows for better integration of renewable energy on the grid.

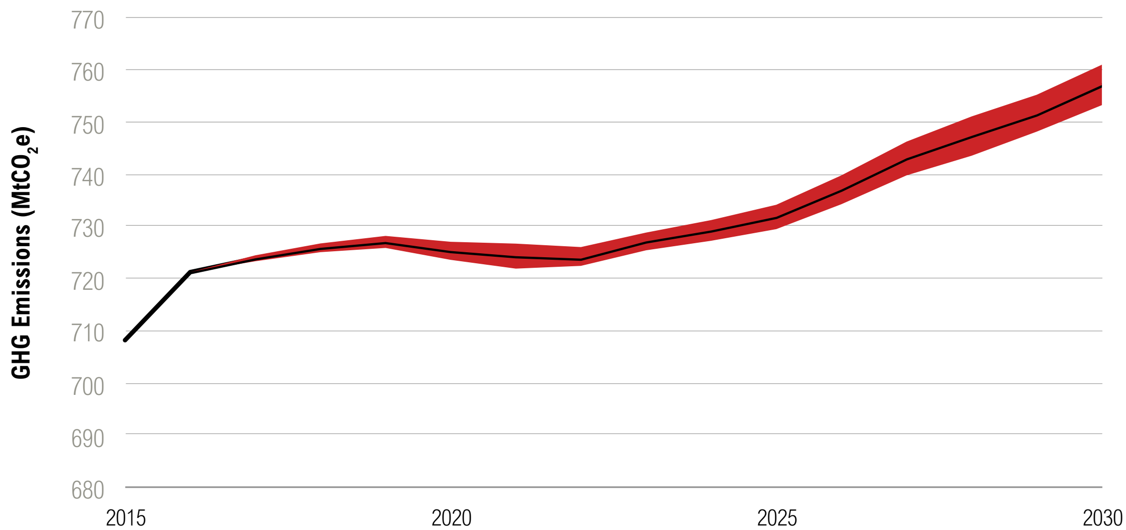
SENSITIVITY ANALYSIS

Monte Carlo sensitivity analysis was used to determine the effects of variance on certain key inputs to our scenarios on final GHG emissions. We chose to explore the effects of 25 percent variance (or uncertainty) in carbon tax rate, natural gas price, and petroleum fuels price. For each of the unconditional and conditional scenario policy packages, 1,000 simulations were performed for each of the three inputs to be varied (a total of 6,000 simulations). Each input parameter was varied randomly with a uniform distribution between +/-25 percent of its regular value in each scenario.

Carbon Tax Variance

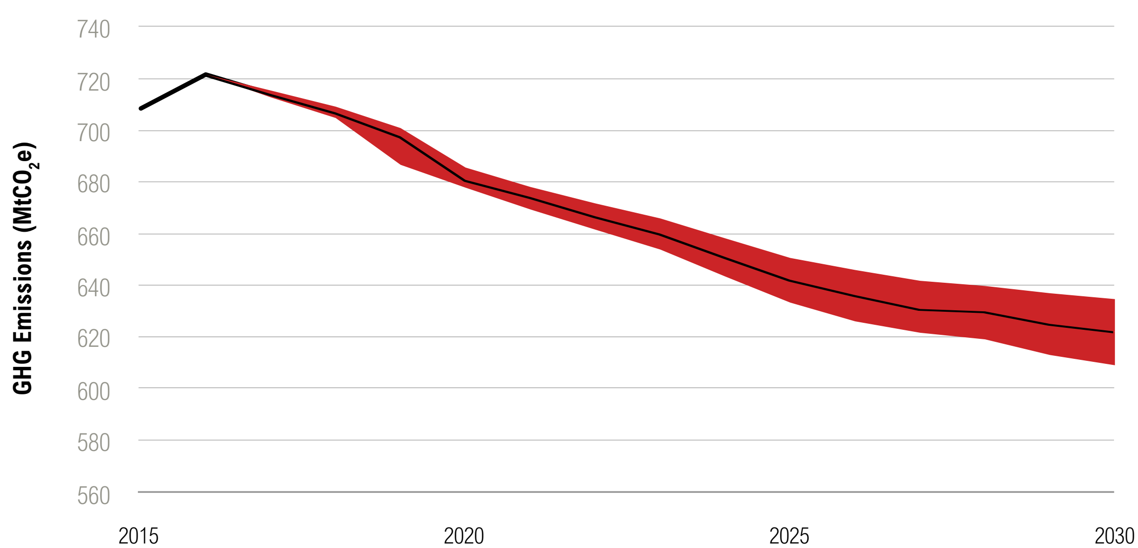
In the unconditional scenario policy package, a 25 percent variance in the carbon tax rate resulted in a 95 percent confidence interval spread of about 8 $MtCO_2e$ in 2030, as shown in Figure A14.

Figure A14 | **95 Percent Confidence Interval for Total GHG Emissions Given a 25 Percent Uncertainty in Carbon Tax Rate (Unconditional Scenario Policy Package), 2015–2030**



In the conditional scenario policy package, a 25 percent variance in the carbon tax rate resulted in a 95 percent confidence interval spread of about 26 $MtCO_2e$ in 2030, as shown in Figure A15.

Figure A15 | **95 Percent Confidence Interval for Total GHG Emissions Given a 25 Percent Uncertainty in Carbon Tax Rate (Conditional Scenario Policy Package), 2015–2030**



Natural Gas Price Variance

In the unconditional scenario policy package, a 25 percent variance in the price of natural gas resulted in a 95 percent confidence interval, which amounts to 5–6 $MtCO_2e$ in 2015 and 2030. A high natural gas price in early years reduces emissions, while a high natural gas price in later years increases emissions (because some coal is substituted for natural gas, since we have reached flexibility limits on renewables deployment), as shown in Figure A16.

In the conditional scenario policy package, a 25 percent variance in the price of natural gas resulted in a 95 percent confidence interval that is 8 $MtCO_2e$ in 2015 but narrows over time, as less and less natural gas remains to be phased out; also, because of the carbon tax, a 25 percent variance in the base price of natural gas represents a smaller change in the overall price of natural gas in later years, as shown in Figure A17.

Figure A16 | **95 Percent Confidence Interval for Total GHG Emissions Given a 25 Percent Uncertainty in Natural Gas Price (Unconditional Scenario Policy Package), 2015–2030**

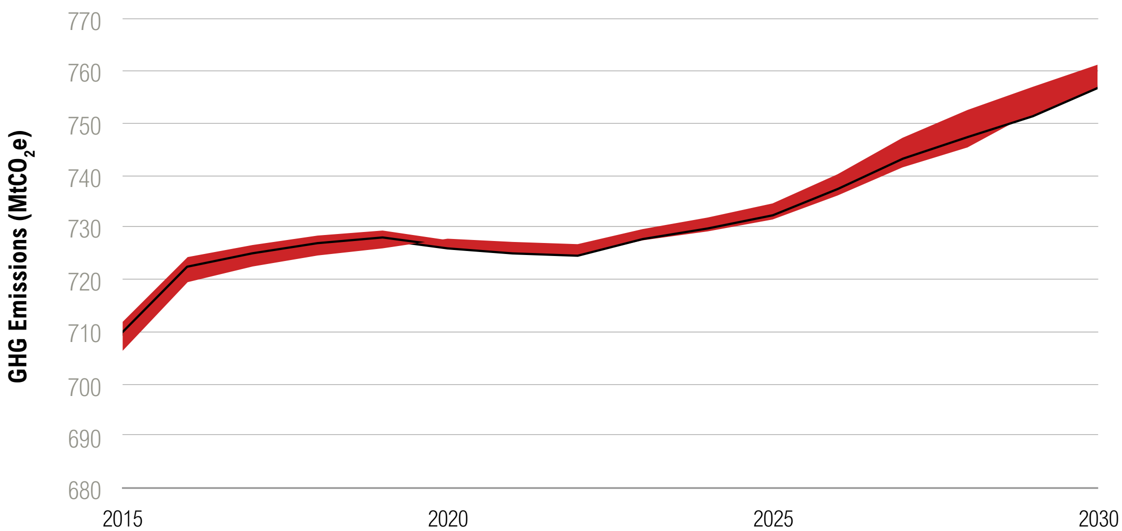
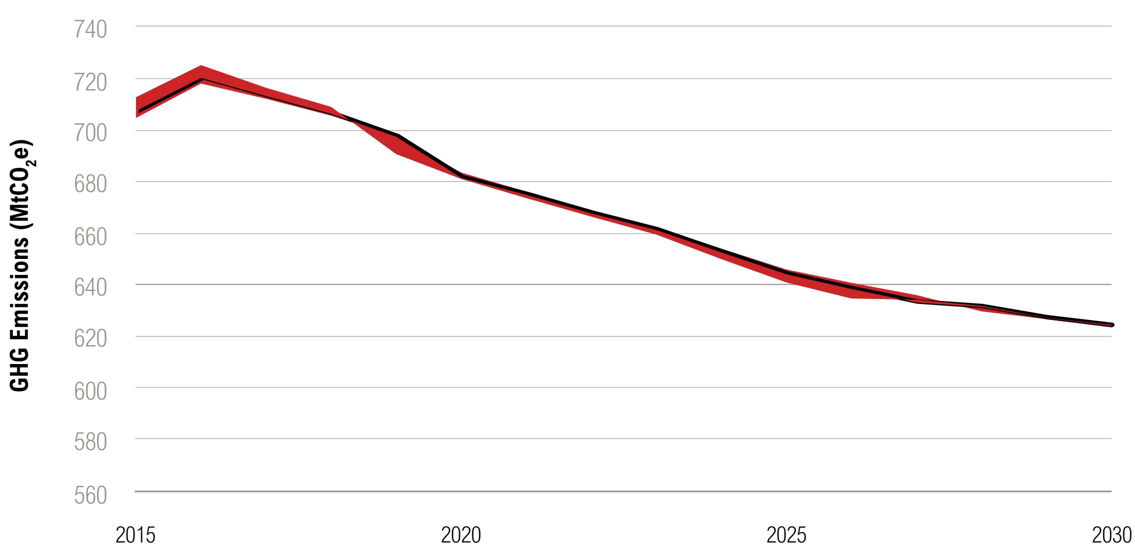


Figure A17 | **95 Percent Confidence Interval for Total GHG Emissions Given a 25 Percent Uncertainty in Natural Gas Price (Conditional Scenario Policy Package), 2015–2030**



Petroleum Price Variance

In the unconditional scenario policy package, a 25 percent variance in petroleum price resulted in a 95 percent confidence interval spread of about 4 $MtCO_2e$ in 2030, as shown in Figure A18.

