México towards a fossil fuel-free future

PARLIAMENTARIANS FOR
A FOSSIL-FREE FUTURE

Report
Mexico towards a fossil fuel-free future

Graphic direction and design:
Juana Pedraza & María Forero

This publication is distributed free of charge.
Its sale is prohibited.

Made in México

parliamentarians.call@gmail.com
www.fossilfuelfreefuture.org/

November 2023

Mexico towards a fossil fuel-free future

PARLIAMENTARIANS FOR
A FOSSIL-FREE FUTURE

CONTENT

INTRODUCTION

This report is the result of research carried out by a group of diverse Mexican parliamentarians, members of the Parliamentarians' Network for a Fossil Fuel-Free Future. This initiative is based on a genuine concern for the climate emergency observed in every corner of the earth, caused by human activities, particularly by the burning of fossil fuels which, according to the Intergovernmental Panel for Climate Change (IPCC) represents close to 80% of the historic emissions of Greenhouse Gases (GHG). In response to this context the Parliamentarians' Network has started an inquiry process with a global scope aimed at evaluating the progress of phasing out from carbon, oil, and gas to meet with the international commitments of the Paris Agreement. Likewise, different countries from the five regions of the earth are advancing on national legislatives inquiries.

Since COP 27 hosted by Egypt in 2022, the Mexican Parliamentarians members of the Network have set out to lead this process in Latin-American and the Caribbean, seeking to understand how Mexico should advance its energy transition and to what extent it could align to the climate commitments. Thus, this report México towards a fossil-fuel free future examines the advancements but is mainly focused on the strategic routes and concrete proposals to achieve a just energy transition in alignment to the country's current circumstances. Throughout this report, the reader will find suggestions and mitigation measures to make Mexico's Nationally Determined Contributions (NDC) reflect a greater ambition, but at the same time are technically feasible and socially just, in line with the analysis carried out and published by Mexico's Climate Initiative at NDC-SC in 2022.

The development of the research, and thus this report, has been led by seven legislators from five different political parties, demonstrating their concern for contributing to the national debate on a subject that is of common interest but from different viewpoints and sectors. Likewise, a technical team of the highest level has supported the development of the research and the drafting of the report itself. As a milestone in the research process, a day-long session was carried out at the Mexican Congress, through an Open Parliament Forum, in which experts were invited to further the analysis of the information. This report presents key messages that summarize the main elements of the analysis of various public policy, academic and legal documents. It is divided in three chapters corresponding to the three main strategic subjects. Mexico has an incomparable potential for climate leadership and could become an example of a just and equitable energy transition for the rest of the countries to follow.

But is mainly focused on the strategic routes and concrete proposals to achieve a just energy transition in alignment to the country's current circumstances.

KEY MESSAGES

To facilitate the phase-out of fossil fuels in key economic sectors, Mexico's NDCs must be ambitious and their implementation urgent and fast. In response to civil society's pressure, Mexico presented by the end of 2022 new mitigation goals for 2030: 35% unconditional emission reduction and up to 40% reduction conditioned on receiving international support. These more ambitious goals are necessary and reflect progress, but, according to the Mexican Climate Initiative (MCI, 2022) the key is to adopt, with efficacy and urgency, the actions included in the decarbonization paths for each relevant sector. In a study that considered 30% mitigation goals, the MCI estimated the investment needed for the adoption of the unconditioned commitment at USD 105.640 million by 2030, and at USD 255.997 million for the conditioned commitment.

The energy transition in Mexico is feasible and can be effectively carried out with the existing technology and with political support that leverage the large variety of measures for the transport and electric power sectors. As in many countries, the energy system transformation requires political will. This is the determining factor that will push or stop the transition process from an energy system based on oil, gas, and carbon to one based on clean and renewable energies.

Mexico already passed its peak of oil production in 2004 and of gas in 2009. While the internal demand for oil grows, the supply is running out, leaving the country in a critical scenario. To date, 88% of the available oil has been extracted and its purchasing power has risen exponentially. Since 2004, well productivity has been reduced 67% and the extraction costs have quintuplicated. The energy security outcast is critical unless strong actions are undertaken for the energy transition across Mexico.

To comply with climate change mitigation goals provided for in the Paris Agreement, radical changes must be undertaken in the transport sector across the world. In Mexico, motorized transport is one of the main emitters of Greenhouse Gases (GHG) In 2019, it was the second most important emitter of GHG nationwide, following energy industries, with a total of 148 MtCO2e, 20% of total country emissions. This high emissions' volume is related to the high fossil fuel consumption and represents an important mitigation potential.

The application of vehicular efficiency regulation NOM 163 will have a reduction potential of 19.5 million tons of CO2e annually by 2030. To have a more efficient vehicular fleet and to reduce its emissions, it is essential to update NOM-163. An optimal regulation on GHG emissions and fuel performance in light vehicles is one of the most cost-efficient reducing emissions mechanisms, while it also contributes to the promotion of national energy security by reducing the demand for imported gasolines.

Promoting active and non-motorized activity will contribute to the reduction of private vehicle use. This means a reduction potential of 7.5 million CO2 tons per year by 2030. Walking and riding bicycles are the cleanest ways to move around a city. In addition to the emission reduction and the improvement of air quality, both mobility options provide co-benefits for health, road safety and equality. To make it an attractive alternative, favourable security, cohabitation, culture and comfort conditions for cyclists and pedestrian must be ensured. This means the adaptation of streets and infrastructure.

Urban planning must favour active and non-motorized mobility and massive public transport. This represents a reduction potential of 14.2 million CO2 tons per year by 2030. Good urban planning will allow people to live and carry out their activities without the need of long rides or, when needed, to make them possible in safe, fast, and comfortable public transport and other cleaner methods. Compact cities with mixed land use and proper public spaces, planned to include various modes of transport, will have lesser carbon footprint, and promote greater equality.

