Compact Cities Electrified: Mexico

BRIEF FOR POLICYMAKERS

ITDP

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New research from the Institute for Transportation and Development Policy and the University of California, Davis, finds that Mexico could feasibly reduce the total direct costs of urban passenger transport to the public and private sectors by $MXN 24,000,000 million through 2050, including $MXN 4,000,000 million[1] in savings for federal, state, and local governments, while simultaneously reducing carbon emissions to a level consistent with Mexico's international commitments. This will require a combination of strategies to support vehicle electrification, compact city planning, and modal shift toward walking, cycling, and public transit. Only the combination of these strategies, not any strategy alone, will be sufficient to achieve the full benefits of decarbonization and cost savings.

This study investigates four possible scenarios for urban passenger transport in Mexico:
Business as Usual: Mexico's current trend of stagnation or slow growth in public transport, walking and cycling combined with rapid growth in car usage, and gradual electrification of vehicles
Electrification (Only): The fastest feasible replacement of internal-combustion vehicles with electric ones, reaching 100% of new vehicle sales by 2050.
Mode Shift (Only): The fastest feasible transformation of city planning priorities in favor of compact land use and public transport, walking, and bicycling, preventing any further increase in car driving.
Electrification + Mode Shift: The combination of the previous two scenarios.

The estimated requirements to achieve each scenario and the cumulative public-sector expenditure entailed are shown in Figure A.

In addition to cost savings, the *Electrification + Mode Shift* scenario would reduce electricity consumption by 30,000 million kWh per year by 2050 compared to *Electrification (Only)*. Qualitatively, this scenario would improve road safety, promote economic inclusion of marginalized groups, and reduce air pollution.

INFRASTRUCTURE REQUIREMENTS AND DIRECT PUBLIC COSTS BY SCENARIO

FIGURE A

	Percent of new light-duty vehicles that are electric	Cumulative lane-km of roadway built 2015–2050	Cumulative track-km of metro rail built 2015–2050	Cumulative lane-km of protected bikeway built 2015–2050	Cumulative publicsector expenditure on urban passenger transport 2015–2050	Cumulative public sector expenditure on urban passenger transport 2015-2020
2015 Baseline	0%					
2050 *Business as Usual*	50%	140,000	400	900	5,400	$MXN 43,000,000 million
2050 *Electrification (Only)*	100%	140,000	400	900	5,400	
2050 *Mode Shift (Only)*	50%	25,000	600	4,300	19,000	$MXN 43,000,000 million
2050 *Electrification + Mode Shift*	100%	25,000	600	4,300	19,000	$MXN 39,000,000 million
2050 *Electrification + Mode Shift*	100%	25,000	600	4,300	19,000	$MXN 39,000,000 million

The research also measures greenhouse gas emissions from urban passenger transportation[2] in each scenario. The results add to a growing body of evidence[3] and show that achieving Mexico's Paris Agreement commitments will require both the complete electrification of vehicles and a change in travel patterns in favor of public transport and nonmotorized mobility. It is insufficient for *Electrification* or *Mode Shift* to occur at the fastest possible rate

1 Throughout the report, numbers are written in a semi-extensive format to avoid lexical ambiguity of the meaning of billion/trillion between English and Spanish. The figure 4,000,000 million should be read as 4,000,000,000,000, or 4x1012. This number would be read as 'trillions' by US English speakers, and as 'billones' by most Spanish speakers.
2 The study's scope is limited to urban passenger transport. No kind of freight transport was included, nor intercity or rural transport.
3 Iniciativa Climática de México (2023), Ruta Emisiones Netas Cero para México 2060, desde Sociedad Civil.

independent of each other—it is only by maximizing both of these complementary strategies that Mexico can reduce emissions fast enough to approach a level consistent with holding global warming below 1.5°C (represented by the blue area in Figure B).

GREENHOUSE GAS EMISSIONS BY SCENARIO

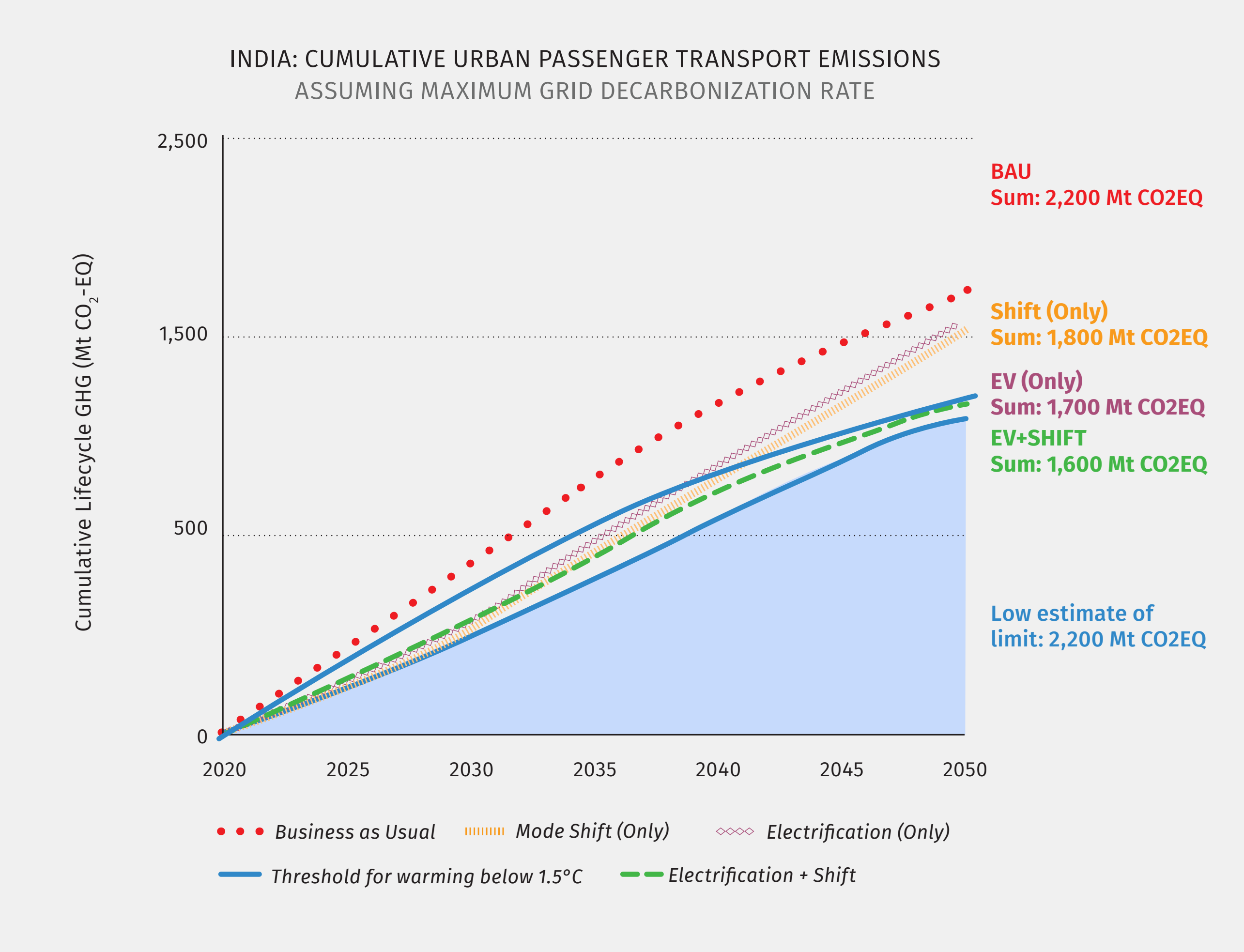

FIGURE B

Mexican cities have a strong foundation of public transport usage, but this foundation is threatened by a trend of rapid growth in car use. That trend is spurred by the indirect subsidy that drivers receive in the form of an inequitable allocation of street space and infrastructure. To achieve the *Electrification + Mode Shift* scenario, Mexico must invest in improving existing infrastructure for public transport, walking, and bicycling, while rapidly reallocating road space and transport funding away from car-centric infrastructure. Such restructuring must be accompanied by incentives and mandates for vehicle electrification, construction of compact mixed-use cities, and travel demand management measures such as vehicle emission restrictions and parking prices to reflect its true cost. In all scenarios, a substantial amount of travel will still be made by car, but the *Electrification + Mode Shift* scenario will offer Mexicans a wide range of travel options using clean, efficient vehicles. The distances traveled might also be reduced, partly by increased density, but more by an increase in mixed-use neighborhoods. This scenario is not an unprecedented revolution: It is a return to a tradition of people-focused city building that has proven successful in Mexican cities throughout most of the country's history as well as in cities around the world.

ACKNOWLEDGEMENTS

LEAD AUTHORS:

Lewis Fulton	**University of California, Davis** *Director, Sustainable Transportation Energy Pathways*
D. Taylor Reich	**Institute for Transportation and Development Policy (Global)** *Data Science Manager*
Emilio Romero	**Institute for Transportation and Development Policy (Mexico)** *Urban Development Coordinator*

SUPPORTING AUTHORS:

Manuel Blanco	**Institute for Transportation and Development Policy (Global)** Transport Data Intern
Santiago Fernández	**Institute for Transportation and Development Policy (Mexico)** Urban Development and Research Manager
Alejandro Lerma	**Institute for Transportation and Development Policy (Mexico)** Public Policy Analyst
Farhana Sharmin	**University of California, Davis** Graduate Student Researcher
Naomi Varinois	**Institute for Transportation and Development Policy (Mexico)** Public Policy Analyst

REVIEWERS:

Luisa Sierra Brozon	**Iniciativa Climática de México** Energy Director
Rodrigo Díaz	**World Resources Institute** Mobility Director
Gustavo Jiménez	**Grupo Emobilitas** Executive Director
Ma. Isabel Studer Noguez	**Sostenibilidad Global AC.** Founding Director

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COVER PHOTO: Electric bus arrives into a renovated Metrobús Station in Mexico City.
SOURCE: Eduardo Pesado y Diego Albarrán

CONTENTS

Road-building is by far the greatest expense that Mexican governments face in urban transportation. Even though metro or BRT is more costly per lane-kilometer, it is much less expensive per passenger, and bicycle lanes are far less expensive in every sense. By serving the public with mass transit and bicycle infrastructure instead of roads, Mexican states and cities will have more resources to devote to other uses or to lower taxes.[4] And when they are not forced to spend so much money on fuel and private vehicles, Mexican families will have the freedom to invest more in other areas of their life. By protecting our planet from the worst threats of climate change, we will make it possible for the country to prosper long into the future.

1. BACKGROUND

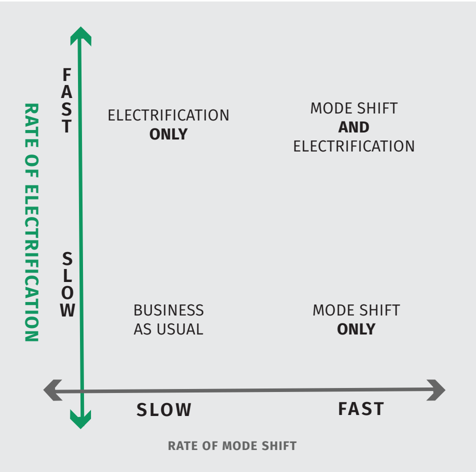
This study is the culmination of a decade of collaboration in transport modeling between ITDP and the University of California, Davis.[5] Ten years of effort have produced a detailed method for high-level modeling of urban passenger transportation, but this study of India—along with sibling studies of other countries—is the first time the model has been used to publish analytical results for a single country.

Like its predecessor, *The Compact City Scenario—Electrified*, the current publication compares the impacts of maximum-feasible electrification, modal shift, and the combination of the two. But while the previous report focused on the global need to pursue both strategies, this study describes the specifics of what will be needed for India to accomplish these goals. We have estimated the quantities and costs of infrastructure that will be required in different scenarios for India's future to provide a "road map" for how those scenarios might be realized.
This study is the culmination of a decade of collaboration in transport modeling between ITDP and the University of California, Davis.[6] Ten years of effort have produced a detailed method for high-level modeling of urban and suburban passenger transportation, but the study of Mexico and parallel studies of other countries mark the first time the model has been used to publish analytical results for a single country.