In the conditional scenario policy package, a 25 percent variance in petroleum price resulted in a 95 percent confidence interval spread of about 6 $MtCO_2e$ in 2030, as shown in Figure A19.

Figure A18 | **95 Percent Confidence Interval for Total GHG Emissions Given a 25 Percent Uncertainty Petroleum Price (Unconditional Scenario Policy Package), 2015–2030**

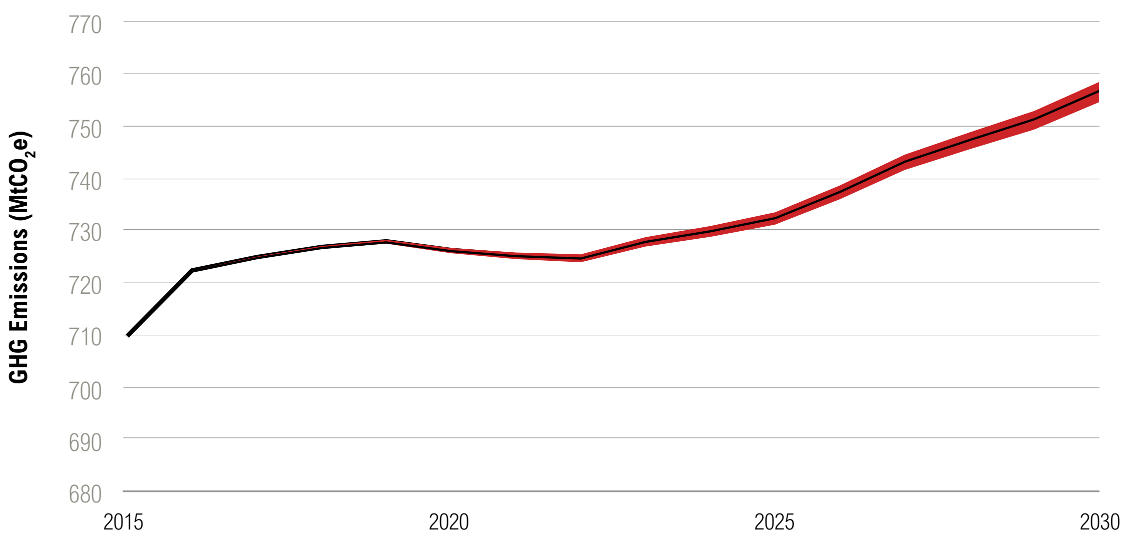
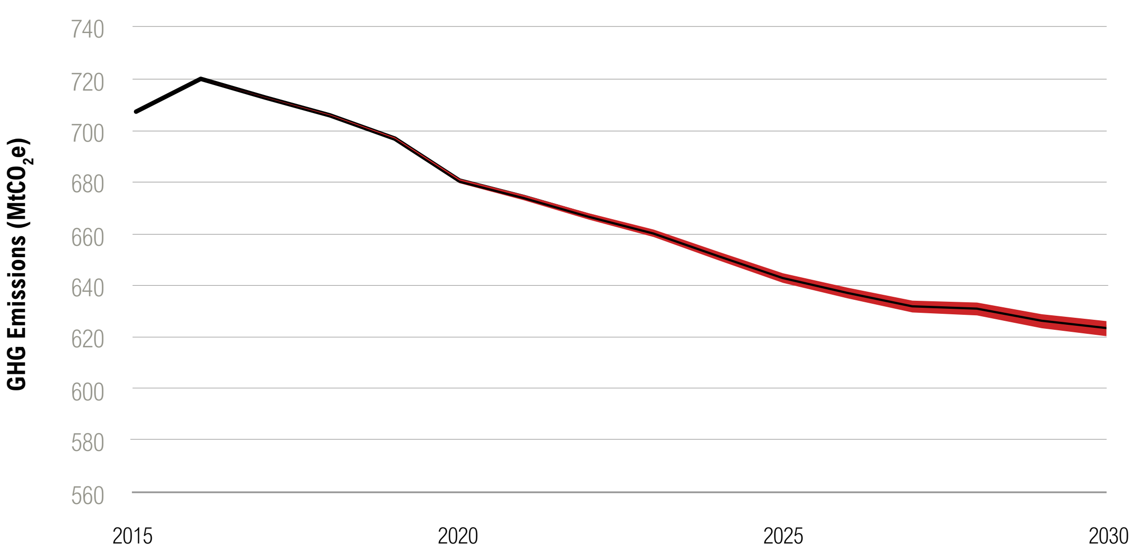


Figure A19 | **95 Percent Confidence Interval for Total GHG Emissions Given a 25 Percent Uncertainty Petroleum Price (Unconditional Scenario Policy Package), 2015–2030**



DATA SOURCES FOR THE MEXICO ENERGY POLICY SIMULATOR

The Mexico Energy Policy Simulator is adapted from the international, open-source release of Energy Innovation's Energy Policy Simulator. Input data in the international release represent the United States. To adapt the model to another country, much of the input data must be replaced. One of the following approaches can be taken for each variable:

- U.S. input data are replaced with Mexican data, which were located in published sources, produced as outputs from other models, provided by the Mexican government, and so on. This is our preferred approach and is used where possible.
- U.S. input data are scaled to better represent Mexico. Scaling factors vary by variable and are selected based on which scaling factor most closely correlates with the variable in question. For example, a variable pertaining to economic output or production might be scaled by GDP, while a variable related to wastewater treatment might be scaled by population.
- U.S. input data are left unchanged. This may be done when the data are not actually country-specific (for example, the global warming potentials of various gases). This may also be done when no Mexican data for a variable are available and scaling the U.S. value would be inappropriate. For example, the expected lifetime of a building component (such as an air conditioner) in the United States may be the best available estimate of the lifetime of that same type of building component in Mexico. Scaling the lifetime of a U.S. air conditioner by any available factor (e.g., population, GDP) would be nonsensical.

Table A4 indicates the approach taken for each input variable in the model and provides brief notes regarding the data sources. Many variables have more than one data source, so full source information can sometimes be extensive. Full source information is available in each variable's associated spreadsheet file, which can be downloaded as part of the Mexico Energy Policy Simulator package (free and open-source) from https://mexico.energypolicy.solutions.

Variables that exist in the international model structure but are not used in the Mexico's Energy Policy Simulator are omitted from this table.

Table A4 | **Data Sources for Each Input Variable in the Mexico Energy Policy Simulator**

MODEL SECTION	ACRONYM	CATEGORY OR VARIABLE	VARIABLES WITHIN CATEGORY	DATA SOURCE (AND SCALING FACTORS, IF ANY)
Additional Outputs	BGRC	Baseline scenario GDP-related calculations	Baseline scenario GDP, Baseline scenario Economy-wide CO_2 emissions intensity	Mexico-specific data. GDP data are from OECD. Baseline scenario CO_2 emissions are from the Mexican government.
Additional Outputs	SCoC	Social cost of carbon		U.S. data. The U.S. social cost of carbon reflects global damages, not just damages to the United States and thus is not U.S.-specific.
Additional Outputs	SCoHIbP	Social cost of health impacts by pollutant		U.S. data from the U.S. Environmental Protection Agency (EPA). Scaled for Mexico by population and by per-capita GDP.
Additional Outputs	VoaSL	Value of a statistical life		U.S. data from the EPA. Scaled for Mexico by per-capita GDP.

Table A4 | **Data Sources for Each Input Variable in the Mexico Energy Policy Simulator (continued)**

MODEL SECTION	ACRONYM	CATEGORY OR VARIABLE	VARIABLES WITHIN CATEGORY	DATA SOURCE (AND SCALING FACTORS, IF ANY)
Buildings & Appliances	BASoBC	Baseline scenario amount spent on building components		Data from Mexican Census on number of urban and rural households. Data from the U.S. Energy Information Agency (EIA) on spending on building components. Scaled for Mexico based on the average of population and GDP.
Buildings & Appliances	BCEU	Baseline scenario components energy use		Mexican data from the Secretariat of Energy (SENER).
Buildings & Appliances	BDEQ	Baseline scenario distributed electricity quantities	Baseline scenario distributed electricity source capacity, baseline scenario electricity output from distributed sources	Mexican data from SENER and the Federal Electricity Commission.
Buildings & Appliances	CL	Component lifetime		U.S. data from the Department of Housing and Urban Development, the Department of Energy, and the State of California.
Buildings & Appliances	CpUDSC	Cost per unit distributed solar capacity		U.S. data from Lawrence Berkeley National Laboratory and National Renewable Energy Laboratory.
Buildings & Appliances	DSCF	Distributed solar capacity factor		Mexican data from Federal Electricity Commission.
Buildings & Appliances	ECiCpCU	Embedded carbon in components per currency unit		U.S. data from Resources for the Future.
Buildings & Appliances	EoBSDwEC	Elasticity of building service demand with regard to energy cost		U.S. data from the EIA.
Buildings & Appliances	EoCEDwEC	Elasticity of component energy demand with regard to energy cost		U.S. data from the EIA.
Buildings & Appliances	EoCPwEU	Elasticity of component price with regard to energy use		U.S. data from the EIA.
Buildings & Appliances	EoDSDwSP	Elasticity of distributed solar deployment with regards to subsidy percent		U.S. data from Bloomberg New Energy Finance. To date, the Mexican government has bought most distributed solar systems (for rural areas), so market elasticities have not yet been established.
Buildings & Appliances	FoBObE	Fraction of buildings owned by entity		U.S. data from the Department of Energy (DOE).