Actively promoting the "Avoid-Shift-Improve" approach within transport demand. The hierarchy for managing transport demand to reduce emissions begins by AVOIDING the need for transport, then SHIFTING the ride distribution to reduce automobile rides and privilege non-motorized mobility and public transport and, as a last instance, IMPROVING the efficiency of conventional vehicular technologies, fuels, and existing road infrastructure to reduce emissions.

The electric-energy sector is key for global and national decarbonization, given it is historically the second with highest GHG emissions in the country and a high fossil consumer. It will become more relevant, as other sectors such as transport and industrial processes are electrified. Countries with developed economies have pledged to achieve a carbon net-zero electric sector by 2035: Mexico, on the other hand, has a renewables goal of only 50% by 2050.

Investment needed to achieve the electric sector's decarbonization is significant and the public sector cannot make it alone. An estimated US$56 billion are required for this purpose by 2030. It is important to promote and include private sector investment and cooperation. The public sector must therefore create the conditions needed to attract investment and get international funding through different cooperation mechanisms.

Mature, accessible, and reliable renewable energy technologies for reducing emissions exist, even with negative implementation costs, and must be deployed rapidly to achieve climate commitments in this decade. Incentive public policy mechanisms and regulations, amongst others, without (or with low) implementation costs will also increase renewables penetration into the system. Certainty must be increased and investments in polluting sectors unincentivized. It is also necessary to invest in the development and research for new technologies with great potential like hydrogen, batteries and net flexibilization.

The implementation of an ambitious roadmap for renewable energies in Mexico by 2030 (IRENA) will bring about the opportunity for the reduction of the total carbon demand by 62%, natural gas by 21% and oil by 6% with reference to current demand.

It is crucial to develop a planning process for the energy transition at a national level, one that articulates the executive, the legislative and civil society. This process must determine the roadmap to transition in the most concrete manner, as well as the tasks and programs needed to achieve it. Given it is a planning process, it must be subject to periodical monitoring and evaluation to identify advancements and setbacks in the subject.

To build a just energy transition, active and strategic community participation in the territories where new energy projects are to be carried out is essential. Participation of state and municipal governments, communal, neighbourhood and popular counsels and assemblies, both in rural and urban contexts, is pivotal.

The current political class can imagine, design, and set the foundations to achieve a transformation of the predominant energy model that may contribute to tackle the climate emergency, through diversifying energy sources and democratizing local level decision making, so that women, men, indigenous people, rural and urban populations can take decisions regarding their own territories.

The predominant development paradigm, founded on a vision of illimited economic growth and promoted by a model of resource consumerism and wastefulness is unsustainable from an energy standpoint. The planet has finite limits and so a drastic reduction of energy, materials and product consumption is needed, giving way to a greater energy efficiency, sustainable mobility, material economy decreases and a critical, responsible, and just consumption.

BASED ON A JOINT EFFORT FROM DIVERSE PARLIAMENTARY GROUPS, THE SIGNERS OF THIS REPORT PLEDGE TO:

Create legal frameworks focused on developing a just energy transition and not increasing fossil fuel dependence.

Allocate the necessary resources on the Federation's Expenditure Budget in accordance with Paris Agreement.

Work on a periodic system of supervision and evaluation of the Executive's advancements in the issues related to energy transition and achievement of climate commitments.

Reform legal and regulatory frameworks to accelerate the de-fossilization of transport and the energy matrix as stated in this document.

Include the concept of justice in the discussions and projects related to energy transition and climate action.

DEPUTIES WHO SIGNED:

Dip. Mario Alberto
Rodríguez Carrillo

Dip. Alberto
Villa Villegas

Dip. Eduardo Enrique
Murat Hinojosa

Dip. Sayonara
Vargas Rodríguez

Dip. Javier
López Casarín

Dip. Braulio
López Ochoa Mijares

Dip. Marcelino
Castañeda Navarrete

Include the concept of justice in the discussions and projects related to energy transition and climate action.

01

CHALLENGES FOR MOBILITY DECARBONIZATION IN MEXICO

1. CURRENT MOBILITY SITUATION IN MEXICO

One of the most pressing challenges of our time presents itself in the crossroads between transport and climate change. Transport is not only a significant part of global carbon dioxide emissions (CO2) related to energy, but its contribution also grows at an accelerated pace, surpassing other sectors. This chapter explores the complex dynamic of this phenomenon, analysing key figures and tendencies that delineate the relationship between transport and climate change in Mexico. It is urgent to adopt significant changes in the transport sector to achieve the mitigation goals set on the Paris Agreement and thus lead Mexico to a future less dependent on fossil fuels. NDCs play a crucial role in this transformation.

Transport represents a considerable and ever-growing part of the carbon dioxide (CO2) and black carbon emissions, amongst others, related to energy globally. It makes up for around a fourth of these emissions and its contribution is increasing more than in any other sector, by 2.5 percent annually, -data for the 2020-2015 period (IEA 2017, taken from Fransen, 2019).

To meet the climate change mitigation goals transformational changes in the transport sector are therefore needed. In 2019, direct emissions of Greenhouse Effect Gases (GHG) from the transport sector reached 8.7 GtCO2-eq globally (compared with 5.0 GtCO2-eq in 1990) and made up 23% of global emissions of CO2 related to energy. 70% of direct emissions from transport came from ground vehicles whilst 1%, 11% and 12% came from train rails, maritime transport, and aviation respectively. Transport emissions in developing regions of the world are increasing more rapidly than in Europe or North America, a tendency that will likely continue the coming decades (Jaramillo et al 2022: 1052).

Mexico's Climate Initiative (ICM, 2022: 344, 375-376), has pointed out that motorized transport is one of the main emitters of GHG in Mexico. In 2019, it was the second main emitter nationwide second to the energy industry, with a total of 148 MtCO2e, 20% of the country's total emissions. This emissions volume is directly related to the high level of fossil fuel consumption and represents a great mitigation potential. Road transport is the main emitter with a 92.2% of the sector's emissions, followed by aviation, maritime transport and finally railroads. Between 2010 and 2019, a reduction in GHG emissions in the transport sector has been observed: whilst in 2010 164 MtCO2 were produced, in 2019 it reached 148 MtCO2, that is, a 10% less. The evolution of the sector's emissions has not had a lineal behaviour; from 2013 to 2016 emissions increased at a positive average annual growth rate but in the last few years it has had an oscillatory behaviour.