Like its predecessor, The Compact City Scenario—Electrified, the current publication compares the economic and environmental implications of four scenarios for the future of urban passenger transportation: 1) the current trajectory; 2) intensive electrification; 3) intensive mode shift; and 4) the combination of the latter two. But while the previous report focused on the global need to pursue these strategies, this study describes the specifics for Mexico. In addition to quantifying the emissions that each scenario would entail, we have also estimated the quantities and costs—or savings—of infrastructure that would result from different scenarios for the future of Mexico. These results provide a "road map" for how those scenarios might be realized.

2. FOUR SCENARIOS

Like the global study and parallel reports for other countries, this research investigates four scenarios for urban passenger transport in Mexico through 2050. These scenarios are diagrammed in Figure A. We start by understanding these scenarios qualitatively, including a summary of the impacts that they might have outside the scope of our modeling analysis—factors such as public health and economic inclusion. In Section 3 (page 12), we define these scenarios quantitatively for modeling.



4 *The numbers are summarized in Figure A (above) and shown in detail in Section 7 of the report.*

6 ITDP & UC Davis (2021), The Compact City Scenario—Electrified; ITDP & UC Davis (2017), Three Revolutions in Urban Transportation; ITDP & UC Davis (2015), A Global High Shift Cycling Scenario; ITDP & UC Davis (2014), A Global High Shift Scenario: Impacts and Potential for More Public Transport, Walking and Cycling with Lower Car Use.

BUSINESS AS USUAL ("BAU")

Assumptions:

- Mexico continues its current trajectory. Private motorized travel increases, remaining responsible for about 50% of urban passenger travel but increasing by around 25% in terms of total person-km.

Qualitative impacts:

- Increase in traffic fatalities[1]
- High direct public and private costs[2]
- Increasing gap in access to opportunities between people with and without cars, possibly leading to increased wealth inequality[3]
- Increase in local air pollution, causing many premature deaths and increased healthcare costs[4]
- Increase in urban highways and sprawl primarily in midsize cities, with a lack of vertical development[5]
- Increase in carbon emissions, leading to climate catastrophe[6]

1 Mexico City has seen a 19% increase in traffic fatalities in the past five years. See: SEMOVI (2024), Reporte trimestral de hechos de tránsito.

2 For example, highway infrastructure spending per mile has risen dramatically: Accounting for inflation, $8 million in the 1960s per mile became $30 million per mile by the 1990s. See: American Economic Association (2023), Infrastructure Costs.

3 National Equity Atlas, Indicator: Car Access.

4 Despite great gains in air quality in the US, as of 2022, approximately 85 million people nationwide lived in counties with pollution levels above National Ambient Air Quality Standards. Increased natural events such as wildfires partially due to climate change will further erode air quality. See Union of Concerned Scientists (2014), Vehicles, Air Pollution, and Human Health; United States Environmental Protection Agency (2023), Air Quality National Summary, 1980–2022.

5 SEDATU (2022), Política Nacional de Suelo.

6 Andrew Moseman, MIT Climate Portal (2022), Are electric vehicles definitely better for the climate than gas-powered cars? The answer is yes, though the extent to which improvement is meaningful is based on electricity source and manufacturing emissions. The Business as Usual scenario will encourage car-oriented development with a limited increase of clean energy.

ELECTRIFICATION (ONLY)

Assumptions:

- *Electrification* proceeds much more rapidly than is currently projected, in alignment with the latest draft for the National Strategy for Electric Mobility from 2023[1], with 50% of new vehicles (cars, buses, and two-wheelers) electric by 2030 and 100% before 2050.

Qualitative impacts:

- 👍 Sharp reduction in carbon emissions[2]
- 👍 Sharp reduction in local air and noise pollution[3]
- 👍 Reduced costs of operation for public transport as well as many private vehicles
- 👍 Road safety benefit if technology such as speed regulators or automatic braking is included in EVs
- 👎 The negative impacts of car-based infrastructure listed in Business as Usual also apply
- 👎 Consumption of limited supply of critical minerals, raising concerns related to extractive industries, conservation, national security, and supply chain

Key policies:

- Supply- and demand-side EV incentives
- Ambitious fuel economy and tailpipe GHG emission standards
- Battery reuse and recycling
- Equitable placement of standardized public charging points for EVs (including two-wheelers)
- Electric grid expansion and decarbonization
- Gradual reduction of fossil fuel subsidies

1 The latest draft from 2023 has not yet been published as official national policy. https://www.cofemersimir.gob.mx/portales/resumen/55366666666666666666666666
2 With high electrification, the emissions from transport will be reduced sharply. See: Andrew Mosemen, MIT Climate Portal (2022). Are electric vehicles definitely better for the climate than gas-powered cars?
3 Tsoi et al. (2023), The co-benefits of electric mobility in reducing traffic noise and chemical air pollution: Insights from a transit-oriented city.

MODE SHIFT (ONLY)

Assumptions:

- Compact city planning and development is combined with reallocation of both funding and street space to walking, bicycling, and public transport. In this case, Mexico considerably reduces the construction of new urban roadways, focusing instead on providing denser housing, mixed land use, retrofitting intra-urban services, and better bus/bicycle infrastructure on existing roadways to increase accessibility to peripheral areas in cities. Total car travel (in person-km) remains constant, while the percentage of travel by car falls dramatically.

Qualitative impacts:

- 👍 Reduction in traffic fatalities[1]
- 👍 Increased access to opportunities, especially for low-income people and other groups suffering from spatial segregation—people with disabilities and the elderly or young[2]
- 👎 Increase in walking and cycling, which improves physical and mental health, reducing healthcare costs[3]
- 👎 High local air and noise pollution from internal-combustion (ICE) vehicles relative to *Electrification (Only)*

Key policies:

- Reallocation of transport budgets to walking, cycling, and public transport, especially BRT
- Street redesigns that shift space from travel lanes and parking to BRT lanes, physically protected bicycle lanes, and footpaths
- Promotion of bicycles, especially shared electric bicycles
- Design of pedestrian and cycling infrastructure promotes safe and comfortable trips, including adaptations to different climatic conditions
- Zoning reforms with an inclusion perspective to promote denser development that considers affordable housing options and mixed land uses

1 Smart Growth America & The National Complete Streets Coalition (2022), Dangerous by Design.
2 See: National Library of Medicine (2023), Does the compact city paradigm help reduce poverty? Note, this is most effective in mitigating poverty in combination with housing affordability measures; also see Urban Institute (not dated), Causes and consequences: Separate and unequal neighborhoods.
3 Matthew Raifman et al. (2021), Mortality implications of increased active mobility for a proposed regional transportation emission cap-and-invest program.

ELECTRIFICATION + SHIFT

Assumptions:

- Compact cities and policies to prevent an increase in driving, combined with rapid electrification: *Electrification* and *Mode Shift* together.

Qualitative impacts:

- Reduction in traffic fatalities[1]
- Increased access to opportunities for all
- Increase in walking and cycling, which improve physical and mental health, reducing healthcare cost
- Extensive reduction in local air and noise pollution
- Massive reduction in carbon emissions consistent with the objectives of the Paris Agreement

Key policies:

- All policies listed for *Electrification (Only)* and for *Mode Shift (Only)*, except for expansion of urban highways
- Creation of low-emission areas to incentivize both mode shift and vehicle electrification

1 Smart Growth America & The National Complete Streets Coalition (2022), Dangerous by Design.

Achieving the *Electrification* or *Mode Shift* scenarios would require profound and challenging changes in Mexican policy. However, these changes are possible under Mexico's current political and economic structure. A key barrier to this scenario is an increase in population and income, which can entail more private vehicle use. Political will is required to improve mobility systems so that public transport, walking, and cycling are more convenient and attractive for urban transport than driving, and even as more of the population gains the income that would enable car ownership, people will continue to choose to travel by sustainable modes. This improvement will involve restructuring how transportation budgets are allocated, how street space is used, how travel in private vehicles is regulated, and how taxes and subsidies are applied to vehicles and fuel. But these are incremental changes that can be reached in the current system.

In Appendix B, we envision a narrative for the *Electrification + Mode Shift* scenario in the city of Monterrey, Mexico.

3. METHODOLOGY

This study uses the same methods as the 2021 Compact City Scenario—Electrified and the other 2023/2024 country-level studies published by ITDP and UC Davis. In each of these studies, we define four scenarios and estimate their impacts using the same modeling methods. This section will first describe the structure of these modeling methods and then outline our process for defining the scenarios that are taken as modeling input.

Our application of this model to Mexico has been reviewed by experts representing a range of national specialist institutions to help ensure accuracy. These experts' names and affiliations are listed on this brief's title page. For a more detailed description of the methodology, including a complete set of data, please review the accompanying methodological appendix.

3.1. STRUCTURING THE MODEL

Our study is limited to urban passenger transportation and does not include intercity travel, rural travel, or freight transport of any kind. We define "urban" based on United Nations data, including all urban or suburban areas of 300,000 people or more.[7] This definition encompasses about 80% of the Mexican population.[8] Other research shows that both *Electrification* and *Mode Shift* will be necessary to decarbonize rural/intercity[9] and freight[10] transport, and this focus in our scope allows us to model urban and suburban travel with more precision.

Our model is calibrated to industry-standard data from the International Energy Agency's Mobility Model[11] except where more detailed Mexico-specific data is available. The base year modal split was determined using Mexico-specific data based on the intercensal survey of 2015 by the Mexican National Institute of Statistics and Geography (INEGI). This calibration determines the estimation of conditions in the base year, the projection of the *Business as Usual* scenario, and factors such as emissions factors, fuel emission intensities, and costs.

This general modeling approach was reviewed as part of the 2021 publication, and a list of reviewers can be found there.[12] Our method provides a high-level comparison of different scenarios rather than a detailed bottom-up analysis. This results in a perspective that's relevant to the urban passenger transport sector broadly rather than focusing exclusively on a handful of particular policies.

3.2. DEFINING SCENARIOS

After setting the scope and calibrating the model, the next step is to quantitatively define the four scenarios for urban passenger transportation in Mexico that were described on page X. Beginning from a base year of 2015[13] and looking to future time points in 2030 and 2050, we describe possible futures. These scenarios are not intended to precisely define the only options for the future of the sector; rather, they are meant to give an idea of general trajectories that are possible for urban passenger transport.

For electrification, our forecasting is expressed in terms of the percentage of new vehicles that are electric. The *Business as Usual* and Mode Shift scenarios share the same lower electrification rates; the *Electrification* and *Electrification + Mode Shift* scenarios share the same higher electrification rates. There may be fewer new cars sold per year in the Mode Shift scenario, but the same percentage of those cars are electric. Similarly, modal splits and travel activities (defined in terms of person-kilometers traveled by different modes) are identical in the *Business as Usual* and *Electrification* scenarios, with higher levels of car use; these are also identical in the Mode Shift and *Electrification + Mode Shift* scenarios, with lower levels of car use.

After defining these scenarios, we will estimate their implications. For each scenario, based on the size of vehicle fleets and the amount of activity per vehicle, we estimate life cycle[14] greenhouse gas emissions (Section 4), energy consumption (Section 5), and total quantities and costs of infrastructure, vehicles, fuel, and operation (Section 6).