Table A4 | **Data Sources for Each Input Variable in the Mexico Energy Policy Simulator (continued)**

MODEL SECTION	ACRONYM	CATEGORY OR VARIABLE	VARIABLES WITHIN CATEGORY	DATA SOURCE (AND SCALING FACTORS, IF ANY)
Buildings & Appliances	FoLRfCTbRP	Fraction of lifetime remaining for components targeted by retrofitting policy		U.S. data from KEMA and the California Public Utilities Commission.
Buildings & Appliances	PCFURfE	Percentage of components fuel use reduction for electricity		U.S. data from the DOE.
Buildings & Appliances	PEURfRC	Percentage of energy use reduction for retrofit components		U.S. data from Lawrence Berkeley National Laboratory.
Buildings & Appliances	PPEIdtICEaT	Potential percentage efficiency improvement due to improved contractor education and training		U.S. data from the American Council for an Energy-Efficient Economy.
Buildings & Appliances	PPEIdtIL	Potential percentage efficiency improvement due to improved labeling		U.S. data from the American Council for an Energy-Efficient Economy.
Carbon Capture and Sequestration (CCS)	CC	CCS costs	Capital cost of equipment to sequester one tonne of CO_2 per year, CCS total O&M cost per tonne sequestered, energy use per tonne CO_2 sequestered	U.S. data from Massachusetts Institute of Technology.
Carbon Capture and Sequestration	CCEL	CCS capital equipment lifetime		European data from the Advisory Council of the European Technology Platform for Zero Emission Fossil Fuel Power Plants.
Carbon Capture and Sequestration	CPbE	CCS percentages by entity	Fraction of CO_2 Sequestration by Sector, Percentage of Industry CCS by Industry, Fraction of Electricity Sector CCS by Energy Source	OECD-wide data from the International Energy Agency (IEA).
Carbon Capture and Sequestration	CSA	Carbon sequestration amounts	Baseline scenario tonnes CO_2 Sequestered, Additional CCS Potential	Mexico-specific data from the IEA.
Carbon Capture and Sequestration	PDiCECpDoC	Percent decline in CCS equipment cost per doubling of capacity		U.S. data from the Congressional Research Service.

Table A4 | **Data Sources for Each Input Variable in the Mexico Energy Policy Simulator (continued)**

MODEL SECTION	ACRONYM	CATEGORY OR VARIABLE	VARIABLES WITHIN CATEGORY	DATA SOURCE (AND SCALING FACTORS, IF ANY)
Cost Outputs	DR	Discount rate		Mexican data from the Secretariat of Finance and Public Credit.
Electricity Supply	ARpUIiRC	Annual retirement per unit increase in relative cost		U.S. data from Resources for the Future.
Electricity Supply	BBSC	Baseline scenario battery storage capacity		Mexican data from Centro Mario Molina.
Electricity Supply	BCpUC	Battery cost per unit capacity		U.S. data from Sandia National Laboratory and Rocky Mountain Institute.
Electricity Supply	BCR	Baseline scenario capacity retirements		Mexican data from SENER.
Electricity Supply	BDSBaPCF	Boolean Do suppliers bid at peak capacity factors?		Configuration of model behavior, not input data.
Electricity Supply	BDtESQutR	Boolean Does this electricity source qualify under the RPS?		Mexican data from the Official Journal of the Federation (legislative text).
Electricity Supply	BECF	Baseline scenario expected capacity factors		Mexican data from Centro Mario Molina.
Electricity Supply	BGCL	Baseline scenario generation capacity lifetime		U.S. data from the National Renewable Energy Laboratory and the EIA.
Electricity Supply	BHRbEF	Baseline scenario heat rate by electricity fuel		Mexican data from Centro Mario Molina.
Electricity Supply	BITPTaP	Boolean Is this plant type a peaker?		Configuration of model behavior, not input data.
Electricity Supply	BPHC	Baseline scenario pumped hydro capacity		Mexican data from the National Inventory of Renewable Energy.
Electricity Supply	BPMCCS	Baseline scenario policy mandated capacity construction schedule		Mexican data from SENER.
Electricity Supply	BTaDLP	Baseline scenario transmission and distribution loss percentage		Mexican data from SENER.
Electricity Supply	BTC	Baseline scenario transmission capacity		Mexican data from SENER.

Table A4 | **Data Sources for Each Input Variable in the Mexico Energy Policy Simulator (continued)**

MODEL SECTION	ACRONYM	CATEGORY OR VARIABLE	VARIABLES WITHIN CATEGORY	DATA SOURCE (AND SCALING FACTORS, IF ANY)
Electricity Supply	CCaMC	Capacity construction and maintenance costs	Baseline scenario construction cost per unit capacity, annual fixed O&M cost per unit capacity, variable O&M cost per unit electricity output	Mexican data for capacity costs (from the Federal Electricity Commission) and O&M costs (from Centro Mario Molina). U.S. data for cost improvement rate for non-wind, non-solar technologies and DC to AC Derate Value (from National Renewable Energy Laboratory).
Electricity Supply	DRC	Demand response capacities	Baseline scenario demand response capacity, potential additional demand response capacity	U.S. data from the Federal Energy Regulatory Commission. Scaled for Mexico by GDP.
Electricity Supply	EIaE	Electricity imports and exports	Baseline scenario imported electricity, baseline scenario exported electricity	Mexico-specific data from the U.S. EIA.
Electricity Supply	EStCwCMC	Electricity sources to consider when calculating mean cost		Configuration of model behavior, not input data.
Electricity Supply	FoOMCtiL	Fraction of O&M costs that is labor		U.S. data from the EPA and Sargent and Lundy LLC.
Electricity Supply	FPC	Flexibility point calculations	Flexibility points provided per unit natural gas peaker capacity, flexibility points provided per unit pumped hydro, flexibility points provided per unit battery storage, flexibility points provided per unit demand response capacity, FPC flexibility points provided per unit transmission capacity across modeled region border, transmission connectivity coefficient, FPC curtailment second order coefficient, FPC curtailment first order coefficient, FPC curtailment zeroth order coefficient, target maximum fraction of flexibility points used	U.S. data from Pacific Northwest National Laboratory, the National Renewable Energy Laboratory, Energy and Environmental Economics, GE Energy Consulting, JBS Energy, and the Western Electricity Coordinating Council.
Electricity Supply	MCGLT	Max capacity growth lookup table		U.S. data from the EIA, Department of Energy, and National Renewable Energy Laboratory. Scaled for Mexico by average of population and GDP (except endogenous wind and solar PV curves, which are capacity-based and do not require scaling).
Electricity Supply	MPCbS	Max potential capacity by source		Mexican data from the National Inventory of Renewable Energy, Mexico 2050 Calculator, and Centro Mario Molina.

Table A4 | **Data Sources for Each Input Variable in the Mexico Energy Policy Simulator (continued)**

MODEL SECTION	ACRONYM	CATEGORY OR VARIABLE	VARIABLES WITHIN CATEGORY	DATA SOURCE (AND SCALING FACTORS, IF ANY)
Electricity Supply	MPCFR	Max possible capacity factor reduction		Assumption selected for Mexico.
Electricity Supply	NGEpUO	Nonfuel GHG emissions per unit output		U.S. data from the National Renewable Energy Laboratory, Dolan and Heath, and Hsu et al.
Electricity Supply	NSDoDC	Normalized standard deviation of dispatch costs		U.S. data from the EIA and International Energy Agency.
Electricity Supply	NSDoNCC	Normalized standard deviation of new capital costs		U.S. data from the Congressional Research Service, the National Renewable Energy Laboratory, and Energy and Environmental Economics.
Electricity Supply	PDiBCpDoC	Percent decline in battery cost per doubling of capacity		U.S. data from Bloomberg New Energy Finance.
Electricity Supply	PDiCCpDoC	Percent decline in capacity cost per doubling of capacity		U.S. data from Bloomberg New Energy Finance.
Electricity Supply	PTCF	Peak time capacity factors		U.S. data from the EIA.
Electricity Supply	RM	Reserve margin		U.S. data from the North American Electric Reliability Corporation.
Electricity Supply	SLF	System load factor		Mexican data from SENER.
Electricity Supply	SYC	Start year capacities	Start year electricity generation capacity, fraction of peakers that provide flexibility points	Mexican data from Centro Mario Molina and SENER.
Electricity Supply	TCAMRB	Transmission capacity across modeled region border		Mexico-specific data from Transmission & Distribution World.
Electricity Supply	TCCpUCD	Transmission construction cost per unit capacity distance		Mexican data from the Federal Electricity Commission.
Fuels	BFCpUEbS	Baseline scenario fuel cost per unit energy by sector		Mexican data from Centro Mario Molina. U.S. data from the EIA and the DOE.
Fuels	BFTRbF	Baseline scenario fuel tax rate by fuel		Mexico-specific data from Trading Economics.