With regards to energy consumption, calculations from Mexico's Climate Initiative (ICM, 2022) show that the transport sector will consume 3,304 PJ in 2030, having grown at an average annual growth rate of 7.84% during the 2020 decade. Electric vehicles' power consumption will be 4,486 GWh by 2030, with an exponential growth during the projected decade. This is due, in part, to the ascending penetration of electric vehicles and to the fact that electric power consumed by public transport does not vary significantly during that period. Growth of electric vehicular park was adjusted pursuant to PRODESEN 2022 – 2026 and to the National Strategy of Electrical Mobility (NEEM), where authors calculated the inclusion of around 800 thousand electric vehicles by 2030 (Octaviano, 2022 taken from ICM, 2022).

ICM (2022) calculated GHG emission projection from 2020 to 2030 and got it from the product of transport demand by the specific energy consumption and the evaluated fuel's GHG emissions factor. These emissions were calculated with a reference or inventory base year, which was set in 2013 due to the amount of information available for that year. The projected emissions results show that, by 2030, the transport sector will emit 248.9 MtCO2e, at an average growth rate of 8.1% during the period remaining of the 2020 decade. This result includes the decrease in demand caused by Covid-19 health pandemic.

Improvement in mobility is therefore the way to reach the goals set on nationwide to comply with the Paris Agreement. NDCs can help adjust the road. However, although most world countries mention transport in their NDCs, only some of them take advantage of the full array of available solutions and less than a fifth include specific quantitative goals regarding transport. (Fransen, 2019).

2. PROPOSALS FOR A SUSTAINABLE MOBILITY

To meet the Paris Agreement, it is necessary to cut down emissions form this sector at a global scale by half. This reduction will not be possible relying solely on the technological transformation of different transport methods. Most of the fleet will continue to use fossil fuels during many of the years to come. While the technological transformation is over, measures to reduce the number of motor vehicle rides must therefore be undertaken.

The hierarchy for managing transport demand to reduce emissions begins by AVOIDING the need for transport, then SHIFTING the ride distribution to reduce automobile rides and privilege non-motorized mobility and public transport and, as a last resort, IMPROVING the efficiency of conventional vehicular technologies, fuels, and existing road infrastructure to reduce emissions. This hierarchy not only reduces Greenhouse Effect Gases but also road congestion, noise levels, ride timing, road accidents and emission of other pollutants, the impact of which have been widely documented on mortality and morbidity.

a) Public transport

According to the Climate Leadership Group C40 (C40, 2022), the proportion of public transport rides in world cities must be doubled to keep the trajectory of 1.5°C. The cultural change calls for the improvement of urban design and planning, but also for a diverse public transport supply that speaks to the needs of different urban areas, better transport units (less polluting, safer, more comfortable and inclusive), better infrastructure (safe, lit, accessible, well placed, comfortable and inclusive stations), better planned routes designed in accordance with people´s demands and at a low cost; all of this is needed to reduce the barriers to switch from private to public transport. ICM (2022) therefore suggests two main mitigation measures for the sector: a) Optimizing public transport routes in metropolitan areas, b) Modernizing public transport routes in metropolitan areas.

Optimizing public transport routes in metropolitan areas

This measure suggests optimizing public transport routes for metropolitan areas aiming at:

- Attracting those who use private vehicles to public transport by means of a faster, efficient, clean, trustworthy, comfortable, and safe service for all.
- Optimizing service efficiency, reducing ride and transfer timing, and increasing schedule trustworthiness through public transport route operation and infrastructure.
- Promote, through the characteristics set above, the permanence of people in public transport so they don't change to particular vehicles if they increase their income.
- Reduce pedestrian and cyclist exposure to risks of injuries or death caused by accidents with private vehicles.
- Guarantee the right to mobility with road safety..

For the unconditioned scenario, this measure is proposed to start on 2024 and reach 2040, with the consequent removal of 15.5% of the public transport fleet due to the optimization of its routes. Given that there are 74 metropolitan areas in the country, it is suggested that 4 or 5 areas are integrated yearly to the program, so that by 2040

they have all adopted improvements in their public transport system. This would allow to have by 2030 a mitigation of 1.58 $MtCO_2e$ and to have avoided the emission of 6.30 $MtCO_2e$ (ICM, 2022).

Modernization of public transport routes in metropolitan areas

Reduction in private vehicle use is also linked to the improvement of public transport quality and the promotion of non-motorized modes of transport. This measure seeks for the integrated design of public transport, that is, creating specialized stations that can be shared between different public transport categories, giving way to a net of intermodal and efficient urban transport. For the non-conditioned scenario, the proposal is to have at least one BTR route of 7 lineal kms with around 26 fast transit buses in each of the 74 metropolitan areas. This means that around 9 to 10 cities incorporate this technology in their public transport fleet annually. This would mitigate 1.9 $MtCO_2e$ by 2030, the equivalent of reducing 8.3 $MtCO_2e$ during this decade, taking into consideration the technological and cultural change enacted on people using their private vehicle prior to public transport improvements. (ICM, 2022).