7 United Nations Department of Economic and Social Affairs (2018), World Urbanization Prospects.
8 The UN definition may differ from other definitions, such as INEGI's.
9 International Transport Forum: OECD (2023), ITF Transport Outlook 2023.
10 Lynn H Kaack, Environmental Research Letters (2018), Decarbonizing intraregional freight systems with a focus on modal shift.
11 The *Mobility Model* is only available under a closed license, and the full dataset cannot be shared. However, all relevant variables for Mexico are included in the Methodological Appendix and may be reviewed there.
12 ITDP & UC Davis (2021), The Compact City Scenario—Electrified.
13 Selected for data availability and compatibility between sibling studies and to avoid distortions due to COVID-19.
14 Including emissions not only from the production and consumption of fuel or electricity but also from the manufacture and disposal of vehicles and the construction and maintenance of infrastructure.

3.2.1. SCENARIOS FOR ELECTRIFICATION RATES

The ***Business as Usual and Mode*** Shift scenarios follow the same projections for the percentage of new vehicles that are electric, broken down by year and vehicle type—the sales shares of vehicles. In these scenarios, our projections are meant to align with the country's current trajectory. This projection takes into account current market trends, including total new sales for electric and hybrid vehicles, which in recent years have represented around 4.5% of sales.[15]

The ***Electrification and Electrification + Mode Shift*** scenarios follow sales share projections that are consistent with the National Strategy for Electric Mobility and Mexico's Nationally Determined Contribution,[16] aligned with the Glasgow Agreement at COP27.[17] These also align with the targets modeled in a recent report by the Iniciativa Climática de México.[18]

FIGURE B. ELECTRIFICATION RATES BY VEHICLE TYPE, YEAR, AND SCENARIO

	Percentages of New Vehicle Sales that Are Electric (Rather than InternalCombustion)[31]					
	Business as Usual and Mode Shift (Only)			*Electrification (Only) and Electrification Mode Shift*		
	2015	2030	2050	2015	2030	2050
LDVs (Cars and light trucks)	0%	25%	50%	0%	50%	100%
2- Wheelers/motorcycles (not including e-bikes)	0%	25%	50%	0%	50%	100%
buses	0%	25%	50%	0%	50%	100%

3.2.2. SCENARIOS FOR MODE SHIFT RATES

The ***Business as Usual and Electrification scenarios*** start from base year (2015) modal splits calibrated to data from the intercensal survey of 2015 carried out by the Mexican National Institute of Statistics and Geography (INEGI). For future years, modal splits were projected forward from that baseline according to travel activity projections based on the industry-standard International Energy Agency's (IEA) Mobility Model numbers for Mexico. This includes future projections of travel breakdowns by mode. They can be seen in Figure E and Figure F.

The ***Mode Shift and Electrification + Mode Shift*** scenarios follow our own calculations, in two steps. First, we project possible future urban densities in Mexico under a maximum-feasible policy to promote compact, mixed-use cities. Second, we identify the maximum feasible replacement of car and motorcycle travel and substitution with walking, bicycling, public transportation, telecommuting, or shorter trips, including a factor to show how mode shift can be more easily achieved in compact communities. For more detail on this modeling process, see the methodological appendix.

The first step of the calculation draws on data from the European Commission's Global Human Settlement Layer,[19] identifying the current trends in urban density and then also projecting a compact cities scenario in which various policies come together to achieve the following effect:

Cities in Mexico immediately stop sprawling, consuming no new undeveloped urban land. Rather, population growth is concentrated in areas that currently have less than 8,000 people per km2 to bring them to a population above that level. This threshold is arbitrary, but it reflects a general point at which it becomes feasible to serve urban areas with public transportation. The modeling approach is meant to generally represent a densification that could be achieved through zoning reform to permit by-right multifamily construction (without parking minimums) on all urban land.

15 INEGI (2022). Registro administrativo de la industria automotriz de vehículos ligeros.
16 Secretaría de Medio Ambiente y Recursos Naturales Press Release (November 8, 2022), México anunciará en la COP27 el incremento de sus ambiciones climáticas.
17 UK Government Policy Paper (2022), COP26 declaration on accelerating the transition to 100% zero emission cars and vans.
18 Iniciativa Climática de México (2023), Ruta Emisiones Netas Cero para México 2060, desde Sociedad Civil.
19 GHSL - Global Human Settlement Layer. Available at ghsl.jrc.ec.europa.eu/.

This densification is meant to represent the maximum land use reform that can be achieved without anyone having to leave or redevelop their current home. It will only provide new options: Densification will be promoted ideally in central neighborhoods and in places with access to mass transit networks. Currently, suburban areas are diverse and concentrate sprawling single-family homes and also informal settlements with high densities. Affordable housing near transit and in central neighborhoods needs to be promoted to offer alternatives for lower-income groups.

In the *Business as Usual* projections, most population growth is in areas that are already dense, with more than 8,000 people per km2. However, there is some slight growth in more sprawling areas, such that about 25 million urban Mexicans will live in areas less dense than 8,000 ppl/km2 by 2050 (up from about 20 million today). In the Mode Shift projections, that growth is redirected so that only about 14 million urban Mexicans will live in such sparse urban environments. Some of these low-density areas are wealthy suburbs, others are poorer peri-urban areas where low-income people may be "captive" riders of public transport. In either case, low-density areas are the places where people have the strongest incentive to purchase and use cars as soon as their income permits.

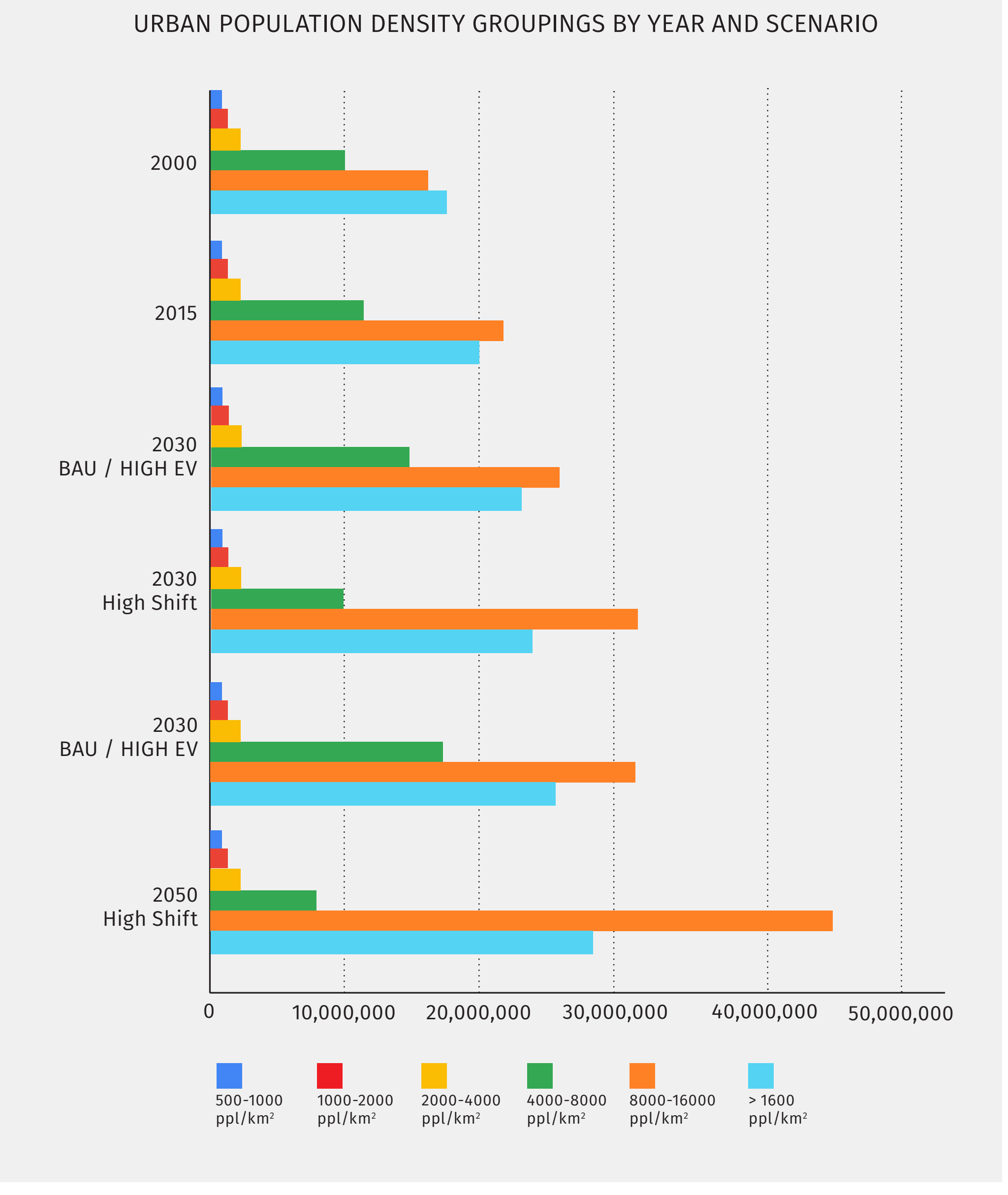


Figure C. Urban density groupings

In the second step, after estimating future densities, we used the projected potential urban densities to identify the maximum feasible reductions in car and motorcycle travel as a function of those densities. In more compact communities, it will be easier to replace car travel with travel by other modes. We estimate that it will be possible to prevent growth in car and motorcycle travel, holding them nearly constant (as measured by total person-km traveled) through 2050. Overall travel demand will continue to grow rapidly, but the increase in travel will be directed to other modes rather than cars and motorcycles. The specific redistribution of this travel to other modes was based on the same pattern used in other Compact Cities Electrified country-level reports, and it was approved by the Mexico-specialist reviewers listed on page X. More detail can be found in the methodological appendix. The results of this calculation are a modal shift relative to *Business as Usual*, shown in Figure E and Figure F below.

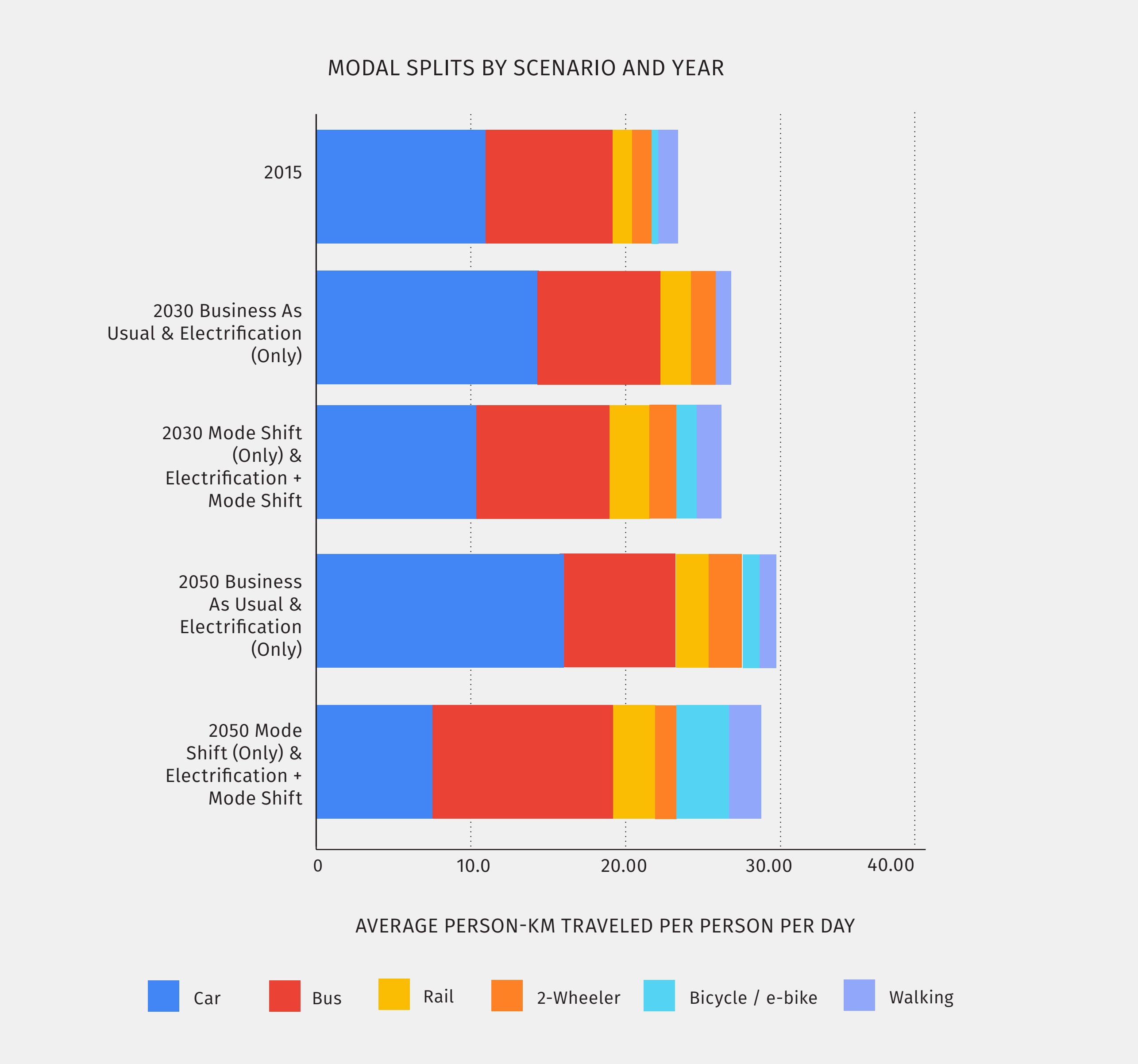


Figure E. Travel activity[20]