Table A4 | **Data Sources for Each Input Variable in the Mexico Energy Policy Simulator (continued)**

MODEL SECTION	ACRONYM	CATEGORY OR VARIABLE	VARIABLES WITHIN CATEGORY	DATA SOURCE (AND SCALING FACTORS, IF ANY)
Fuels	BS	Baseline scenario subsidies	Baseline scenario subsidy for thermal fuels per energy unit produced, Baseline scenario subsidy per unit electricity output	Mexico-specific data from the International Energy Agency and Centro Mario Molina.
Fuels	GbPbT	GWP by pollutant by timeframe		International data from the Intergovernmental Panel on Climate Change (IPCC).
Fuels	PEI	Pollutant emissions intensities	Transportation fuel pollutant emissions intensities, electricity fuel pollutant emissions intensities, buildings fuel pollutant emissions intensities, industrial fuel pollutant emissions intensities	U.S. data from Argonne National Laboratory.
Industry	BIFU	Baseline scenario industrial fuel use		Mexican data from SENER.
Industry	BPEiC	Baseline scenario process emissions in CO_2e		Mexican data from Secretariat of Environment and Natural Resources (SEMARNAT). Future years estimated by scaled GDP projections from the OECD.
Industry	CESTR	Capital equipment sales tax rate		Mexico-specific data from Trading Economics.
Industry	CtIEPpUESoS	Cost to implement efficiency policy per unit energy saved or shifted		U.S. data from Rocky Mountain Institute, MacCurdy et al., Babcock and Wilcox, and Energy and Environmental Analysis.
Industry	EoP	Elasticities of production	Elasticity of production with regard to fuel cost, percent change in production per unit carbon tax due to nonfuel impacts, elasticity of GDP with regard to fuel cost	U.S. data from Resources for the Future and Aswath Damodaran (NYU).
Industry	FLRbI	Foreign leakage rate by industry		U.S. data from Resources for the Future.
Industry	PERAC	Process emissions reductions and costs	Potential reductions in end year process emissions by policy, potential percent reduction in end year process emissions from cement, mass CO_2e avoidable by marginal cost	Mexico-specific data from the U.S. EPA, the World Business Council for Sustainable Development, and the European Cement Association.

Table A4 | **Data Sources for Each Input Variable in the Mexico Energy Policy Simulator (continued)**

MODEL SECTION	ACRONYM	CATEGORY OR VARIABLE	VARIABLES WITHIN CATEGORY	DATA SOURCE (AND SCALING FACTORS, IF ANY)
Industry	PPRiEY-FUfERoIF	Potential percent reduction in end-year fuel use from early retirement of inefficient facilities		U.S. data from the EIA.
Industry	PPRiEYFUfI-CaWHR	Potential percent reduction in end-year fuel use from increased cogeneration and waste heat recovery		U.S. data from Rocky Mountain Institute.
Industry	PPRiEYFUfI-IaIoE	Potential percent reduction in end-year fuel use from improved installation and integration of equipment		U.S. data from Rocky Mountain Institute.
Industry	RIFF	Recipient industrial fuel fractions		U.S. data from Rocky Mountain Institute.
Industry	WMITR	Worker marginal income tax rate		Mexico-specific data from the OECD and Price Waterhouse Coopers.
Land Use & Forestry	BLACE	Baseline scenario land use and land-use change and forestry (LULUCF) anthropogenic CO_2 emissions		Mexican data from SEMARNAT.
Land Use & Forestry	CpMCAbIFM	Cost per mass CO_2 abated by improved forest management		Mexico-specific data from McKinsey and Company.
Land Use & Forestry	FoFEtiL	Fraction of forestry expenses that is labor		Assumption selected for Mexico.
Land Use & Forestry	FoFObE	Fraction of forests owned by entity		Mexican data from SEMARNAT.
Land Use & Forestry	PCRfIFM	Potential CO_2 reduction from improved forest management		Mexican data from SEMARNAT.
Land Use & Forestry	RPEpUACE	Rebound pollutant emissions per unit avoided CO_2 emissions		U.S. data from EPA.

Table A4 | **Data Sources for Each Input Variable in the Mexico Energy Policy Simulator (continued)**

MODEL SECTION	ACRONYM	CATEGORY OR VARIABLE	VARIABLES WITHIN CATEGORY	DATA SOURCE (AND SCALING FACTORS, IF ANY)
Land Use & Forestry	VFC	Various forestry calculations	Potential incremental increase in CO_2 reduction from afforestation and reforestation each year, lost value per incremental increase in CO_2 abatement by afforestation and reforestation, one-time cost per incremental increase in CO_2 abatement by afforestation and reforestation, ongoing cost per mass CO_2 abated by afforestation and reforestation, potential annual CO_2 reduction from forest set asides, lost value per mass CO_2 abated by forest set asides, potential annual CO_2 reduction from avoided deforestation, lost value per mass CO_2 abated by avoided deforestation	Mexico-specific data from McKinsey and Company.
Transport	AADTbVT	Average annual distance traveled by vehicle type		Mexican data from the National Institute of Ecology and Climate Change.
Transport	AVL	Average vehicle lifetime		Mexican data from the National Institute of Ecology and Climate Change. U.S. data from Boeing and the State of California.
Transport	AVLo	Average vehicle loading		Mexican data from UN-Habitat, North American Transportation Statistics, and the National Institute of Statistics and Geography.
Transport	BFFU	Baseline scenario fuel fleet use		Mexican data from the National Institute of Ecology and Climate Change, SENER, and North American Transportation Statistics.
Transport	BFoEToFU	Baseline scenario fraction of each type of fuel used		Mexican data from the National Institute of Ecology and Climate Change. U.S. data from the EIA.
Transport	EoDfVUwFC	Elasticity of demand for vehicle use with regard to fuel cost		U.S. data from the EPA and NHTSA. International data from the International Air Transportation Association, and Sinha and Labi.
Transport	EoFoNVFE	Effect of feebate on new vehicle fuel economy		U.S. data from Greene et al. (Oak Ridge National Lab, DOE, Argonne National Lab, and National Transportation Research Center).

Table A4 | **Data Sources for Each Input Variable in the Mexico Energy Policy Simulator (continued)**

MODEL SECTION	ACRONYM	CATEGORY OR VARIABLE	VARIABLES WITHIN CATEGORY	DATA SOURCE (AND SCALING FACTORS, IF ANY)
Transport	EoNVFEwFC	Elasticity of new vehicle fuel economy with regard to fuel cost		U.S. data from Small, Harrington, and Krupnick.
Transport	EoVPwFE	Elasticity of vehicle price with regard to fuel economy		U.S. data from the EPA and the Center for Automotive Research.
Transport	FoVObE	Fraction of vehicles owned by entity		Assumptions selected for Mexico, and U.S. data from the Bureau of Transportation Statistics, the General Services Administration, the National Fire Protection Association, the Bureau of Justice Statistics, the Bureau of Labor Statistics, and the Census Bureau.
Transport	FoVSwMB	Fraction of vehicles sold within model boundary		U.S. data from the Bureau of Transportation Statistics and the EIA.
Transport	PCiCDT-dtTDM	Percent change in cargo distance transported due to TDM		OECD-wide data from the International Energy Agency.
Transport	PTFURfE	Percentage transportation fuel use reduction for electricity		U.S. data from the DOE, EPA, and M.J. Bradley & Associates.
Transport	VFP	Various fleet properties	Baseline scenario cargo distance transported, baseline scenario new cargo distance transported for vehicles with sales data, baseline scenario new vehicle fuel economy	Mexican data from the National Institute of Ecology and Climate Change, North American Transportation Statistics, and the Ministry of Transport and Communications.
Transport	VPaEC	Vehicle prices and embedded carbon	Baseline scenario average vehicle price, embedded carbon per vehicle	U.S. data from the Center for Automotive Research, TruckerToTrucker, and PE International.
Web Application Support	BCF	BTU conversion factors	BTU per million short tons coal, BTU per trillion cubic feet natural gas, liquid fuel BTU conversion factors	Mexican data from the National Energy Balance. U.S. data from the EIA.
Web Application Support	DpOCU	Dollars per output currency unit		Mexico-specific data from Oanda.

POLICY PRIORITY TABLE

Most policies in the Mexico Energy Policy Simulator were tested and rated according to their impacts on five metrics: CO_2e abatement potential, cost effectiveness, political feasibility, human health co-benefits, and energy security. Policies that could be set to different settings for different subscript values (e.g., technologies or sectors) were tested separately for each relevant or important subscript value, though when ratings were the same for multiple subscript values, they shared a line in the Policy Priority Table.

The specific numerical results (e.g., amount of CO_2e abatement caused by a given policy, amount by which it increases or decreases costs) depend both on the policy setting and on what other policies are enabled at the same time. As there are no definitive numerical values for each policy, in this table, we provide letter grade ratings (A, B, C, D, or E) rather than numerical output. The goal of the Policy Priority Table is to provide a general sense of which policies are effective at accomplishing particular goals, not to convey quantitative results.

The following guidelines were used to assign letter grades to each policy.

- **CO_2e Abatement Potential**
  - **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.

- **Cost Effectiveness**
  - **A:** Financial savings from the policy are larger than its costs.
  - **B:** Financial savings are smaller than costs, but net costs are much higher than monetized social benefits from avoided climate and human health damages.
  - **C:** Net costs are similar in magnitude to monetized social benefits.
  - **D:** Net costs are significantly smaller than monetized social benefits.
  - **E:** This rating is not used for this indicator.