At the same time and in a complementary manner, local authorities can enact regulations to limit the circulation of combustion vehicles, for example, restricting circulation in Low Emitting Areas, reduce speed, establish caps to parking lots and park meters, remove fuel subsidies, enact congestion tariffs, non-motorized/electric last mile transport (for goods delivery) that are barriers for combustion vehicles. The cultural change not only contributes to the reduction of pollution and improving people´s health, but it also means the creation of thousands of jobs required for the transport system´s operation and maintenance.

b) Vehicular efficiency standards and regulations

According to the International Counsel for Clean Transport (ICCT, 2022:1-2), the Mexican government, through the Secretaries of Environment and Natural Resources, Energy and Economy, published in September 2018 a draft to modify the regulation regarding fuel performance for light vehicles NOM-163-SEMARNAT-ENER-SCFI- 2013 (NOM 163). The term proposed was from 2017 to 2025 and the following potential results were considered:

- 53 % increase in the performance of light vehicle fleet by 2025
- 27.5 million accumulated tons of carbon bioxide ($MtCO_2e$) reduced in the 2027-2025 period, in contrast to 2016 levels.
- 18.5 $MtCO_2e$ emission reduction by 2030. Equivalent to 9 % of the NDC Greenhouse Effect Gases (GHG) reduction goal NDC, published in 2017.
- 1277 million gasoline barrels saved in the 2017-2037 period, translated into 477 million tons of CO_2e emissions avoided.

Without considering the application of credits provided for in the same regulation, light vehicles commercialised by corporates must reach an average fuel consumption performance of 23.7 km/l by 2025, starting at the 15.5 km/l level reached in 2016. Some of the flexibilities included in the regulation aimed at facilitating its adoption, however, reduce its mandate regarding annual caps, which will impair its effectiveness for up to 30 % of the total GHG emission reduction estimated for 2030. (ICCT, 2022).

Vehicular efficiency regulation NOM 163 has a mitigation potential of 19.5 million tons of equivalent CO2 per year by 2030. To have a more efficient fleet and to reduce its emissions it is essential to update NOM-163 because, since 2013 the vehicular efficiency standard stagnated, while other countries have witnessed an accelerated advance. A good regulation of GHG emissions and light vehicle fuel performance (NOM-163) is one of the most cost-effective instruments for the reduction of emissions, in addition to advancing the country's energy security helping reduce the demand for imported gasolines.
ICM (2022) pointed out that the starting date for this regulation should be 2023, which means that by 2030 the average light vehicle fuel performance would be of 27.96 km/litre for private vehicles and 19.69 km/litre for light vans. Therefore, by 2030, 31.7% of light vehicles in circulation would comply

with updated NOM limits with a corresponding 12.85% reduction in fuel consumption. This measure would support a reduction of 19.5 $MtCO_2e$ by 2030 (ICM, 2022).

The drafted regulation presented in June 2023 by the Economic Secretary and SEMARNAT has too many flexibilities and compensations for industry that only happen in Mexico, like hybrid and electric technology credits which are 5 and 13 times higher than other similar international regulations. Given this situation, the emission reduction potential of NOM-163 is only half. If enacted as it stands, there would be a setback in the climate ambition.

c) Electromobility

In the field of technologies and public policies aimed at promoting a transition to emission free mobility the subject of electromobility has recently taken relevance. According to Jaramillo et al. (2022:1120), electric vehicles (EV) play a key role by using low carbon electricity and are a very effective mechanism for significantly reducing GHG emissions of the main sources of pollution in the transport sector: cars, motorcycles, moto taxis, buses and trucks.

EV mitigation potential depends on the decarbonization of the electric system. EVs may be charged with renewable energy at homes and companies before or parallel to the transition to a low carbon content grid. Electromobility is advancing fast in micro mobility (e-moto taxis, e-scooters, e-bicycles) and in public transport systems, particularly in buses. The adoption of EVs is also accelerating in the case of private cars. EVs can be used to stabilize the electric grid through intelligent charging applications. Last generation lithium ionic batteries (Li-Ion) available since 2020 are superior to alternative cell technologies in terms of battery lifecycle, energy density, specific energy, and costs. Improvements in Li-Ion batteries suggest that these chemical elements will continue to be superior to alternative battery technologies in the mid-term, and Li-Ion batteries will thus keep dominating the electric vehicle market. (Jaramillo et al 2022:1120).

From the standpoint of resource availability and costs, Li-Ion battery dependency on metals will continue to be a concern. Nonetheless, the demand for these metals is inferior to available reserves, with many new mines starting operation in response to the new market, particularly in diverse places of the world. Batter recycling will, in the long term, significantly reduce the demand for these minerals. Standardization of battery modules and packing within and between vehicular platforms, and a greater focus on design for recyclability are important. Many mobility manufacturers and governments are considering battery recycling to ensure main current integration. Having opportunities for electrical recharge is one of the most significant enabling conditions for electromobility (Jaramillo et al 2022:1120).

EVs in Mexico are already a real zero-emissions transport alternative. ICM (2022) calculated the potentially mitigated CO2e equivalent tons (unconditioned scenario) through the introduction of battery electric vehicles as hybrid pluggable vehicles: 118 MtCO2e by 2030 and an accumulated 46.9 MtCO2e during this decade. Regarding electromo-

bility power consumption under the unconditioned scenario, it is estimated that by 2023 electric vehicles will be responsible for consuming 12,745 GWh, 2.84 times higher than provided for by the trend scenario; it is therefore important to create public policies and regulations related to best practices regarding vehicle charging timing, so as not to impact the National Electric System's demand and capacity. Under the conditioned scenario, it is estimated that, by 2030, electric vehicles will be responsible for the consumption of 20,218 GWh, 4.5 times higher than in the trend scenario estimates and 58% more than provided for by the unconditioned scenario.

The adoption of battery electric vehicles must be paired with prioritizing and massifying public transport and non-motorized mobility over private passenger vehicles. It is also important to note that if electric vehicle recharges are not sourced by renewable energies, they will not achieve their full mitigation potential. Strengthening the country's enabling conditions for electromobility is also important, such as steadily increasing existing charging infrastructure, adjusting the charging system, electric vehicles, and battery's legal framework. Also, the creation of incentives for manufacturing companies as well as for final users is needed, strengthening an electromobility value chain. (ICM, 2022)

d) Active and non-motorized mobility

Promotion of active and non-motorized mobility has many benefits such as air pollution reduction, traffic reduction, improvement in people's physical and mental health and the reduction of transport costs. Making streets friendlier to pedestrians and cyclists also encourages social interaction and community building in urban areas, promotes local community identity and creates opportunities for aesthetic and architectural appreciation.