Modal Splits by Scenario and Year (by person-km traveled, rather than by trip; independent of overall travel activity, which grows over time)					
	2015 Base Year	2030 *Business as Usual* & *Electrification* (Only)	2030 *Mode Shift (Only)* & *Electrification + Shift*	2050 *Business as Usual* & *Electrification (Only)*	2050 *Mode Shift (Only)* & *Electrification + Shift*
Car	47%	48%	42%	55%	27%
Bus	39%	35%	39%	27%	45%
Rail	4%	6%	7%	5%	7%
2-Wheeler	4%	4%	4%	6%	3%
Bicycle/e-bike	2%	2%	4%	3%	11%
Walking	4%	4%	5%	3%	7%

Figure F. Mode splits by percent of travel

These scenarios will require substantially different investments in infrastructure (kilometers of railway, busway, road, and bicycle lanes) and in vehicle fleets, and estimates of these are shown in Section 7.3.

It is important to note that the numbers shown in Figure F reflect the percentage of person-km traveled by each mode, not the percentage of trips. The percentage of trips by car is in fact much lower in all scenarios and years (INEGI, the source of our data, indicates about 24% of trips were by car in 2015, considering a weighted average of trips to school and work in the largest metropolitan areas). But because car trips tend to be much longer than trips by public transport or by walking or cycling, the proportion of passenger-km is very different.

In summary, the 2050 Mode Shift is an ambitious scenario. We believe that it will be feasible for Mexico to prevent an increase in person-km traveled by car, but it will require significant investment in public transport and sustainable mobility modes, as well as a diverse range of policy considerations (included in Appendix A).

20 Data used for *Business as Usual* adapted from INEGI (2015).

4. SCENARIO COMPATIBILITY WITH MEXICO CLIMATE COMMITMENTS

Mexico's commitments to greenhouse gas reductions are ambitious. Our modeling shows that the country's decarbonization goals in the urban passenger transport sector cannot be met with *Electrification* or with *Mode Shift* alone—they require both strategies in concert.

4.1. MEXICO CLIMATE TARGETS

In 2022, Mexico enhanced its climate mitigation goals, targeting a 35% reduction in greenhouse gas (GHG) emissions by 2030—significantly higher than the previous 22% reduction proposed in 2020. If external support is secured, Mexico has pledged to surpass that goal and reach a more ambitious 40% GHG reduction by 2030.[21]

Across all economic sectors, 35 measures have been identified and categorized into three groups: Natural solutions, low-carbon transportation, and industrial regulation and promotion. These measures are anticipated to yield an estimated total annual mitigation of 88.9 million tons of carbon dioxide equivalent (Mt CO2eq) by 2030.

In the transportation sector, aligned with commitments from COP26 in Glasgow to end the sale of new ICE vehicles by 2040, Mexico is intensifying efforts in collaboration with the private sector and cities nationwide, particularly focusing on advancing electric vehicles.

The Mexican government has not established an official net zero emissions policy or target. However, there have been efforts for establishing a Net Zero Emissions Pathway for Mexico 2060 from Iniciativa Climática de México (Mexico Climate Initiative).[22] This pathway proposes a viable scenario to reach net zero emissions, considering 2060 as the shortest possible time for achieving this goal.

This pathway has important considerations regarding electric power, as it states that to achieve net zero, from 2027 onward, no new electricity-generation plants that use fossil fuels should be installed. Electricity must also be decarbonized to a level that achieves an 88% clean and renewable energy–generation matrix. In terms of the transport sector, it establishes that by 2060, electric vehicles should represent 92% of the national fleet. Furthermore, the promotion of nonmotorized mobility and improvements in the design and planning of cities are also considered key measures in reaching net zero emissions by 2060.

4.2. SCENARIO IMPACTS ON TRANSPORT EMISSIONS

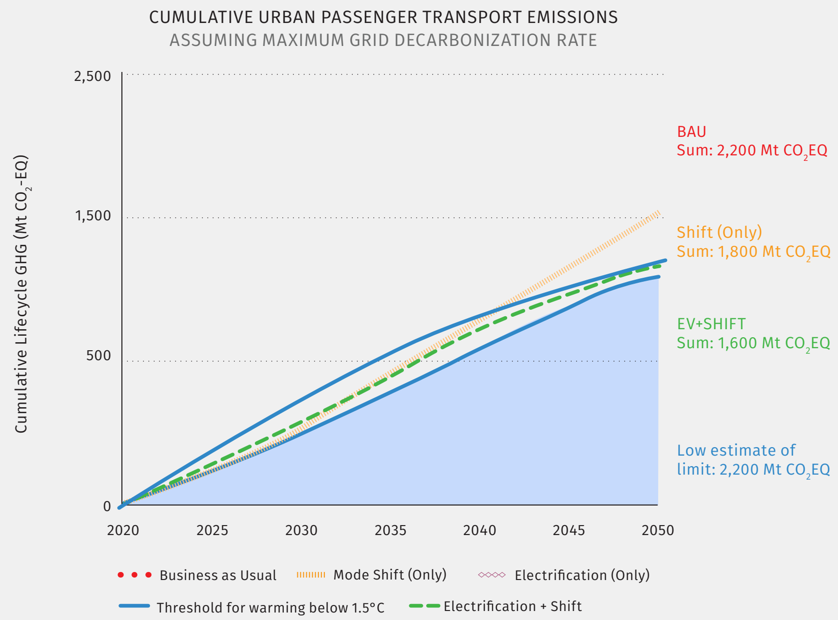


Figure G. Greenhouse gas emissions by scenario

21 UNDP, Mexico. Available at https://climatepromise.undp.org/what-we-do/where-we-work/mexico.
22 Iniciativa Climática de México (2023), Ruta Emisiones Netas Cero para México 2060, desde Sociedad Civil.

Although the *Electrification* and *the Mode Shift* scenarios would each considerably reduce GHG emissions, only the combined *Electrification + Mode Shift* scenario even comes close to keeping cumulative urban passenger transport emissions within a level potentially compatible with limiting climate change to 1.5°C in this century. This is shown by the area under the blue threshold curve[23] in Figure G, above.[24] To reflect uncertainty in calculations of the carbon budget, we have included "high" and "low" estimates of the threshold that must not be exceeded to potentially stay within 1.5°C (assuming equivalent decarbonization in every sector and country). Even the most optimistic *Electrification + Shift* scenario only barely comes within that margin of error.

Not only is *Electrification + Mode Shift* the only scenario that approaches holding global warming within Paris Agreement goals, it is the only scenario that approaches the possibility of achieving net zero by 2060, a goal explored by the Iniciativa Climática de México.[25]

Mode Shift and *Electrification + Mode Shift* are also the only scenarios that even approach Mexico's NDC goal of a 35% reduction in GHG emissions by 2030. Figure H shows that *Electrification + Mode Shift* offers an 18% reduction in emissions relative to 2015, or a 12% reduction relative to 2030 *Business as Usual*, with all other scenarios offering less dramatic improvements. It may not be realistic to expect more extensive decarbonization than this in the urban passenger transport sector; perhaps additional decarbonization may come from other sectors of the Mexican economy. Figure I shows that emissions reductions in all scenarios are much more extensive in 2050.

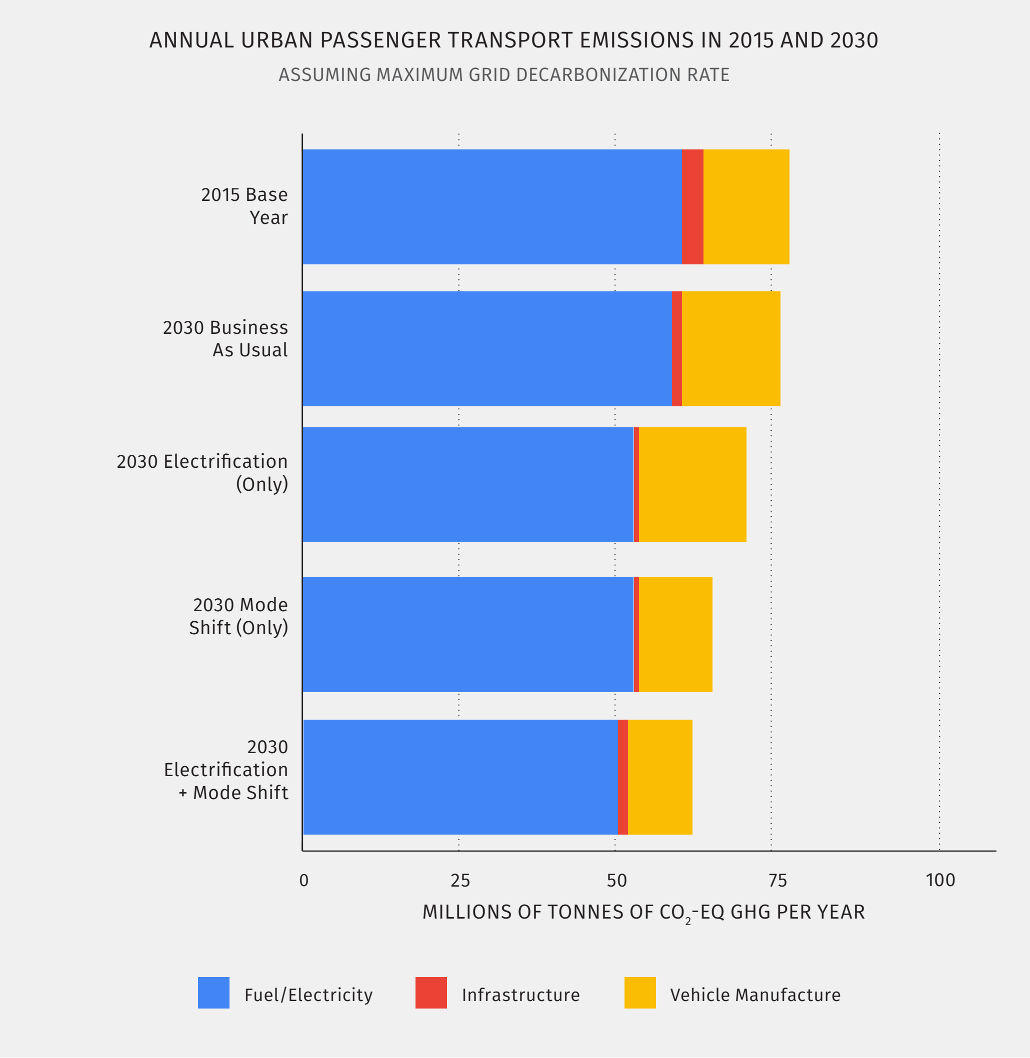


Figure H. Annual GHG emissions by scenario and source, as of 2015 and 2030

23 Carbon budgets are allocated by the ratio of the US's cumulative emissions in the *Business as Usual* scenario to worldwide emissions in the *Business as Usual* scenario. For more detail, see the Methodological Appendix.
24 Note: Our analysis shows that the *Electrification + Mode Shift* scenario will exceed the 1.5° C threshold by nearly 1Gt, a shortfall that will need compensation from decarbonization of other sectors of the American economy.
25 Iniciativa Climática de México (2023). Available at https://www.iniciativaclimatica.org/emisionesnetascero/.