- **Political Feasibility**
  - **A:** The policy is already used in weaker form in Mexico, or is widely used internationally. Powerful industries and political actors would likely not be strongly incentivized to oppose the policy.
  - **B:** The policy is used in some other countries. It may involve some coordination or implementation challenges, such as requiring local and regional governments to participate and coordinate their efforts, or it may be easy to implement but have an industry opponent.
  - **C:** The policy is seldom used in other countries, and/or technical limits make compliance or enforcement difficult. Or, the policy may have multiple, powerful political opponents, and/or have coordination and implementation challenges.
  - **D:** A larger number of the problems listed in ratings B and C apply in conjunction. The policy may be rarely used in other countries, have many political opponents, be difficult to comply or enforce from a technical perspective, require coordination between different actors or levels of government, etc.
  - **E:** This rating is not used for this indicator.

- **Health Co-benefits**
  - The guidelines are largely the same as those for the "CO_2e Abatement Potential" indicator, but applied to PM2.5 emissions rather than CO_2e emissions.
- **Energy Security**
  - **A:** The policy significantly reduces consumption of coal, natural gas, and/or petroleum fuels.
  - **B:** The policy moderately reduces consumption of coal, natural gas, and/or petroleum fuels.
  - **C:** The policy slightly reduces consumption of coal, natural gas, and/or petroleum fuels.
  - **D:** The policy has no significant effect on the consumption of coal, natural gas, and/or petroleum fuels. Policies that substitute one of these fuels for a similar quantity of a different one of these fuels are included in this category.
  - **E:** The policy increases consumption of coal, natural gas, and/or petroleum fuels.

Table A6 presents the results of the policy screening exercise conducted on 56 potential climate and energy policies in Mexico. Each policy is given a letter grade for its abatement potential, cost effectiveness, political feasibility, health co-benefits, and contribution to national energy security as described above.

Table A6 | **Policy Priority Table**

SECTOR	POLICY	SUBSCRIPT VALUE	ABATEMENT POTENTIAL	COST EFFECTIVENESS	POLITICAL FEASIBILITY	HEALTH CO-BENEFITS	ENERGY SECURITY
Transportation	Feebate for light-duty vehicles (LDVs)		A: A feebate is very effective at encouraging the selection of lower-emitting LDV models. (The full magnitude of reductions would only be seen after a significant delay due to fleet turnover time.)	B: A feebate modestly increases spending on capital equipment in all years of the model run. Fuel savings begin small but outweigh capital expenditures after about six years.	A: A feebate can be implemented at the time of LDV sale (from dealerships and used car lots, not individuals), with no net cost to government apart from processing overhead.	C: A feebate achieves modest reductions to particulate emissions, as gasoline is a moderate contributor of particulate matter (PM).	B: A feebate moderately reduces consumption of gasoline, much of which is imported from U.S. refineries.
Transportation	Fuel economy standard	LDVs	B: LDVs are the most important emissions source in the transportation sector. Standards can substantially reduce these emissions, resulting in moderate abatement. (The full magnitude of reductions would be seen only after a significant delay due to fleet turnover time.)	A: Fuel economy standards cost little to implement, and after a number of years, fuel savings outweigh increased vehicle cost.	A: LDV fuel economy standards are already used in Mexico. Other countries, including the European Union, Japan, and India have stronger standards, implying there is room for Mexico to improve.	B: Fuel economy standards for LDVs achieve moderate reduction in particulate emissions.	B: LDV fuel economy standards moderately reduce consumption of gasoline, much of which is imported from U.S. refineries.
Transportation	Fuel economy standard	Heavy-duty vehicles (HDVs)	C: HDVs are the second-most important emissions source in the transportation sector. Standards can substantially reduce these emissions, resulting in modest overall abatement.	A: Fuel economy standards cost little to implement, and HDV fuel economy standards achieve net savings soon after implementation.	B: HDV standards are not presently used in Mexico, but they are used in many countries (including the United States Canada, China, the EU, and India), and Mexico is discussing them.	C: Fuel economy standards for HDVs achieve a modest reduction in particulate emissions.	B: HDV fuel economy standards moderately reduce consumption of diesel, much of which is imported from U.S. refineries.

Table A6 | **Policy Priority Table (continued)**

SECTOR	POLICY	SUBSCRIPT VALUE	ABATEMENT POTENTIAL	COST EFFECTIVENESS	POLITICAL FEASIBILITY	HEALTH CO-BENEFITS	ENERGY SECURITY
Transportation	Fuel economy standard	Aircraft, rail, ships, motorbikes	D: These vehicle types are minor emissions sources. Except for motorbikes, they are long-lived. Fuel economy standards achieve little abatement.	A: Fuel economy standards cost little to implement, and fuel savings tend to outweigh increases to vehicle cost.	C: Standards for these vehicle types are not commonly used (though the United States is working on its first standard for aircraft). They could likely be implemented in a manner similar to standards for LDVs and HDVs.	D: Aircraft and motorbikes are minor sources of particulate emissions. Rail and ships are slightly larger sources, but the impact of standards on overall particulate emissions is minor.	D: Jet fuel (kerosene) is not a major driver of energy security concerns. Rail is a minor fuel user (and is more efficient than trucks per unit cargo-distance transported). Ships and motorbikes are minor fuel users.
Transportation	Transportation demand management		A: Mode shifting has significant abatement potential.	B: Requires substantial investment in public transit systems. Payback in fuel savings and reduced congestion outweigh expenses, but benefits are distributed throughout society.	D: Requires coordination of local and regional governments. It can be difficult to get political support for large up-front expenditures. Locals often block transit projects or attempts to zone for higher density (NIMBYs).	A: Significant mode-shifting and transportation demand reduction would significantly reduce PM emissions in densely-populated areas.	A: Reduces consumption of gasoline, much of which is imported from U.S. refineries.
Transportation	Vehicle electrification	Passenger LDVs	C: Mexico's electricity system is mostly natural gas and offers significant emissions benefits over gasoline, but there is little appetite for electric vehicles in Mexico.	D: Electric vehicles are expensive, particularly for per tonne of CO_2e abated.	B: A subsidy for electric vehicles could be implemented in a straightforward manner. Given low likely uptake of electric vehicles, total costs might not be too high.	C: Mexico's electricity system is mostly natural gas and offers significant particulate emissions benefits over gasoline, but there is little appetite for electric vehicles in Mexico.	C: Reduces consumption of gasoline, much of which is imported from U.S. refineries, but there is little appetite for electric vehicles in Mexico.
Transportation	Vehicle electrification	Passenger HDVs	B: Buses are a substantial contributor to transportation sector emissions.	B: Electric buses cost roughly twice as much as diesel buses, but electricity is cheaper than diesel fuel, and in the long term, costs should be in the same ballpark.	B: Cities in the United States and China have purchased electric buses. Procurement should pose no particular challenges, though installation of charging stations would be required.	B: Diesel buses are a substantial source of particulate emissions in densely populated areas.	A: Reduces consumption of diesel fuel, much of which is imported from U.S. refineries.
Transportation	Vehicle electrification	Passenger rail	D: Except for subways, which are already electrified, there is no significant passenger rail in Mexico.	D: Electrification of rail is expensive, requiring new lines and rolling stock.	D: Except for subways, which are already electrified, there is no significant passenger rail in Mexico.	D: Except for subways, which are already electrified, there is no significant passenger rail in Mexico.	D: Except for subways, which are already electrified, there is no significant passenger rail in Mexico.

Table A6 | **Policy Priority Table (continued)**

SECTOR	POLICY	SUBSCRIPT VALUE	ABATEMENT POTENTIAL	COST EFFECTIVENESS	POLITICAL FEASIBILITY	HEALTH CO-BENEFITS	ENERGY SECURITY
Buildings and Appliances	Building component electrification	Urban residential	C: Energy for urban residential buildings is the main emissions source in the buildings sector, but additional electricity mostly comes from natural gas.	D: This policy increases capital outlays with very little change in fuel expenditures for building owners. Capital outlays outweigh monetized health and climate benefits.	B: This policy would likely be implemented as a building code, which may require action by local or regional governments.	D: Natural gas use in buildings is a minor source of particulates.	C: Urban residential buildings are a moderate user of natural gas, which is often imported from the United States
Buildings and Appliances	Building component electrification	Rural residential	D: Energy for rural residential buildings is a minor emissions source.	D: This policy increases capital outlays with very little change in fuel expenditures for building owners. Capital outlays outweigh monetized health and climate benefits.	D: This policy would likely be implemented as a building code, which is hard to enforce in rural areas. Also, access to electricity may be limited.	A: Reducing biomass combustion inside rural residences may bring indoor air quality benefits.	D: Rural residential buildings are a minor natural gas consumer.
Buildings and Appliances	Building component electrification	Commercial	D: Energy for commercial buildings is a minor emissions source.	D: This policy increases capital outlays with very little change in fuel expenditures for building owners. Capital outlays outweigh monetized health and climate benefits.	B: This policy would likely be implemented as a building code, which may require action by local or regional governments.	D: Natural gas use in buildings is a minor source of particulates.	D: Commercial buildings are a minor natural gas consumer.
Buildings and Appliances	Building energy efficiency standards	Cooling and Ventilation, Appliances	B: Cooling and ventilation in buildings is not a very large emissions source in Mexico, but energy efficiency standards have good abatement potential in percentage terms.	C: Capital costs tend to outweigh fuel savings within the model timeframe for more efficient air conditioning equipment or appliances.	A: Implementing standards for equipment such as air conditioners and ovens is straightforward and can be done upstream, affecting what is sold.	D: Natural gas use in buildings is a minor source of particulates. Some buildings already use electricity.	C: Buildings are a moderate natural gas consumer.
Buildings and Appliances	Building energy efficiency standards	Envelope, lighting	B: Lighting in buildings is not a very large emissions source in Mexico, but energy efficiency standards have good abatement potential in percentage terms.	A: Designing buildings with improved lighting systems and envelope tends to have fuel savings that outweigh capital cost increases	B: Lighting standards are straightforward and can be implemented upstream. Envelope standards would be part of a building code and may need local or regional government cooperation.	D: Natural gas use in buildings is a minor source of particulates. Some buildings already use electricity.	C: Buildings are a moderate natural gas consumer.
Buildings and Appliances	Contractor Education and Training		D: This policy only affects cooling system energy use in new or retrofit buildings and has small potential.	A: Training costs little and results in fuel savings with no change in capital costs.	A: Training programs are likely to be politically uncontroversial and inexpensive.	D: Cooling systems are generally powered by electricity, which does not emit pollutants.	D: Electricity savings are small.