Walking and riding bicycles are the cleanest ways to move around a city. In addition to the emission reduction and air quality improvement, both mobility options provide co-benefits for health, road safety and equality and less road congestion. Many cities are investing in infrastructure to diversify its transport options and promoting their use, safety, and social-spatial appropriation. Some examples of active and non-motorized mobility include:

1. Walking: Moving around on foot is one of the simplest and most effective forms of active mobility. It is an option accessible to most people and may be used for short rides, like going to the shop, work, or school.
2. Riding a bicycle: Riding a bicycle is another environmentally friendly form of active mobility. Bicycles are a versatile option for mid-distance rides and offer health benefits, as well as reducing traffic congestion and GHG emissions.
3. Skating: Line skaters or skateboards are also a form of active mobility. Although they might be less common than walking or riding a bicycle, they are a fun and efficient option for some rides.
4. Scooters and electric skateboards: Although scooters and electric skateboards have motors, they are considered part of active and non-motorized mobility when used in shared or personal mode, as they require the user to take an active part in its operation.
5. Pedestrian mobility: Urban planning that prioritizes pedestrians contribute to the creation of safer and nicer spaces for walking. This includes spacious and reliable sidewalks, safe pedestrian crossings and pedestrian streets and areas.

Estimates of the ICM (2022) determined that if bicycle use is promoted through the improvement of cycling infrastructure, its use could rise to 5%, with a consequent saving of 4.06% kilometres travelled and a 5.72 MtCO2e mitigation with a total 23.19 MtCO2e reduction between 2020-2030. The annual marginal abatement cost by 2030 through the development of active and non-motorized mobility infrastructure is -207.26 USD/tCO2e, while the life-long abatement marginal cost is - 272.37 USD/tCO2e., by far the most cost effective of all mitigation measures analysed by ICM.

To make active and non-motorized mobility an attractive alternative for different population sectors, favourable connectivity, safety, convenience, culture and comfort conditions for cyclists and pedestrian must be ensured.

This means the adaptation of streets and infrastructure to widen benches, build bicycle lane or plant trees. It can nonetheless be a political and social challenge due to opposition of groups that could be negatively impacted.

Local authorities must therefore design strategies not only to build required infrastructure, but also to promote a collective and individual behavioural change and a pedestrian and cyclist favourable culture. They must be intertwined with measures aimed at managing vehicular demand and disincentivizing excessive vehicle use as in the case of low emission areas, congestion tariffs, management of parking lots, etc. A close coordination between federal and local mobility policy must also exist, to properly articulate project financial resources and urban planning investment. Cities like Bogota, Copenhagen, Montreal, Seville, and Barcelona demonstrate that the transition can be fast and profound. Mexico City has expanded its bicycle lane net and increased its use. According to data from Mexico City's government, by February 2022 the current administration had built 200 km of bicycle lane and hope to reach 400 kms by 2024[1]

e) Urban planning for mobility

Mexican cities in general have been conceived around the idea of streets for private combustion engine vehicle use. In the path to decarbonization of transport, urban design could have an impact in mid- and long-term land use destination to promote active, non-motorized and electromobility. In the last decades, however, urban planning has been restricted to regulation of land use in the peri urban interface, building gated communities for a high earning sector, increasing distances between households, working and leisure centres. Urban planning thus faces the difficult challenge of having to intervene an already consolidated city, transforming public spaces into areas and corridors that enable connectivity, reduce distances and displacement costs.

According to Leo, Morillón, & Silva (2017: 300) planning plays a key role in mobility urban policies. Improving mobility policies means offering incentives for promoting efficient use of existing transport methods. To get there, strategies aimed at changing travel behaviours and prioritizing other transport methods above privately owned vehicles such as walking, bicycle riding, electric public transport, home-office, shared use of vehicles, amongst others must be implemented. That said, adequate urban planning will allow people to live and carry out their activities without the need of long rides, or if needed, making them safely, fast, and comfortable in public transport and other cleaner transport means. This condition enables a systematic independence of fossil fuels.

Transport decarbonization means a shift from the urban paradigm based on private vehicles and a transition to zero-emission transport modes. It is widely accepted that local Mexican authorities face the challenge to transform cities into healthier, safer, inclusive environments that enable the free flow of people and goods, promoting social cohesion and decarbonization of transport means.

The full alignment between the description offered in this chapter and Mexico's reality is yet to be verified as well as the possibilities for its adoption of a city vision that enables mobility decarbonization as socio-economic and political barriers to the implementation of the measures described remain.

[1] https://gobierno.cdmx.gob.mx/noticias/ciclovias/ consultado el 10/10/2023.

02

DECARBONIZATION OF THE ELECTRICAL MATRIX THROUGH RENEWABLE ENERGY SOURCES

1. 1. INTERNATIONAL CONTEXT

The success of the energy transition depends on a transformation of the global energy sector; this means going from energy sources based on fossil fuels to zero carbon emitting sources by 2050. This would contribute to limiting the increase of global temperature between 1.5-2°C, over pre-industrial levels.

According to the World Economic Forum, the electric power sector is the largest source of GHG, which increased in 1.3% in 2022, reaching its maximum peak (WEC, 2023). The International Energy Agency' roadmap (IEA, 2023) indicates that developed countries should achieve neutrality in the electricity sector by 2035, while developing countries should do so by 2040. Furthermore, they foresee that the electric sector shall be the first to achieve carbon neutrality, which is important due to the tendency to electrification in other electricity sector such as transport and industrial processes.

To achieve the Paris Agreement's objectives, USD $5.7 billion must be invested annually until 2030. Most of the capital for investment shall come from the private sector. However, a public contribution is needed to catalyze private financing, and, above all, to create a favorable environment (public policies, regulatory framework, incentives, among others) for a transition resulting in optimal socio-economic benefits, including employment associated with the transition and gross national product.

In June 2021, the G7 leaders agreed to reach "carbon neutrality by 2050 at the latest". Furthermore, in April 2021, the United States established the objective of creating "a carbon contamination-free electric sector by 2035".