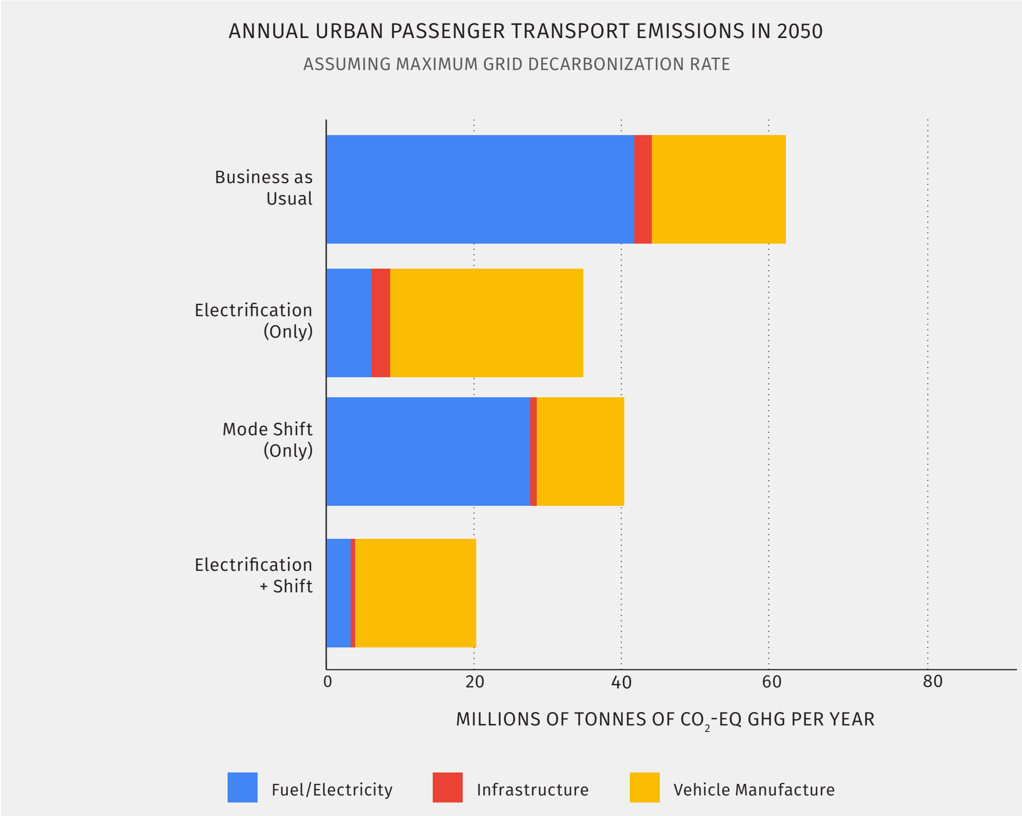


Figure I. Annual GHG emissions by scenario and source, as of 2050

With a decarbonized grid, electric vehicles will cause very low emissions through their operation. However, the use of cars, electric or not, will still lead to substantial GHG emissions from the production of steel, batteries, and other industrial processes, such as lithium used in batteries involved in vehicle manufacture and disposal. Under the *Electrification* scenarios, as can be seen in Figure I, more than half of emissions are from these sources, which are much more challenging to decarbonize. Indeed, electrification actually increases manufacturing emissions by about 18 percent relative to *Business as Usual* because of the emissions intensity of battery manufacture and of heavier vehicles.[26] For Mexico to reach net zero by 2060, all emissions must be minimized—and that can only be accomplished by combining electrification with compact development and modal shift that limits private vehicle use and boosts an already positive usage of public transportation.

Electrification alone also requires exponential growth in the use of scarce critical minerals for batteries. The environmental, environmental justice, and national security challenges entailed by that would be significantly mitigated by combining *Electrification* with *Mode Shift* and reducing overall dependence on passenger vehicles while electrifying.[27]

4.3. MODE SHIFT REDUCES DEPENDENCE ON GRID DECARBONIZATION

Mode Shift provides a hedge against obstacles that may arise in decarbonizing the electrical grid. By combining *Mode Shift* and *Electrification*, Mexico may still achieve substantial decarbonization even if the shift to electric vehicles and/or renewable electricity generation is slower than optimistically projected.

Mexico's electricity grid currently has an emissions intensity of roughly 215g CO2eq per kWh. The results displayed in the previous section have assumed a highly ambitious level of grid decarbonization in line with the International Energy Agency's (IEA) Sustainable Development Scenario. Following this assumption, the grid emissions intensity falls to nearly 0g CO2eq /kWh by 2050.

26 This 25 percent figure is conservative, based on the assumption of rapid decarbonization of the manufacturing sector by 2050. Eighty percent is a reasonable estimate today: See Andrew Moseman & Sergey Paltsev, MIT Climate Portal (2022), [Are electric vehicles definitely better for the climate than gas-powered cars?]
27 Center on Global Energy Policy (2023), [Q&A: Critical minerals demand growth in the net-zero scenario].

However, current policies (as per IEA's Stated Policies Scenario) are only projected to reach a grid intensity of about 80g CO2eq/kWh by 2050, compared to 215 today. This is still an optimistic forecast, but in this case, our *Electrification* scenario loses some of its effectiveness in reducing cumulative emissions, while *Mode Shift* loses less, as shown in Figure J below. In this case, none of the scenarios is conclusively within the blue area signifying potential compatibility with the 1.5°C threshold, but *Electrification + Mode Shift* is barely on the line.

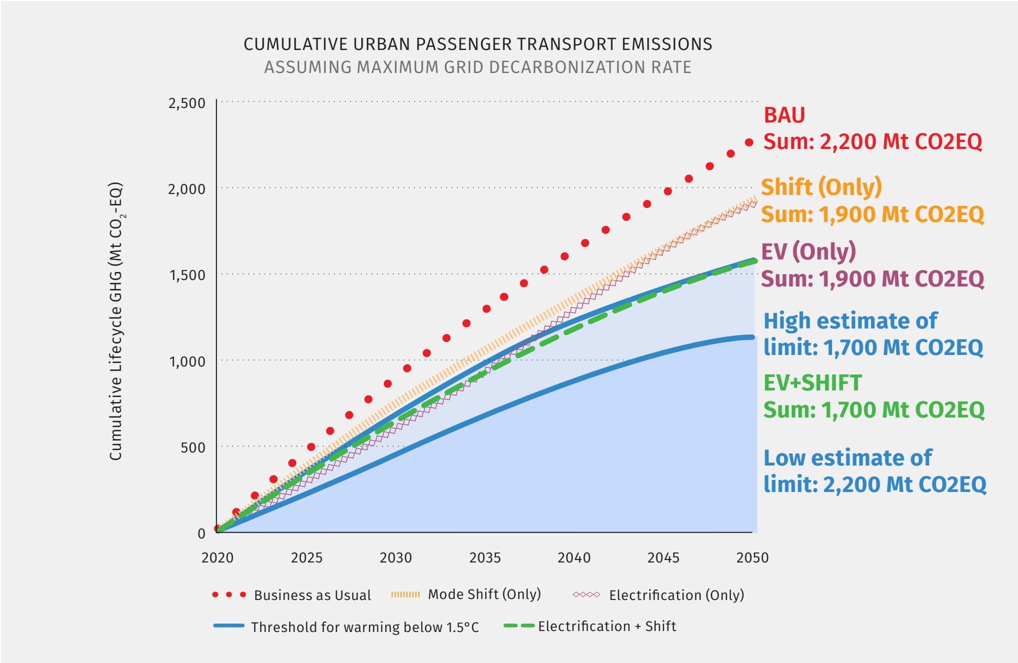


Figure J. GHG emissions by scenario, assuming slower grid decarbonization than in Figure G

The more conservative grid decarbonization projections also shed light on Mexico's prospects for reaching the goal of net zero by 2060, as seen in Figure K. If grid decarbonization proceeds in line with current stated policies, it will be very difficult if not impossible for Mexico to achieve that goal without both *Electrification* and *Mode Shift*, and even in the combined scenario, an extensive carbon-recapture effort, beyond the possibilities of known technology, will be necessary.

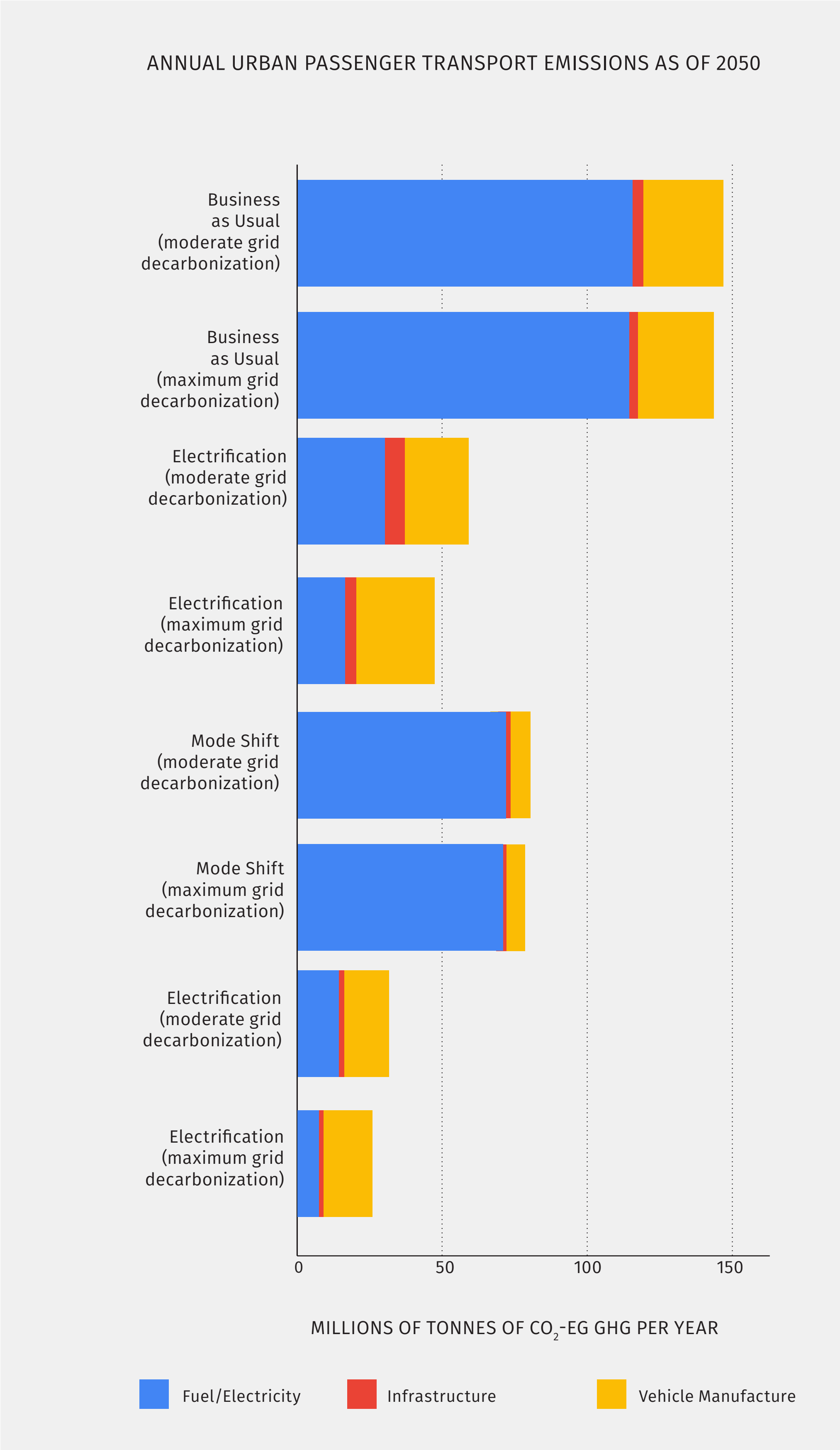


Figure K. Annual greenhouse gas emissions by scenario, source, and contingency

5. SCENARIO IMPACTS ON ELECTRICITY CONSUMPTION

Mode Shift not only provides a degree of redundancy with *Electrification*, it also reduces the burden of rapid grid decarbonization by dramatically reducing the increased electricity demand that vehicle electrification will cause. Furthermore, Mode Shift increases resiliency at all levels by providing redundancy in transportation options.