Table A6 | **Policy Priority Table (continued)**

SECTOR	POLICY	SUBSCRIPT VALUE	ABATEMENT POTENTIAL	COST EFFECTIVENESS	POLITICAL FEASIBILITY	HEALTH CO-BENEFITS	ENERGY SECURITY
Buildings and Appliances	Distributed solar carve-out		A: Abatement potential for distributed solar is significant, and a carve-out both causes significant distributed solar to be built and helps the development of utility-scale solar via cumulative capacity-based learning curves.	B: This policy tends to be roughly cost-neutral for consumers. It mostly benefits solar equipment and natural gas suppliers, while harming coal suppliers. Monetized public health and climate benefits are larger than the increase in outlays.	D: There is no current discussion of implementing a renewable portfolio standard (RPS) with distributed solar carve-out. A strong RPS can be hard to achieve without complementary policies and utility market design.	A: Distributed solar tends to first replace coal and then natural gas, resulting in very large reductions in particulate emissions.	A: Distributed solar reduces consumption of both coal and natural gas.
Buildings and Appliances	Improved energy efficiency labeling		C: Improved labeling has a modest effect on building-sector emissions (and a very minor effect on national total emissions).	C: Capital costs of more efficient equipment tend to outweigh fuel savings during the model timeframe.	A: Labeling that clearly discloses energy use by appliances and building components is typically noncontroversial.	C: Improved labeling has a modest effect on buildings sector particulate emissions (and a very minor effect on national total emissions).	C: Buildings are a moderate natural gas consumer.
Buildings and Appliances	Increased Retrofitting of Commercial Buildings		D: On its own, increased retrofitting of commercial buildings has very little abatement potential. (This policy is best paired with others, such as improved building energy efficiency standards.)	D: Due to the low abatement potential (when not paired with other policies), this policy on its own is not a cost-effective way to reduce emissions.	C: Mandated retrofitting of private buildings can be politically challenging, as many building owners will not have the money to do retrofits and/or will oppose the requirement.	D: On its own, increased retrofitting of commercial buildings has very little abatement potential. (This policy is best paired with others, such as improved building energy efficiency standards.)	D: On its own, increased retrofitting of commercial buildings has very little potential to reduce fuel use. (This policy is best paired with others, such as improved building energy efficiency standards.)
Electricity Supply	Change electricity exports		D: Decreasing electricity exports has very little abatement potential (and it would be largely offset by increased emissions in other countries).	D: Increasing electricity imports tends to increase overall costs without concomitant emissions benefits.	B: Electricity exports from Mexico are small and are handled by a small number of utilities, so the government could likely require a reduction in exports without great backlash.	D: Decreasing electricity exports has very little particulate abatement potential.	D: Reducing electricity sales to/from the United States would increase the isolation of Mexico's grid and make it harder to balance. Larger balancing areas are often more secure against blackouts and disruption.
Electricity Supply	Change electricity imports		D: Increasing electricity imports has very little abatement potential (and it would be largely offset by increased emissions in other countries).	D: Decreasing electricity exports tends to reduce overall costs (though revenue would also be lower), but it is not a cost-effective way to reduce emissions.	B: The United States would likely be willing to sell more electricity to Mexico, but transmission line capacity may limit the amount that could be purchased at times when it is needed.	D: Increasing electricity imports has very little particulate abatement potential.	D: Reducing electricity sales to/from the United States would increase the isolation of Mexico's grid and make it harder to balance. Larger balancing areas are often more secure against blackouts and disruption.

Table A6 | **Policy Priority Table (continued)**

SECTOR	POLICY	SUBSCRIPT VALUE	ABATEMENT POTENTIAL	COST EFFECTIVENESS	POLITICAL FEASIBILITY	HEALTH CO-BENEFITS	ENERGY SECURITY
Electricity Supply	Demand response		B: The Mexican grid is flexibility-constrained, so increasing demand response adds flexibility that allows for a moderate increase in wind deployment, lowering emissions.	A: Demand response programs cost little and return large savings by reducing the need for expensive peaker plants.	C: Demand response requires high-quality grid infrastructure and the ability for users to respond to demand/price signals from utilities in real time. The market must also be set up to allow utilities to procure demand response instead of traditional power from power plants.	B: The increased deployment of wind enabled by the flexibility from demand response mostly displaces natural gas, which is only a moderate contributor to particulate emissions.	C: The increased deployment of wind enabled by demand response slightly lowers natural gas consumption.
Electricity Supply	Early Retirement of Power Plants	Coal	C: Coal is not a large part of Mexico's electricity supply, and when the early retirement policy is used on its own, coal is mostly replaced by natural gas, limiting overall abatement.	B: Early retirement of coal has net economic costs (not savings), but the costs are smaller than the monetized public health and climate benefits.	B: Early plant retirement is often politically contentious, as coal operators often are opposed to it. Early retirement may be achieved via regulations on emissions of conventional pollutants that would require installation of expensive control equipment.	A: Despite being a small portion of Mexico's power, coal is responsible for a large fraction of particulate emissions. Replacement of coal, even with natural gas, has tremendous health co-benefits.	C: Mexico imports a large fraction of its coal each year, and early retirement of coal plants may reduce the need for imports. However, when the early retirement policy is used on its own, coal is mostly replaced by natural gas, which also has energy security concerns.
Electricity Supply	Increase transmission		B: The Mexican grid is flexibility-constrained, so increasing transmission adds flexibility that allows for a moderate increase in wind deployment, lowering emissions.	B: The construction of transmission lines and associated build-out of wind plants increase costs in early years, but they are outweighed by fuel savings after 2024. Costs are below monetized climate and public health benefits by 2021.	C: Siting transmission lines can be difficult due to local opposition and the need to coordinate local and regional governments and other actors.	B: The increased deployment of wind enabled by the flexibility from demand response mostly displaces natural gas, which is only a moderate contributor to particulate emissions.	C: The increased deployment of wind enabled by increased transmission slightly lowers natural gas consumption.
Electricity Supply	Plant lifetime extension	Nuclear	D: No nuclear plants are scheduled for retirement during the model run, so a lifetime extension has no meaningful effect.	D: No nuclear plants are scheduled for retirement during the model run, so a lifetime extension has no meaningful effect.	D: No nuclear plants are scheduled for retirement during the model run, so a lifetime extension has no meaningful effect.	D: No nuclear plants are scheduled for retirement during the model run, so a lifetime extension has no meaningful effect.	D: No nuclear plants are scheduled for retirement during the model run, so a lifetime extension has no meaningful effect.

Table A6 | **Policy Priority Table (continued)**

SECTOR	POLICY	SUBSCRIPT VALUE	ABATEMENT POTENTIAL	COST EFFECTIVENESS	POLITICAL FEASIBILITY	HEALTH CO-BENEFITS	ENERGY SECURITY
Electricity Supply	Reduce plant downtime	Preexisting natural gas nonpeaker	D: Reducing the downtime of natural gas plants allows fewer natural gas plants to be built but does not significantly change emissions.	B: Reducing downtime of natural gas nonpeaker plants tends to save money but may be limited in practice by technical capability.	C: Utilities likely determine plant downtime based primarily on technical considerations, which might only be addressed through a variety of policies that lead to a different electricity system composition or structure.	D: Reducing the downtime of natural gas plants allows fewer natural gas plants to be built but does not significantly change particulate emissions.	D: Reducing the downtime of natural gas plants allows fewer natural gas plants to be built but does not significantly change fuel usage.
Electricity Supply	Reduce plant downtime	Newly built wind	B: Increasing the capacity factor of newly built wind plants allows for less natural gas to be burned, with a moderate impact on emissions	A: Improving wind plants' capacity factors tends to reduce costs but may be limited in practice by technical considerations.	C: Improving wind capacity factors may be limited by siting considerations (which could be partially addressed via policy) and technical limits (which are not amenable to being changed directly by policy).	A: Improvement in wind capacity factor reduces natural gas and, in later years, coal use, significantly reducing particulate emissions.	A: Increasing wind capacity factors allows for less consumption of natural gas and coal.
Electricity Supply	Reduce plant downtime	Newly built solar PV	C: Increasing the capacity factor of newly built solar PV plants causes some additional deployment of solar PV, but impact on emissions is modest due to the small amount of solar that is deployed.	B: Improving solar PV capacity factor tends to increase costs within the model run, due to the increased construction of solar PV plants. However, they would pay for themselves in fuel savings given a longer time horizon. Costs are always below monetized public health and climate benefits.	C: Improving solar PV capacity factors may be limited by siting considerations (which could be partially addressed via policy) and technical limits (which are not amenable to being changed directly by policy).	A: Improvement in solar PV capacity factor reduces natural gas and, in later years, coal use, significantly reducing particulate emissions.	A: Increasing solar PV capacity factors allows for less consumption of natural gas and coal.
Electricity Supply	Reduce transmission and distribution (T&D) losses		B: Reducing transmission and distribution losses to a level similar to many developed countries has a moderate effect on emissions.	A: Reducing transmission and distribution losses is strongly cost-saving, reducing expenditures on both fuel and on the construction of new power plants.	C: This policy requires investment in grid infrastructure throughout the country, including in rural and poor areas. Likely requires cooperation or coordination of local or regional governments and utilities.	C: Most of the reduction in power generation is from natural gas, which is not a major source of particulates. Particulate improvement is modest.	B: Reducing T&D losses moderately reduces natural gas consumption (and very slightly reduces coal consumption).