[2] https://www.weforum.org/agenda/2023/04/decarbonization-of-the-power-sector-is-underway-power- sector-emissions-may-have-peaked-in-2022-as-wind-and-solar-reached-record-heights/

2. CURRENT ELECTRICAL MATRIX SITUATION[3]

Mexico has the unconditioned goal of reducing 35% of its emissions by 2030 (larger than the 22% which was previously established in the 2020 NDCs' first version). Also, if international financing, innovation, and technological transference increase, the conditioned goal is to reduce 40% emissions by 2030. Unlike other countries, Mexico does not have a net zero scenario, only an emission reduction goal of 50% by 2050 (SEMARNAT, 2022).

In 2020, México emitted 609.07 million tons of CO2e, representing 1.35% of global emissions. The energy sector emitted, between 2000 and 2019, 71% of the total national emissions (INECC 2019b). The electric sector is the second largest emitter of GHG after transport, according to the 2019 National Inventory of Greenhouse Effect Gases and Composites: 23.3% (171 MtCO2e). The goals associated to the sector are:

- The Climate Change General Law establishes the reduction goal at 31%.
- The Energy Transition Law establishes the minimal participation of clean sources in electric power at 25% for 2018, 30% for 2021, 35% for 2024, 38.2% for 2030, and 50% for 2050%.

In Mexico, 69% of locally generated electric power comes from conventional energy sources (fossil fuels), and combined cycle is the dominant technology (Prodesen 2023-2037).

Tabla 1. Capacidad instalada interconectada de la CFE y permisionarios (MW)[4]

TECHNOLOGY	2019	2020	2021	2022
Hydroelectric	12.612	12.612	12.614	12.612
Geo-thermoelectric	899	951	976	976
Wind-electric	6.050	6.504	6.977	6.92
Photovoltaic	3.646	5.149	5.955	6.535
Bioenergy	375	378	378	408
Renewable clean sum	**23.582**	**25.594**	**26.899**	**27.453**
Nuclear-electric	1.608	1.608	1.608	1.608
Efficient Cogeneration	1.720	2.305	2.305	2.308
Non-renewable clean sum	**3.318**	**3.913**	**3.913**	**3.916**
Total capacity clean electric energy	**26.900**	**29.506**	**30.812**	**31.369**
Percentage	**34.3**	**35.5**	**35.8**	**36.0**
Combined Cycle	30.402	31.948	33.640	34.413
Conventional Thermal	11.831	11.809	11.793	11.343
Turbo gas	2.960	3.545	3.744	3.815
Internal combustion	891	850	701	728
Carbon-electric	5.463	5.463	5.463	5.463
TOTAL	78.447	83.121	86.153	87.130

Fuente:
SENER (2023)

[3] Matriz eléctrica incluye la capacidad instalada y generación por tipo de combustible o fuente energética

[4] Power plants being tested are not included.

In 2022, additions in combined cycle capacity power plants were the most frequently installed (772 MW). In second place came the photovoltaic solar power plants (580 MW). On the other hand, power plants that are being tested for operation on December 31st, 2022, are mainly clean renewable energy 1,811 MW (photovoltaic and wind), while the combined cycle power plants are 883 MW. (SENER, 2023).

3. PROPOSED STRUCTURING OF THE ENERGY MATRIX (2030 AND 2050 SCENARIOS)

INTERNATIONAL VISION

The International Energy Agency (IEA, 2023) predicts a total energy capacity increase of 50% based on renewable sources will occur in the world between 2019 and 2024. The IEA survey Zero Net Emissions by 2050 (2023) concludes that, at a global level, approximately USD $4 trillion in clean energies, that would create millions of jobs and economic growth, should be invested. On this subject, the following measures were identified and ought to be considered:

- By 2030, it is necessary to invest in commercially available technologies. However, by 2050, investments shall focus on technologies that are presently in demonstration phases or prototypes.
- In 2025, 50% of electric power should come from low emissions power plants, and boilers would not be sold.
- In 2030, 60% of cars should be electric.
- In 2035, advanced economies with net zero emissions in the electric sector.
- In 2040, electric power shall provide 40% of industrial needs (electrification).
- In 2045, no internal combustion truck is sold, and 50% of heating demand shall be provided by heat pumps (electrification).
- In 2050, 90% of electric power comes from renewable energies, and there will be more than 3.670 electrolyzers (hydrogen).

The International Renewable Energy Agency (IRENA) has established a mitigation route to contribute to achieving the Paris Agreement goal of 1.5°C, that includes measures and their mitigation potential:

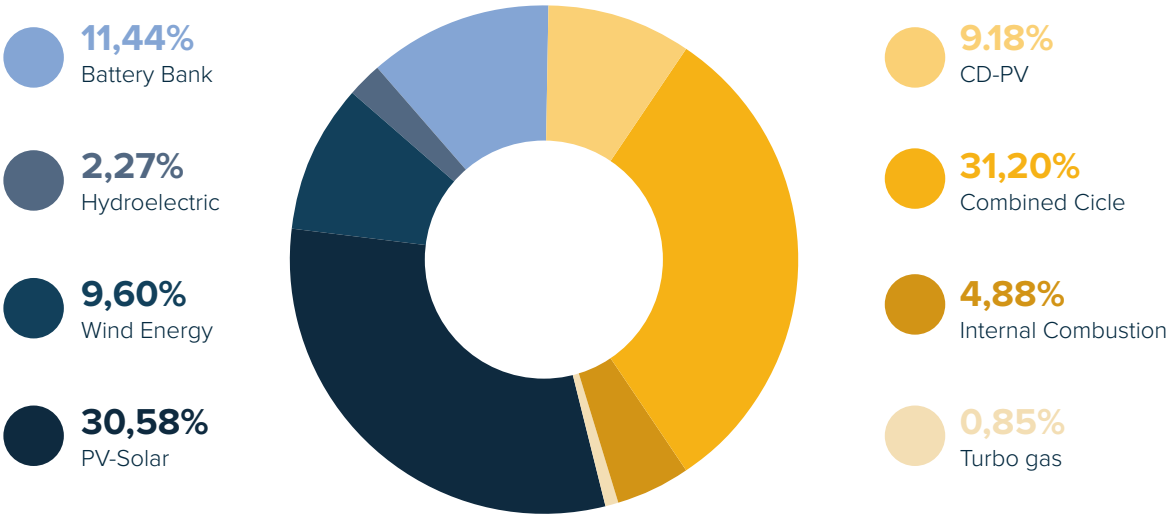
- Renewable energies: mitigates 25%
- Energy efficiency (producing the same with less energy): mitigates 25%
- Electrification (conversion of thermal processes in electric processes): mitigates 20%
- Hydrogen: 10%