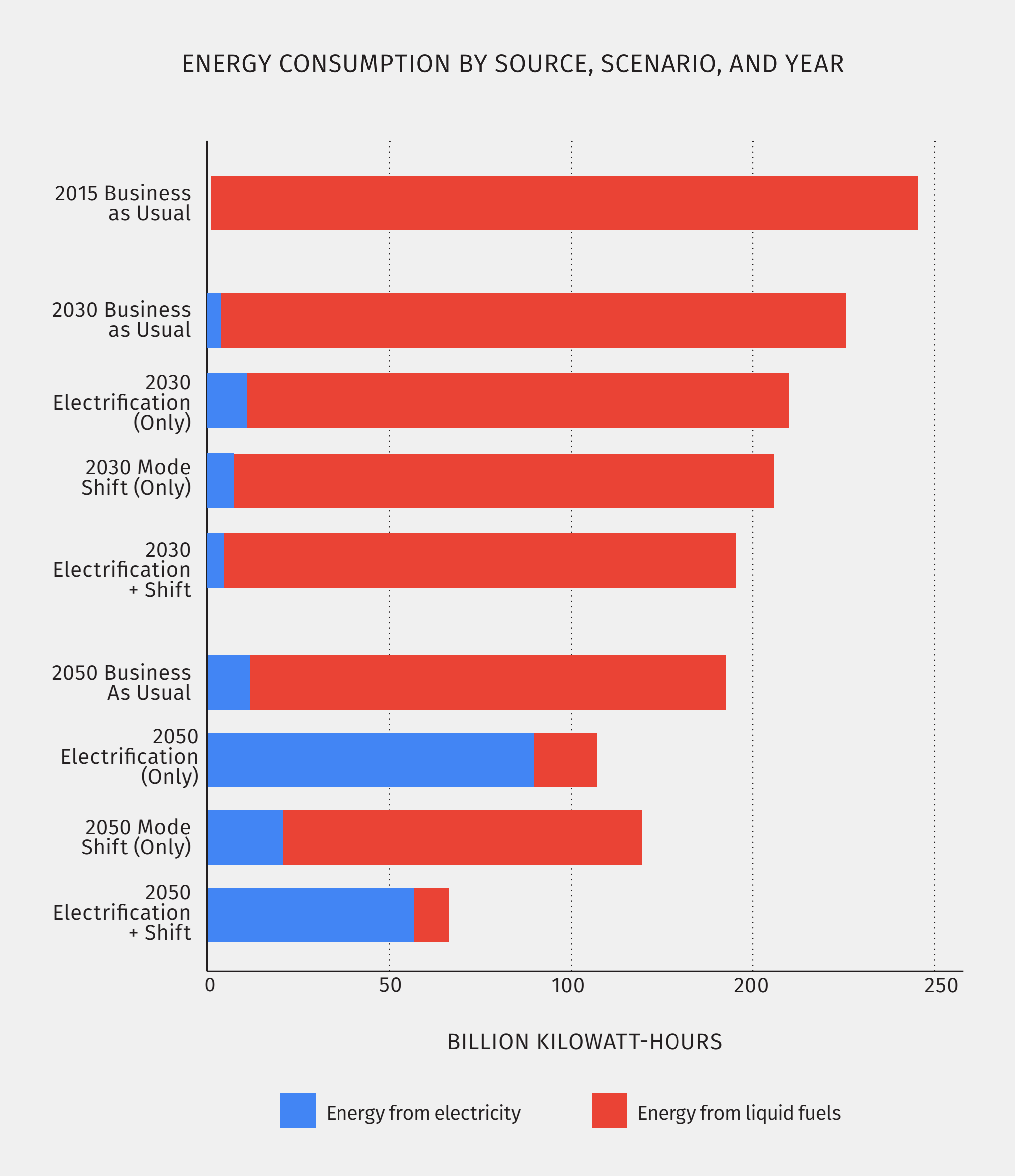


Figure L. Annual energy consumption

The *Electrification (Only)* scenario represents a major reduction in total energy consumption relative to *Business as Usual*, because electric vehicles are much more efficient per mile than internal-combustion vehicles. This massive reduction in total energy consumption and the use of liquid fuels is accompanied by a smaller increase in the use of electricity, seen in Figure L.

In the *Electrification* scenario, urban passenger transport in Mexico will consume about 90,000 million kWh of electricity annually by 2050. *Electrification + Mode Shift* reduces this consumption by about 32 percent (29,000 million kWh), or the equivalent of the annual power generation of about 6,000 wind turbines. Considering that Mexico's overall electricity consumption in 2022 was about 350,000 million kWh, this represents a savings equivalent to about 9% of the nation's entire electricity consumption. That might mean a reduction in the costs of building infrastructure for renewable power generation or freeing up electricity for other urgent needs in the face of the climate crisis, along with energy security, reduced dependence on fossil fuels, and other health benefits.

6. DIRECT PUBLIC AND PRIVATE EXPENSES IN EACH SCENARIO

The Mode Shift and *Electrification* + Mode Shift scenarios offer efficiencies that could save about MXN $24,000,000 million for Mexico's economy overall, including savings to the public and private sectors.

The structure of a transportation system has many impacts on a nation's economy, direct and indirect. Our model tabulates only the direct impacts—the expenses of manufacturing, maintaining, fueling, and operating vehicles and the expenses of building and maintaining infrastructure. These are shown in Figure M.

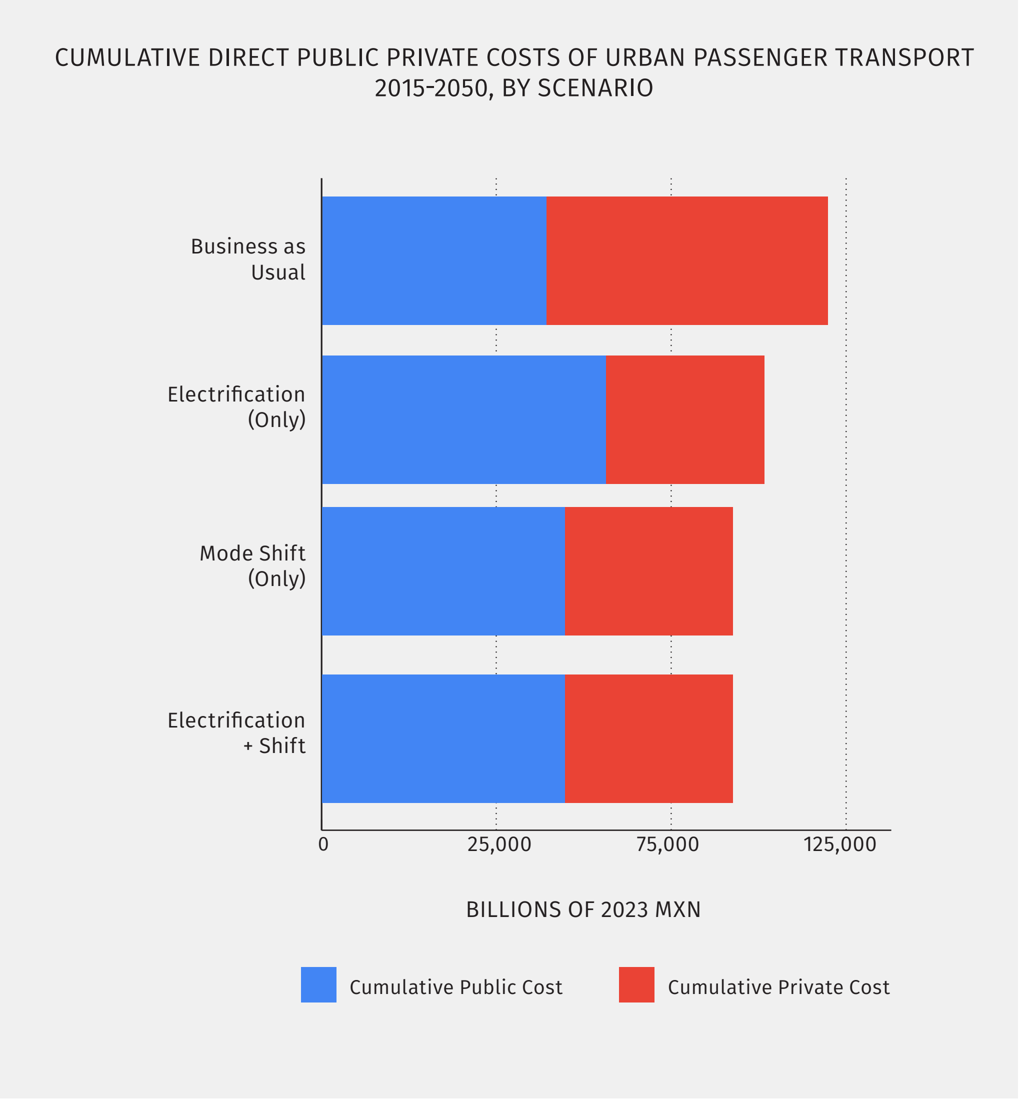


Figure M. Cumulative direct costs of urban passenger transport

These expenses can be divided into those borne ultimately by the public sector and by individuals.[28] Mode Shift would lead to enormous economic savings for the Mexican economy—a cumulative savings of about $24,000,000 million MXN. Of this, about $4,000,000 million MXN in savings would accrue to national, state, and local governments, tabulated in Figure O in Section 7, below.

Our calculations only include the direct costs of urban passenger transport and not indirect costs such as healthcare expenses related to vehicle collisions or sedentary lifestyles; costs related to air, noise, or water pollution; costs of farmland or natural areas lost to suburban sprawl; or, conversely, the economic benefits derived from job creation.[29] All of these indirect costs are likely to mean that the true economic benefit of *Electrification + Mode Shift* would be many times higher than we have calculated.

28 For the sake of conservatism, in these calculations we have assumed that the government will bear the entire cost of public transport operations—that is, fares will be free. We do expect that public transport subsidies will increase in the *Mode Shift* scenarios, though possibly not to this extreme.
29 Investments in public transit create nearly twice as many jobs per dollar as investments in new road-building. See: Transportation for America (2021), [Road and public transit maintenance create more jobs than building new highways](#).

7. MEASURABLE GOALS FOR URBAN PASSENGER TRANSPORTATION

It is possible for Mexico to achieve the *Electrification + Mode Shift* scenario. This scenario offers enormous savings to the public sector as well as private individuals and enterprises, while also reducing emissions from urban passenger transportation to the level most closely consistent with the country's climate commitments. It will not require any additional funding beyond the resources that Mexico already expends for urban passenger transportation—rather, *Electrification + Mode Shift* will only require a change in policies and a reallocation of resources. Instead of spending 43,000,000 million pesos building new highways, Mexico can spend 39,000,000 million pesos on electrification, BRT, bicycle lanes, new buses, and metro—and serve the public even more effectively.