Table A6 | **Policy Priority Table (continued)**

SECTOR	POLICY	SUBSCRIPT VALUE	ABATEMENT POTENTIAL	COST EFFECTIVENESS	POLITICAL FEASIBILITY	HEALTH CO-BENEFITS	ENERGY SECURITY
Electricity Supply	Renewable portfolio standard (RPS)		B: An RPS is effective at certain percentages, but due to Mexico's definition of hydro and nuclear as renewables, the required RPS percentages are high (over 40%). Wind deployment is limited by flexibility, so the RPS works best when supplemented with flexibility-boosting policies such as increased transmission.	B: On its own, an RPS tends to increase costs. Costs are similar to monetized public health and climate benefits in most years. With supplementary policies to promote flexibility, costs are lower.	A: Renewable portfolio standards are widely-used policies in many countries and states/provinces with a track record of success.	A: An RPS tends to cause coal retirement, which greatly reduces particulate emissions.	B: An RPS greatly reduces coal consumption but increases natural gas consumption.
Electricity Supply	Subsidy for electricity production	Nuclear	C: A subsidy for nuclear plants causes a modest amount of increased nuclear deployment, slightly lowering emissions.	C: A subsidy for nuclear plants tends to have greater costs than savings (though overall costs are limited by the small number of nuclear plants). Costs are similar to monetized public health and climate benefits for most of the model run.	A: Subsidies for power generation are relatively straightforward to implement and seldom generate intense political opposition.	B: Nuclear primarily replaces coal, leading to a drop in particulate emissions.	B: A subsidy for nuclear slightly decreases coal consumption. Uranium consumption is increased, but uranium is not a major driver of energy security concerns.
Electricity Supply	Subsidy for electricity production	Wind	B: On its own, a subsidy for wind does not lead to a great deal of deployment due to flexibility limits. With complementary policies that provide flexibility, wind growth is more robust.	B: A subsidy for wind tends to have greater costs than savings. In later years, costs are lower than monetized public health and climate benefits.	A: Subsidies for power generation are relatively straightforward to implement and seldom generate intense political opposition.	A: Subsidizing wind (and using complementary policies to address flexibility constraints) leads to the phase-out of most coal, substantially reducing particulate emissions.	B: Subsidizing wind (and using complementary policies to address flexibility constraints) reduces coal consumption.
Electricity Supply	Subsidy for electricity production	Solar PV	B: A subsidy for solar leads to substantially increased solar deployment, replacing coal. However, even a large relative increase in solar still has a moderate effect on emissions, as the growth is starting from a very low base of existing solar.	B: A subsidy for solar tends to have greater costs than savings, but costs are lower than monetized public health and climate benefits.	A: Subsidies for power generation are relatively straightforward to implement and seldom generate intense political opposition.	A: Subsidizing solar leads to the phase-out of some coal, reducing particulate emissions.	B: Subsidizing solar reduces coal consumption.

Table A6 | **Policy Priority Table (continued)**

SECTOR	POLICY	SUBSCRIPT VALUE	ABATEMENT POTENTIAL	COST EFFECTIVENESS	POLITICAL FEASIBILITY	HEALTH CO-BENEFITS	ENERGY SECURITY
Industry	Cement clinker substitution		C: Cement clinker substitution causes a slight reduction in CO_2 emissions.	B: Cement clinker substitution has a cost that is very small and is far outweighed by monetized climate benefits of abatement.	A: The techniques and appropriate uses of low-clinker cement are well known from other countries, and implementing this standard should not cost the government money or attract much public notice or opposition.	D: Cement clinker substitution does not reduce particulate emissions.	D: Cement clinker substitution does not reduce fuel consumption.
Industry	Cogeneration and waste heat recovery requirement		C: A cogeneration / waste heat recovery requirement causes a slight reduction in emissions.	A: Savings from this policy outweigh costs.	B: Requiring industry to perform retrofits may be difficult, particularly for industries that lack the cash for upfront investment. However, with proper education about the benefits and eventual cost savings, it should be feasible. Political feasibility could be enhanced if a funding mechanism were provided.	C: Cogeneration modestly decreases natural gas and coal consumption, very slightly reducing particulate emissions.	C: Cogeneration modestly decreases natural gas and coal consumption.
Industry	Early retirement of inefficient industrial facilities		C: Early retirement of inefficient industrial facilities (and replacement with modern, efficient facilities) causes a slight reduction in emissions.	C: This policy substantially increases capital costs in all years of the model run. Fuel savings slowly accumulate through the run and begin to exceed costs on an annual basis after about a decade.	C: It is difficult to require private companies to shutter inefficient facilities before the end of their economic lifetimes based on fuel efficiency alone, though if they also are significant emitters of conventional pollutants, a requirement for technology to control these pollutants may lead an owner to choose to retire a facility rather than invest in it. Mexico has a number of old PEMEX facilities that may be ripe for retirement, making this a more feasible policy in Mexico than in some countries.	C: Early facility retirement leads to a small reduction in particulate emissions.	C: Early facility retirement slightly reduces fuel consumption.

Table A6 | **Policy Priority Table (continued)**

SECTOR	POLICY	SUBSCRIPT VALUE	ABATEMENT POTENTIAL	COST EFFECTIVENESS	POLITICAL FEASIBILITY	HEALTH CO-BENEFITS	ENERGY SECURITY
Industry	Industry energy efficiency standards		B: Industry energy efficiency standards result in a moderate drop in emissions.	A: Energy efficiency standards have fuel savings that outweigh costs (as they target equipment/ facilities when they would be replaced or built anyway, not forcing early retirement).	A: Due to the diversity of industry, good efficiency standards may be complex, but standards are relatively straightforward to implement and might be at least partially enforced upstream, at the point of manufacture or import of motors, boilers, etc.	B: Efficiency standards reduce particulate emissions by a moderate amount.	A: Efficiency standards significantly reduce natural gas consumption, and they also reduce coal consumption nontrivially.
Industry	Improved system design		D: Improved industrial system design and integration achieves very little emissions reduction.	A: Improved system design has net cost savings.	D: Improved system design is hard to legislate or enforce, since it is particular to each facility and has to do with the way equipment and systems are interconnected, rather than the major machines or components of those systems.	C: Improved system design leads to a very modest decline in particulate emissions.	C: Improved system design leads to a very modest decline in fuel consumption.
Industry	Industrial fuel switching		D: Substituting natural gas for coal used directly in industrial facilities provides almost no emissions reduction.	A: This policy is very slightly cost-saving.	C: Requiring industry to perform retrofits may be difficult, particularly for industries that lack the cash for upfront investment. They are unlikely to see long-term fuel savings that would pay for the capital cost (barring a policy that increases the price of coal, such as a carbon tax).	A: Substituting natural gas for coal leads to a substantial drop in particulate emissions from industry.	D: Substituting natural gas for coal does not have clear energy security benefits, as neither of these fuels is abundant domestically.
Industry	Methane capture		A: Methane capture has excellent abatement potential.	A: The model indicates this policy has small costs that are outweighed by health and climate benefits. The model does not account for the economic value of the captured methane–if it did, this policy would likely be cost-saving.	C: Due to the diversity of places where methane can leak (from wells, anywhere in the natural gas distribution system, coal beds, wastewater treatment plants, etc.), a comprehensive methane capture policy must be designed to address many sectors and be cognizant of many technologies and industrial approaches.	D: Methane capture does not reduce particulate emissions.	A: Methane capture reduces the amount of natural gas that must be imported or mined, though it does not reduce natural gas consumption by equipment (which is the sense the model measures).

Table A6 | **Policy Priority Table (continued)**

SECTOR	POLICY	SUBSCRIPT VALUE	ABATEMENT POTENTIAL	COST EFFECTIVENESS	POLITICAL FEASIBILITY	HEALTH CO-BENEFITS	ENERGY SECURITY
Industry	Methane destruction		D: Methane destruction has very modest abatement potential.	B: Methane destruction has net costs, but the costs are minimal.	B: Requirements to flare rather than vent methane are relatively straightforward, and due to the low cost of compliance and small number of affected industries (perhaps just the natural gas and petroleum industry), political opposition may not be intense.	D: Methane destruction does not reduce particulate emissions.	D: Methane destruction results in no fuel savings.
Industry	Reduced high-global warming potential (GWP) gas venting/use		A: Reduced venting and use of high-GWP gases has good abatement potential.	B: This policy has minimal costs or savings, well below its monetized health and climate benefits.	A: Alternatives for high-GWP gases exist for most use cases. The policy may be able to be handled under the Montreal Protocol, providing a useful mechanism for implementation and overcoming political resistance.	D: Reducing the venting and use of high-GWP gases does not reduce particulate emissions.	D: Reducing the venting and use of high-GWP gases does not reduce fuel consumption.
Industry	Worker training (to avoid certain methane and F-gas emissions)		D: Worker training has very little abatement potential.	D: Except at low policy settings, worker training tends to have costs that outweigh health and climate benefits.	D: Requiring specific improvements in training is difficult because work processes vary by industry and even by employer. Evaluating whether specific facilities have properly trained workers is also difficult.	D: Reducing methane and F-gas emissions does not reduce particulate emissions.	D: Reducing methane and F-gas emissions does not reduce fuel consumption.
Agriculture, Land Use, and Forestry	Afforestation and reforestation		C: Afforestation and reforestation has modest abatement potential.	B: Afforestation and reforestation have modest costs that are outweighed by monetized climate benefits.	B: Afforestation and reforestation are easiest on government-owned land; it is difficult or expensive to incentivize private landowners to forest their land (and commit to keeping it forested).	D: Afforestation and reforestation do not reduce particulate emissions.	D: Afforestation and reforestation do not reduce fuel use.