From both analysis we may conclude that solar and wind renewable energies, the electrification of transport and industry, and new technologies, mainly hydrogen and electric power storing with batteries, play an important role in achieving carbon neutrality in the electric sector by 2050. The capture and storage of carbon shall play a major role.

NATIONAL VISION

The Secretary of Energy, in the National Electric System Development Program (PRODESEN) 2023 - 2037 indicates that the size of the system would grow 1.7 times, reaching almost 160 GW in 2037 from a base of 92 GW in 2022. PRODESEN projects it is necessary to install 20,248 net MW in new power plants between 2023 and 2026 incorporating power plants' distributed generation, abatement, conversion, and substitution. The type of additional power plants is dominated by those of combined cycles (31.20%) and, in second place, solar photovoltaic (30.58%).

Figura 1: Capacidad adicional por tecnología del 2023 a 2026



Source: SENER-PRODESEN (2023)

During this period, 8.858 MW were established as strategic electric processes, Combined Cycle (6.328 MW) and Internal Combustion (993 MW) power plants being selected for this purpose. This aims at the electric industry's development and efficient operation, ensuring reliability, strengthening the productivity of State companies in the energy sector, and continuing with the integration of "intermittent" renewable energy. For the period 2027-2037, the capacity due to be integrated is 46.138 MW, including distributed generation (6.480 MW). In this period, new additions will be dominated by large scale photovoltaic (37.06%), distributed solar generation in second place (14.04%), battery bank power plants in third place (13.92%); and finally combined cycles (13.27%).

Participation of clean energies in 2037 is projected to be 54.6% (It was 36.9% in 2022) including renewable, clean (nuclear and large hydroelectric), batteries, green hydrogen in combined cycle power plants (CCP), integration of distributed solar generation. It also comprises the conversion of CCP 1.024 MW by a mix of 70% natural gas and 30% hydrogen between 2033 and 2036, as well as the addition of 150 MW nuclear energy.

4. PROPOSED ENERGY ALTERNATIVES

There are different perspectives on how to achieve NDCs' decarbonization goal. The Sixth National Communication suggests to: i) increase clean energy participation and integration in energy generation; in fact, it seeks to add 40 GW of clean energies, ii) substitute high carbon content fuels for natural gas in high efficiency power plants, and iii) reduce technical energy losses in transmission and distribution networks. (INECC, SEMARNAT, 2018) Modernization of 40% of CFE hydroelectric plants (repowering, change of turbines and desilting) and building of 4 new hydroelectric power plants, increased participation of photovoltaic energy (at small and large scale), wind and geothermic, as well as green hydrogen are also specifically mentioned.

In 2018, the INECC estimated the costs and benefits of implementing mitigation measures and identified three key actions to be undertaken: i) integration of clean energies for electric power (hydroelectric, solar, geothermic wind, and efficient cogeneration), ii) reduce losses in distribution lines, and iii) substitute fuel oil by natural gas in electric generation. The most cost-effective measure in the electric sector is the substitution of fuel oil by natural gas, with a negative cost of implementation (-78 USD/tCO2e), followed by the implementation of renewable energies (-5.8 USD/tCO2e) with a great abating potential of GHG both in the electric and the transport sectors through their electrification (INECC, 2018).

WRI- México (2019) identified a combination of 21 public policy strategies (directives, measures, and technologies) to attain NDC conditions at a low average cost (12 USD/tCO2e). Among the measures identified for the electric sector, the following are emphasized: i) increase the electric sector's capacity and efficiency (transmission and distribution), ii) increase energy efficiency in commercial and residential buildings, iii) industry energy efficiency standards, iv) renewable energies portfolio standards, v) distributed solar generation, vi) early abatement of electric power plants: carbo-electric, among others.

On the other hand, ICM (2022) suggested nine measures to achieve the unconditioned goals: i) limiting the installation of new fossil fuel based power plants, ii) promoting penetration of CO2 capture and storage (CCS) technologies, iii) creating and supervising programs aimed at incentivizing compliance with code red, iv) planned and just abatement of outdated thermal plants, v) decentralizing or diversifying generation centers, vi) investments in the National Transmission Network (NTN) aimed at reducing transmission losses, vii) increase transmission capacity by incorporating new strategic links, viii) mechanisms for fostering the installation of large-scale clean capacity: solar, wind, hydroelectric, geothermic, and nuclear, ix) mechanisms for fostering the installation of distributed generation clean capacity, x) energy efficiency: agroindustry, motors, refrigeration and industry. ICM abatement costs are ranged between -112.3 USD/tCO2e and 257.8 USD/tCO2e.

According to Mexico's Climate Initiative team's most recent calculations, achieving the government's goals requires an estimated annual investment of approximately USD $ 56billon by 2030 and US$1.4 trillion by 2060. This entails an unprecedented resource mobilization, where the public and private sectors, as well as international cooperation shall play a key role in financing the transition and especially in the electrical sector's transformation.

To conclude, electrical system decarbonization may be achieved with cost-effective options, even with negative costs through available and tested technology. Although official documents include gas as a transition fuel, national and international think tanks do not. This point is crucial for understanding the role this fuel plays in decarbonization plans.