Three elements must come together to achieve the *Electrification + Mode Shift* scenario: first, increased vehicle efficiency, primarily through electrification; second, land-use reform to make trips shorter by promoting compact mixed-use neighborhoods in existing cities; third, facilitating Mode Shift, primarily by providing alternative infrastructure but also by pricing car travel according to its true cost, especially through parking regulation (such as Mexico City's 2017 off-street parking reform[30]). All of these changes require high political will.

In this section we provide evidence-based goals for each of these three elements based on the quantitative analysis in this study. If achieved, these goals would bring the benefits of the *Electrification + Mode Shift scenario*. These goals could be accomplished in many ways, and in Appendix A, we provide basic policy agendas at the federal, state, and local levels that could help Mexico reach them.

7.1. GOALS FOR ELECTRIFICATION

To achieve the country's climate commitments, electrification must proceed much more rapidly than its current course allows. As discussed in Section 3.2.1, new sales of different vehicle types must be electrified at the rates shown in bold in Figure N, below. Most importantly, 50 percent of all new light-duty vehicle sales (cars and light trucks) must be electric by 2030, and 100 percent by or before 2050.

Percentages of New Vehicles that Are Electric (Rather than internal-Combustion)						
	Business as Usual and *Mode Shift (Only)*			*Electrification (Only)* and *Electrification + Mode Shift*		
	2015	2030	2050	2015	2030	2050
LDVs (Cars and light trucks)	0%	25%	50%	0%	50%	100%
2- Wheelers/ motorcycles (not including e-bijes)	0%	25%	50%	0%	50%	100%
Buses	4%	25%	50%	4%	50%	100%

Figure N. Sales of electric vehicles by year and scenario

30 ITDP (2020), Más Ciudad, Menos Cajones—Evaluación de impacto del cambio a los requerimientos de estacionamiento en la Ciudad de México y recomendaciones de política pública.

7.2. GOALS FOR LAND USE

More compact, mixed-use urban form will have a twofold benefit for the cities of Mexico. First, when people live closer to their places of work or leisure, trips will be shorter, and so even ICE cars will emit less and cost motorists less. This will require large policy shifts to promote new affordable housing in central areas, detailed in Annex B. Second, when trips are shorter, they are easier to take by bicycle or public transport, facilitating Mode Shift.

Achieving the *Electrification + Mode Shift* scenario and meeting the country's climate commitments will require Mexico to adopt policies that make it possible for cities to become more compact. As described in Section 7.2 below, these policies will not require anyone to live in a dense neighborhood who does not wish to.

Reaching the *Electrification + Mode Shift* scenario will require policies that put the country on track for the population density distribution described in Section 3.2.2, preventing any further creation of new neighborhoods below a density of 8,000 people per km2.

7.3. GOALS FOR TRANSPORTATION INFRASTRUCTURE

This analysis provides the clearest agenda for the third of the three components necessary to achieve the *Electrification + Mode Shift* scenario: the specific transportation infrastructure investments that will be needed to achieve such levels of Mode Shift and the estimated savings that are possible by pursuing such a strategy.

Figure O, below, indicates the extent of infrastructure and vehicle investment that Mexico must make to achieve the *Electrification + Mode Shift* scenario. As shown in Figure N, the Shift element of the scenario will mean that federal, state, and local governments will save about $4,000,000 million MXN by 2050. The expense of building and operating transit will be more than balanced by the reduced need to build and maintain highways.

Total New Infrastructure and Vehicles Required Through 2030							
	Road, two-way km	BRT, two-way km	Railway, two-way km	Physically protected bicycle lanes, two-way km	Buses (total urban buses and minibuses)	Train cars	Total cost to governments (lakh crore 2023 INR)
Business as Usual & Electrification (Only)	40,000	200	300	2,400	1,170,000	3,300	13
Mode Shift (Only) & Electrification + Shift	25,000	900	300	5,800	1,210,00	3,500	13
Total New Infrastructure and Vehicles Required Through 2050							
	Road, two-way km	BRT, two-way km	Railway, two-way km	Physically protected bicycle lanes, two-way km	Buses (total urban buses and minibuses)	Train cars	Total cost to governments (lakh crore 2023 INR)
Business as Usual & Electrification (Only)	140,000	900	400	5,400	2,800,000	8,600	43
Mode Shift (Only) & Electrification + Shift	25,000	4,300	600	19,000	3,200,000	10,000	39

Figure O. Detailed description of infrastructure and investment requirements by scenario

Note that the number for buses includes minibuses and also replacements to vehicles that are decommissioned, with an expected vehicle lifespan of about 12 years. We do not include cable cars, because they carry such a small fraction of Mexico's urban population.

This analysis provides a clear road map for transportation infrastructure investments in cities across Mexico. It makes a few points clear:

- The most important investments will be in bicycle lanes and BRT infrastructure—Mexico will need to build about 2,000km of bidirectional BRT (4,300 lane-km) by 2050, which is a BRT line on most urban highways. Bicycle lanes must be built even more broadly, on most urban arterials and primary streets, so that all residents of Mexican cities will live within a block or two of a protected bicycle lane.
- This investment in BRT and bicycle lanes, although large, is much less expensive than investment in roadways or metro. By building BRT and bicycle lanes, along with a relatively moderate expansion of metro systems, Mexico's federal, state, and local governments can reduce expenses for highways and save an enormous amount of money over the coming decades. This investment does not replace rail systems and will need to be complementary.
- Road expansion must be severely limited. Only about 25,000 more lane-km of urban roadways can be built, after which road construction and widenings must be stopped altogether in favor of more efficient usage of the existing roadways. Mexican cities have sprawled enough.

This scale of transformation, while massive, is not unprecedented. Paris decreased car travel by almost 50 percent in 30 years by investing in other modes and traffic-control strategies. Jakarta and Bogotá have each built a mass transit system with more than a million riders a day in less than 15 years. There's no reason why Mexican cities can't do the same.

APPENDIX A: BASIC POLICY AGENDA

Achieving the goals established in Section 7 of this report will require coordinated action at the federal, state, and municipal levels of government in Mexico. Here are a series of policy recommendations to advance on these three fronts: vehicle electrification, planning of compact cities, and modal shift in travel in the medium term. Actions related to the responsibilities of the three levels of government are included, reflecting that the federal government must generate the framework and instruments to promote solutions implemented by states and municipalities.

ELECTRIFICATION OF TRANSPORTATION THROUGH POLICIES AND INCENTIVES

FEDERAL LEVEL

1. Guide electromobility policy by setting ambitious national targets around public transportation electrification; complete the final publication of the National Strategy for Electric Mobility with the targets set in the 2023 anteproyecto.
2. Implement federal financial incentives for purchasing EVs. Such incentives can combine increased cost for internal combustion vehicles with a subsidy for EVs to decrease the relative cost of EVs. Other incentives may include tax reductions and subsidies for infrastructure fees such as tolls.
3. Incentivize and favor the electrification of public transport fleets and light electric vehicles through criteria for accessing new or existing financing programs or federal funds.
4. Design a federal chatarrización program to accelerate the switch from internal combustion vehicles to EVs (for both private and public transport).
5. Standardize procurement schemes for suppliers and requirements for electric public transportation fleets and charging infrastructure for different cities so that a joint public tender is possible, thus achieving economies of scale and reducing acquisition and maintenance costs.
6. Invest in a clean electricity supply chain to satisfy increased demand caused by transport electrification. It is important to develop the renewable-energy sector (wind and solar power) and to progressively stop investing in coal and oil power generation. It is also important to review and gradually reduce or eliminate fiscal incentives to fossil fuels' consumers and producers.
7. Ensure that there is a clean energy supply in each stage of the supply chain of EV (mineral use, battery sourcing, and assembly).
8. Reduce the costs of EV in Mexico by developing the EV industry in Mexico, building on the existing internal combustion vehicles industry, or reducing tariffs on imported EV and batteries.
9. Invest in research, education, and training to create a skilled workforce and build capacities in the public and private sectors to manage and lead transport electrification.
10. Draft and establish standards and protocols for safety and maintenance of public transportation EVs.
11. Promote the development of a national network of EV charging infrastructure in an equitable way, ensuring that the availability and strategic location of charging stations considers vulnerable populations.

B. STATE LEVEL

1. Drive electrification by enabling electromobility policies and setting ambitious targets for public transportation electrification in mobility and public transportation plans and programs at the state level. These plans and programs must encompass road maps for the implementation of electric public transport, strategies for financial backup, and financial incentives for the purchase of EVs.
2. Promote the launch of pilot projects of electromobility in specific routes and transit corridors, managed by structured transport organizations. This is particularly relevant for BRT lines, as BRT is projected to be one of the main new public transportation infrastructure expansions by 2050. This includes organizations such as Metrobus in Mexico City and Metrorrey in Monterrey.
3. Design state-level chatarrización programs aiming at accelerating the switch from internal combustion vehicles to EVs (for both private and public transport).
4. Include the purchase of EV in new tenders to incentivize public transport operators to renovate their fleet. Subsequently adapt the concession contracts' duration to consider the higher investment that the purchase of EVs generates.

5. Implement a subsidy scheme for electric vehicles, especially for the logistics industry, to accelerate the shift from vehicles with greater environmental and road safety impacts.
6. Promote the development of state-level networks of EV charging infrastructure in an equitable way, ensuring the availability and strategic location of electrical charging stations.

C. MUNICIPAL LEVEL

1. Draft local plans and strategies to push for the development of the grid and charging infrastructure based on land availability and demand analysis. Include charging infrastructure standards and targets in municipal urban development plans, integral mobility plans, and construction regulation (Reglamentos de Construcción), with a focus on street and parking spaces located close to housing and office buildings.
2. Adopt schemes to incentivize the use of EVs, such as “green plates” that allow drivers to use parking spaces reserved for electric and hybrid vehicles.

REFORMS TO LAND-USE POLICIES, ZONING, MIXED-USE, AND TRANSIT-ORIENTED DEVELOPMENT

A. FEDERAL LEVEL

1. Promote a federal-level housing policy that prioritizes the development of affordable housing in dense areas that are already connected to the public transit network. Federal institutions, such as the Institute of the National Housing Fund for Workers (INFONAVIT), that are able to finance housing development projects are key. The INFONAVIT already has accessibility criteria for funding housing projects, which enables it to prioritize projects that have access to health, education, employment, recreation and provision of basic goods. This needs to be replicated for other actors that finance housing projects.

B. STATE LEVEL

1. Promote programs, incentives, and instruments at the state level that allow municipalities to approve affordable housing projects, giving priority to areas with good connectivity to public transportation and high accessibility to health, education, employment, recreation facilities and provision of basic goods.
2. Promote higher residential densities and mixed uses in state-level planning to guide the updating of municipal-level plans and programs that establish zoning and densities at the block level.

C. MUNICIPAL LEVEL

1. Promote reforms to municipal urban development instruments and construction regulations to eliminate minimum parking requirements and transition to a maximum parking levels model that restricts parking construction and limits trips in private motorized vehicles. Maximum limits need to be aligned to local conditions, considering other factors such as proximity to public transport and accessibility to health, education, employment, recreation facilities and provision of basic goods. This also involves the management of off-street parking supply, especially in high-density urban areas where land is being underutilized to the detriment of housing and businesses.
2. Create infrastructure standards that require vehicle charging in parking spaces in new constructions, considering the federal level specifications for charging infrastructure, the NOM-001-SEDE, relevant for electrical installations, in municipal regulations and construction regulations.
3. Include minimum requirements for bicycle parking spaces in urban development instruments and construction regulations to promote trips in sustainable mobility modes.
4. Promote mixed uses in municipal zoning regulations that create new spaces for health and education facilities, employment, provision of basic goods, and recreational activities in areas with good connectivity to public transport and that allow for shorter trips.
5. Update regulations to promote higher residential densities that consider local conditions and limitations. This includes reviewing residential density limitations, currently established in urban development plans—for example, the Norma General de Ordenación 11 for Mexico City—particularly for areas that have good accessibility to key facilities.