Table A6 | **Policy Priority Table (continued)**

SECTOR	POLICY	SUBSCRIPT VALUE	ABATEMENT POTENTIAL	COST EFFECTIVENESS	POLITICAL FEASIBILITY	HEALTH CO-BENEFITS	ENERGY SECURITY
Agriculture, Land Use, and Forestry	Avoid deforestation		A: Avoiding deforestation has good abatement potential.	A: A requirement to stop deforestation has minimal costs, apart from enforcement.	B: Deforestation often reduces the economic value of the land, so it likely would not be hard to pass a law against deforestation. However, monitoring and enforcement can be very difficult, given that deforestation is often driven by many poor, rural individuals.	D: Reducing deforestation does not reduce particulate emissions.	D: Reducing deforestation does not reduce fuel use.
Agriculture, Land Use, and Forestry	Forest set-asides		D: Forest set-asides have insignificant abatement potential.	B: Forest set-asides do not have direct costs, and lost land value is smaller than climate benefits.	C: Setting aside government-owned forest may be politically easy. It is often difficult to prevent private landowners from harvesting forest products from their own land.	D: Forest set-asides do not reduce particulate emissions.	D: Forest set-asides do not reduce fuel use.
Agriculture, Land Use, and Forestry	Cropland management		D: Cropland management has very little abatement potential.	B: At low levels of implementation, this policy saves a small amount of money. At higher levels, the policy involves net costs, which can exceed monetized climate benefits.	D: Improved cropland management often requires paying farmers year after year to maintain best practices, and stored carbon is released if traditional practices are ever resumed. Therefore, it is difficult to guarantee reductions long-term.	D: Improved cropland management does not reduce particulate emissions.	D: Improved cropland management does not reduce fuel consumption. (It could slightly reduce fertilizer consumption, which may be petroleum-derived.)
Agriculture, Land Use, and Forestry	Improved forest management		D: Improved forest management has very little abatement potential.	B: Improved forest management has net costs, though they are lower than monetized climate benefits.	C: For government-owned lands, the government can specify the management practices to be used. Requiring specific management practices for privately owned forest is challenging to implement and enforce.	D: Improved forest management does not reduce particulate emissions.	D: Improved forest management does not reduce fuel consumption.

Table A6 | **Policy Priority Table (continued)**

SECTOR	POLICY	SUBSCRIPT VALUE	ABATEMENT POTENTIAL	COST EFFECTIVENESS	POLITICAL FEASIBILITY	HEALTH CO-BENEFITS	ENERGY SECURITY
Agriculture, Land Use, and Forestry	Livestock measures		D: Livestock measures have very little abatement potential.	B: Livestock measures have little in the way of costs or savings.	D: Efficient livestock measures, such as anti-methanogen vaccines, are still in the laboratory stage and are unlikely to be implementable via policy in the near term.	D: Livestock measures do not reduce particulate emissions.	D: Livestock measures do not reduce fuel consumption.
Agriculture, Land Use, and Forestry	Rice cultivation measures		D: Rice cultivation measures have very little abatement potential.	B: Rice cultivation measures have significant costs per unit abated, though costs are below monetized climate benefits.	D: Improved rice cultivation measures often requires paying farmers year after year to maintain best practices, and stored carbon is released if traditional practices are ever resumed. Therefore, it is difficult to guarantee reductions long-term.	D: Rice cultivation measures do not reduce particulate emissions.	D: Rice cultivation measures do not reduce fuel consumption.
Cross-Sector	Carbon Capture and Sequestration		C: Carbon capture and sequestration has very modest abatement potential.	C: Carbon capture and sequestration has substantial costs, though slightly lower than monetized climate benefits.	D: Carbon capture and sequestration is difficult to mandate via policy, as the technology is still in early stages, and it requires geologically suitable areas for storage. It likely requires a strong carbon pricing policy to provide an economic incentive.	D: Carbon capture and sequestration does not reduce particulate emissions.	E: Carbon capture and sequestration increases fuel consumption (to power the sequestration process), thereby having a negative effect on energy security.
Cross-Sector	Carbon tax		A: A carbon tax has excellent abatement potential.	D: A carbon tax increases net costs significantly more than monetized public health and climate benefits. (However, depending on how tax revenues are used, this policy could provide net savings or other economic benefits.)	B: A carbon tax can be implemented upstream, at point of fuel import or sale, to simplify administration. There is likely to be some political opposition from fossil fuel interests and from those worried about regressive taxation effects.	A: A carbon tax greatly lowers particulate emissions.	A: A carbon tax lowers consumption of coal, natural gas, and petroleum fuels.

Table A6 | **Policy Priority Table (continued)**

SECTOR	POLICY	SUBSCRIPT VALUE	ABATEMENT POTENTIAL	COST EFFECTIVENESS	POLITICAL FEASIBILITY	HEALTH CO-BENEFITS	ENERGY SECURITY
Cross-Sector	End existing subsidies	Natural gas	E: Ending the subsidy for natural gas causes an increase in coal, significantly increasing emissions.	D: Ending subsidies for natural gas increases total spending (cost increases outweigh savings to government from making reduced subsidy payments).	B: Ending subsidies on mature industries is easy to justify politically, though it is opposed by the subsidized industries.	E: Ending the subsidy for natural gas causes an increase in coal, significantly increasing particulate emissions.	D: Ending the subsidy on natural gas decreases natural gas consumption but increases coal consumption by a similar amount.
Cross-Sector	End existing subsidies	Petroleum gasoline, petroleum diesel, jet fuel	C: Ending subsidies on petroleum fuels slightly reduces emissions, overwhelmingly from the transportation sector.	A: Ending petroleum subsidies has slight cost savings (as savings to government outweigh increases in fuel spending by fuel consumers).	B: Ending subsidies on mature industries is easy to justify politically, though it is opposed by the subsidized industries.	C: Ending petroleum subsidies slightly reduces particulate emissions.	C: Ending petroleum subsidies slightly reduces petroleum fuel consumption. (It might also reduce petroleum fuel production, but that effect, if any, is not modeled.)
Cross-Sector	Additional fuel taxes	Electricity	D: Increasing electricity taxes slightly reduces electricity generation by natural gas, with a small impact on emissions.	D: This policy imposes net costs that far exceed monetized health and climate benefits. (However, depending on how tax revenues are used, this policy could provide economic benefits.)	B: Fuel taxes are likely to be politically unpopular, but they are straightforward to implement and common worldwide.	D: Electricity taxes cause a very small reduction in particulate emissions.	D: Electricity taxes slightly reduce natural gas consumption.
Cross-Sector	Additional fuel taxes	Coal	B: Taxes on coal cause the retirement of most coal power plants by the end of the model run, though they are replaced with natural gas, limiting emissions abatement.	B: Taxes on coal come at a net cost, but it is less than the monetized climate and public health benefits. (However, depending on how tax revenues are used, this policy could provide net savings or other economic benefits.)	B: Fuel taxes are likely to be politically unpopular, but they are straightforward to implement and common worldwide.	A: Taxes on coal greatly reduce coal use, resulting in large reductions to particulate emissions.	D: Taxes on coal decrease coal use but increase natural gas consumption by a similar amount.
Cross-Sector	Additional fuel taxes	Natural gas	E: Taxes on natural gas cause an increase in coal use, slightly increasing emissions.	D: Taxes on natural gas increase total spending.	B: Fuel taxes are likely to be politically unpopular, but they are straightforward to implement and common worldwide.	E: Taxes on natural gas causes an increase in coal use, significantly increasing particulate emissions.	D: Taxes on natural gas decreases natural gas consumption but increases coal consumption by a similar amount.
Cross-Sector	Additional fuel taxes	Petroleum gasoline, petroleum diesel, jet fuel	C: Taxes on petroleum fuels slightly reduce emissions, overwhelmingly from the transportation sector.	D: Taxes on petroleum fuels increase spending far more than monetized public health and climate benefits. (However, depending on how tax revenues are used, this policy could provide net savings or other economic benefits.)	B: Fuel taxes are likely to be politically unpopular, but they are straightforward to implement and common worldwide.	C: Taxes on petroleum fuels slightly reduce particulate emissions.	C: Taxes on petroleum fuels slightly reduce petroleum fuel consumption.

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ENDNOTES

1. Mexico defines clean energy as “those energy sources and electricity generation processes whose emissions or waste, where they exist, do not exceed the thresholds set out in the regulations. This includes renewable energies as wind, solar, tidal, geothermal, bioenergy, hydrogen, methane sources, hydro, nuclear, biomass, carbon capture and sequestration, and other low emission technologies."
2. For more information on how the electric sector works see Energy Policy Simulator Documentation (Energy Sector Main): https://www.energypolicy.solutions/docs/electricity-sector-main.html
3. It is assumed that the system takes into account only the installed capacity of natural gas in 2014 (baseline capacity), the system does not build more natural gas plants and retires existing plants (natural gas nonpeakers).

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