SUPPORT MODE SHIFT BY OPTIMIZING THE USE OF ROAD SPACE WITH WALKING, CYCLING, AND PUBLIC TRANSPORT

FEDERAL LEVEL

1. Integrate the principles and policies of the General Law of Mobility and Road Safety in investment programs, such as the Programa Federal de Apoyo al Transporte Masivo (PROTRAM), and in infrastructure projects to shift public spending toward integrated public transportation projects with energy efficiency criteria and infrastructure, in accordance with the inverted pyramid of sustainable mobility.[31]
2. Strictly follow up on the implementation of the National Strategy for Mobility and Road Safety (ENAMOV) to generate safe transportation in sustainable mobility modes.[32]
3. Update and/or develop official standards (NOM) and manuals related to road infrastructure, public space, equipment, and pedestrian and bicycle infrastructure to comply with the General Law on Mobility and Road Safety (ENAMOV).
4. Develop a National Public Transportation Policy, designing technical and financial support mechanisms for the implementation of integrated transportation systems.
5. Develop federal investment programs specific to the development of active mobility such as infrastructure, cycling equipment, and public bike-sharing systems.
6. Build technical capacities in the federal civil service for implementing the aforementioned measures.

STATE LEVEL

1. Align state regulations with the General Law on Mobility and Road Safety.[33]
2. Revise the distribution of resources allocated to actions, programs, and infrastructure projects related to mobility and road safety so they are aligned with Article 60 of the General Law on Mobility and Road Safety— "Prioritization of actions and resources." Limit as much as possible investments aimed at increasing the level of road service for individual motor vehicles.[34]
3. Revise the criteria under which road infrastructure projects are assessed to consider the distribution of space according to the inverted pyramid of sustainable mobility, as well as the impacts of transportation on air and noise pollution, greenhouse gas emissions, and road safety, and not only travel times and/or level of service.
4. Strengthen the collection of vehicle ownership taxes based on environmental parameters and explore other tax mechanisms focused on ownership, such as feebates on vehicle purchases based on energy efficiency.[35]
5. Promote regulatory changes that support congestion charge strategies based on mobility studies and implemented especially in areas which attract a high level of trips with a diversified offer of transportation services.[36]
6. Streamline the approval and authorization processes for sustainable mobility projects. Align citizen participation mechanisms to the scales of the issues addressed, so that a community has the power to influence but not veto projects that improve sustainable mobility and road safety at the city level.
7. Organize public transportation services to transform the model of individual concessions to integrated transportation systems, promoting the physical, operational, informational, image, and fare integration of public transportation.
8. Invest in the redesign of bus networks with the objective of increasing frequency, adding coverage and universal accessibility, observing the lines of action of Axis 2, "Public Transportation Services for People," of the National Strategy for Mobility and Road Safety (ENAMOV).[37]
9. Implement BRT corridors on primary roads, observing the criteria of the BRT Standard (ITDP, 2016).[38]
10. Develop public bike-sharing systems in the main urban areas of the state, integrated with public transportation to support last-mile trips.
11. In coordination with municipal authorities, develop car-free-street initiatives in the main urban areas of the state to promote sustainable mobility.
12. Build technical capacities in the state civil service for implementing the aforementioned measures.

31 Cámara de Diputados (2023), Ley General de Movilidad y Seguridad Vial.
32 SEDATU (2023), Estrategia Nacional de Movilidad y Seguridad Vial 2023-2042.
33 Cámara de Diputados (2023), Ley General de Movilidad y Seguridad Vial.
34 Cámara de Diputados (2023), Ley General de Movilidad y Seguridad Vial.
35 ITDP (2012), Guía de estrategias para la reducción del uso del auto en ciudades mexicanas.
36 ITDP (2012), Guía de estrategias para la reducción del uso del auto en ciudades mexicanas.
37 SEDATU (2023), Estrategia Nacional de Movilidad y Seguridad Vial 2023-2042.
38 ITDP (2016), The BRT Standard.

LOCAL LEVEL

1. Reform municipal legal frameworks to enable municipal governments to implement low emission zones (LEZ), as was done by the municipality of Guadalajara with the reform of the Bylaws for Integral Urban Management.[39]
2. Use the guidelines of the Manual de Calles (SEDATU, 2018) regarding street design and demand-management strategies for the design of traffic calming interventions, intersections, pedestrian trajectories, vehicle circulation, and parking management.[40] Road design should reflect the inverted mobility pyramid, favoring pedestrian and active mobility trips as a priority.
3. Promote the implementation of networked cycling infrastructure, observing criteria of safety, continuity, coherence, comfort, attractiveness, and adaptability, as set out in the Manual de Calles (SEDATU, 2018).[41]
4. Allocate resources for the development of cycling equipment to meet the objectives of Axis 3 of ENAMOV),[42] including but not limited to installation of bicycle parking racks and retrofitting of public transportation units, stations, stops, and their surrounding areas.
5. Implement necessary mechanisms (e.g., parking meters) so private motor vehicle users are charged for parking at a sum close to the social cost,[43] especially in areas that are in high demand and are covered by public transport services. To the extent possible, this revenue should be directed to finance sustainable mobility projects.
6. Build technical capacities in the municipal civil service for implementing the aforementioned measures.

39 Gobierno de Guadalajara (2024), Reforma al reglamento para la Gestión Integral del Municipio de Guadalajara.
40 SEDATU (2019), Manual de calles. Diseño vial para ciudades mexicanas.
41 SEDATU (2019), Manual de calles. Diseño vial para ciudades mexicanas.
42 SEDATU (2023), Estrategia Nacional de Movilidad y Seguridad Vial 2023-2042.
43 ITDP (2021), Taming Traffic.

APPENDIX B: IMAGINING COMPACT CITIES ELECTRIFIED IN MEXICO

Mexico's current context presents several challenges: Increasing private vehicle ownership, investment in car-oriented infrastructure, and urban sprawl through low-income housing all present obstacles to modal shift and electrification. On the other hand, the latest draft of the National Strategy for Electrical Mobility, which is aligned with the Glasgow climate pact and aims for 100% electric new vehicle sales by 2050, brings an opportunity to promote rapid electrification. Market trends in vehicle sales are also promising for the future of electrification—in 2022, 4.7% of total new sales for light vehicles were either electric or hybrid.[44]

Section 2.1 of this report has presented a qualitative exploration of the study's four scenarios; Section 3.2 defined them quantitatively. Appendix A provided a policy agenda for the federal, state, and local levels to help achieve this future. Here, Appendix B will present a narrative of what the *Electrification + Mode Shift* future might look like in Mexico, taking the city of Monterrey as an example.

The metropolitan area of Monterrey, in the state of Nuevo León, is the third-largest metropolitan area in Mexico. Historically, it is one of the most car-oriented cities in the country, with around 40% of trips to work made in a private vehicle (the total is only 20% in the metropolitan area of Mexico City). Furthermore, in the last 30 years, the urban area has increased 2.8 times, from 363km2 to 1,029km2. At the same time, population density has decreased from approximately 7,000 to 5,000 people per square kilometer.[45]. In public transportation, Monterrey has recently finished construction of three metro lines, with three more in the planning and implementation phase. However, ridership has been affected by the pandemic—in 2022, it was 24% lower than in 2019, the last year before the pandemic began.[46].

In terms of electrification, even though the share of electric vehicles remains less than 5%, the state of Nuevo León has seen a total increase of 10% for electric and hybrid vehicle sales yearly since 2020.[47]. This signals an opportunity to increase private vehicle electrification if policies such as subsidies and tax incentives are applied. In terms of charging points, the state of Nuevo León has a share of around 10% of the total electric-vehicle charging points in the country.

Next steps for the metropolitan area of Monterrey are continuing with the trends of vehicle electrification and charging infrastructure—with further incentives for the private sector that accelerates these trends—as well as investing heavily in mass transport, including new metro and BRT lines. A key component of this plan is to promote the integration of the new rail and BRT infrastructure with its immediate environment through transit-oriented development (TOD)to permit multifamily housing with the option of building less parking through the elimination of parking minimums. This also means increasing connectivity of sustainable mobility modes of travel to and from stations to promote multimodality and sustainable ridership of the new rail and BRT infrastructure. This would ensure a modal shift of travel patterns in the medium to long term. Housing affordability is another key component, which can be achieved through instruments such as selling development rights or inclusionary housing.[48]

Investment in large-scale expansion of the bus fleet, which includes electric buses, must be carried out to create citywide grids of high-frequency bus service. To achieve this, there must be country-wide access to federal funding programs or grants promoting and supporting the adoption of integrated public transportation systems that also consider replacing low-capacity, polluting fleets. Road space must be reallocated to prioritize bus and BRT circulation in main arterial roads that connect municipalities in Monterrey. A protected cycle network on main roads is also needed, along with wide sidewalks and safe, marked crosswalks suitable for universal accessibility on all streets, promoting increased road safety.

Important progress for this has recently been made in Monterrey at a municipal level. For example, in 2022, the municipality of San Pedro Garza García eliminated parking requirements, and the municipal urban development plan for Monterrey is currently being updated and promotes the integration of mass transit stations with key destinations through green corridors, as well as higher densities and mixed uses around Metrorrey stations. The green corridors program is another initiative that shows progress toward a modal shift—it is intended to connect services in the city through green infrastructure that promotes sustainable mobility.

By 2050, after implementing these policies in the different municipalities in Monterrey, more

44 Asociación Mexicana de la Industria Automotriz (2022), Transición a la electromovilidad en México.
45 Sistema de información urbano metropolitano (2020), Expansión Urbana Monterrey.
46 Tovar, R., *El Horizonte* (November 28, 2022), Usan el metro menos personas que en 2019.
47 Instituto Mexicano del Transporte (2022), Situación de la electromovilidad en México.
48 For more examples, see: ITDP México (2017), Hacia una estrategia de vivienda asequible orientada al transporte.

families in the metropolitan area might live in central areas as opposed to the suburbs, or in areas that are well connected through Metrorrey to employment and the different goods and services they require. Different typologies of housing have been built along Metrorrey corridors, allowing families of all income ranges to live in more compact environments, reversing the trend of decreased density in the metropolitan area of Monterrey. With more housing and transportation options, all families will have the option to save money by forgoing the cost of buying a car. In most neighborhoods, families will be able to take short, comfortable, and safe walks or bike rides to their local parks, stores, pharmacies, and schools. If they require longer commutes, they will be able to take an electric BRT or electric bus to get to their workplace,and be able to reach this infrastructure by walking or cycling comfortably, avoid driving and spending hours in traffic.

More residents in Monterrey will be able to live without needing to buy a car, and others will be able to access electric or hybrid personal vehicles—they have become as affordable as diesel ones and are more convenient to drive, since charging infrastructure and policies such as green plates are available and in effect. Despite having less dedicated road space for cars and more lanes dedicated to BRT or other electric buses, reduced demand will mean traffic will not dramatically increase.

Many of these changes seem challenging, especially for a city such as Monterrey, which has emphasized construction of car infrastructure in recent decades. However, this car-oriented planning has many negative externalities, such as congestion, that have an important impact on people's quality of life. Recent changes, such as the expansion of Metrorrey and the elimination of parking minimums in San Pedro, suggest that this trend is reversible, especially highlighting benefits such as reduced congestion and increased public and green space. Confronting the climate crisis through the promotion of electrification and a shift in travel patterns presents an opportunity to amplify this trend in Monterrey.

APPENDIX C: METHODOLOGICAL DOCUMENTATION

Because of its length, the methodological documentation has not been included in this layout of the report. It is available at **Mexico Drafting: Methodological Appendix**

ITDP
Institute for Transportation & Development Policy

UC DAVIS
UNIVERSITY OF CALIFORNIA

Taylor Reich
ITDP

Lew Fulton
UC DAVIS

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