5. PROPOSED RESTRUCTURE OF THE NATIONAL ENERGY SYSTEM (AIMED AT DECARBONIZING THE ELECTRICAL MATRIX IN TERMS OF PUBLIC POLICY AND INSTITUTIONS, INCLUDING PLANNING CHALLENGES)

IEA presented a series of proposals to attain a cero carbon scenario (Net Zero):

- Banning sales of new combustion engine cars by 2035
- Electrical power must attain carbon neutrality by 2040, electrical systems must increase their flexibility: batteries (electric power storage), demand control, hydrogen, hydroelectric plants, carbon capture and storage, among other measures
- By 2050, energy is 90% renewable, dominated by solar photovoltaic and wind energy (70%). The coordination among industry, academy, and government is imperative. Also, cooperation among countries is necessary, mainly for developing economies.

In Mexico's NDC, the legislative branch was set to promote generation activities with photovoltaic, wind, and geothermic power plants, as well as fostering renewable distributed generation and new technologies for electric power generation, such as green hydrogen in hybrid power plants.

NAMA MIPYME was also to promote activities in micro-, small- and medium industries, a sector of great relevance for the national economy, through support for cost-effective measures, mainly related to energy efficiency. Resources and incentives must therefore be allocated from the legislative branch for these measures to be adopted.

Finally, resources and incentives required for promoting clean energy and universal access to energy are also to be allocated from the legislative branch, for instance, through rural electrification projects and solar household pilots.

At the Open Parliamentary Forum Mexico towards a fossil fuel free future, some requirements that must be satisfied to achieve the energy transition in the electric matrix were identified as following:

- Ensure operation conditions
- Must be sustainable
- More efficiency at a minimal cost
- Open: consider the different energy market stakeholders
- The role of State institutions: PEMEX and CFE must promote change and become a development agent with improved corporate governance (increase economic benefits without sacrificing social benefits)
- The Finance Secretary must identify and allocate resources for clean energy projects
- Generate the necessary conditions for corporations with ESG criteria (environmental, social and governance) to undertake sustainability projects.

03

JUST AND INCLUSIVE ENERGY TRANSITION

1. CURRENT SITUATION

The national electric system's installed capacity is primarily controlled (69%)[5] by the Comisión Federal de Electricidad – CFE (Federal Electric-Power Commission), a State productive company, while the private sector controls 30%, and Pemex 1%. This capacity consists mainly of fossil fuel technologies, representing approximately 60%, while clean energy sources[6], represent the remaining 40% (SENER, 2023b).

Despite the need to move towards cleaner energy sources, the country has remained anchored to fossil fuels' exploitation and use. For years, oil extraction contributed to sustain the country's economy, however, oil production has declined. The maximum oil production peak in Mexico was surpassed in 2004, and the maximal gas production has peak since 2009. So far, 88% of available oil has been extracted, and its purchase process cost has exponentially increased. Since 2004, productivity per well has decreased in 67%, and extraction costs have quintupled. In 2000, for every million Mexican pesos annual investment, a production of 66 barrels of crude per day would be obtained, while today, with this same investment of one million Mexican pesos, only 4 barrels are produced daily.[7]

It should also be noted that fossil fuels are not only the biggest contributors to climate change but are finite resources. The country's renewable resources' vast potential, on the other hand, has a high technical usability for electrical power and heat production, particularly regarding wind and solar energies, which have tripled in the last five years (Gabbatiss, 2021). Renewable energy sources may contribute to reducing energy poverty, become a source of employment, and favor a more democratic energy model, where, through technologies such as distributed solar generation, nobody is left behind in accessing renewable energy.

The International Renewable Energy Agency (IRENA) indicates, in its renewable energy perspectives for Mexico by 2030, that it could generate with renewable sources up to 46% of its electric power, something that would entail a larger deployment of wind and solar photovoltaic energy, which could jointly represent 26% of electric production.

IRENA's report also indicates how the adoption of an ambitious renewable energies route in Mexico by 2030 would provide the opportunity for reducing 62% of total carbon demand, 21% of natural gas and 6% of oil demand. However, beyond IRENA's estimates, what should be promoted is not only a technological substitution based on the country's potential, but a transformation of present ways of energy production, consumption, and management.

[5] Includes a CFE-Independent Energy Producers.

[6] Including, by definition, renewable, large hydroelectric plants, nuclear and efficient cogeneration.

[7] From Luca Ferrari's presentation before the Cámara de Diputados for the forum: Mexico towards a fossil fuel free future, on September 13th, 2023.

The main purpose is to leave fossil fuels behind and move on to a model based on renewable energies, acknowledging stakeholders' power relationships and the existence of multiple inequalities and injustices in energy access and consumption between social sectors. The new system should aim at closing participation gaps between men and women, indigenous and non-indigenous people, even rural and urban environments. When the present energy system's power inequalities and asymmetries are not addressed, these are normalized and tend to reproduce. (Bertinat, Chemes y Florero, 2020). In the southern part of Mexico, some solar and wind renewable energy megaprojects have generated socio-environmental conflicts, due to their impact on local biodiversity and the infringement of local indigenous peoples' rights. [8]

Reconceptualizing the energy transition beyond technological substitution, as a transformation process including social and environmental variables is therefore pivotal.

[8] From Beatriz Olivera, Director of Engenera, A.C.'s presentation before the Cámara de Diputados for the forum: Mexico towards a fossil fuel free future, on September 13th, 2023.

2. THE SOCIAL AND ENVIRONMENTALLY JUST ENERGY TRANSITION

A deeper understanding of how energy transitions should be undertaken requires the incorporation of a comprehensive justice approach as a necessary premise of the transition process. This means questioning ¿To what end and for whom is energy to be generated? ¿Where will it be produced? ¿Shall it deepen or reduce power asymmetries between stakeholders involved?

Adding the justice dimension to the concept of energy transition entails a discussion on necessary social transformations; it requires a conscient rethinking and building of societies with sustainable, inclusive, and democratic economic, political, and social structures.

The concept of a just energy transition originated in the world of oil and coal workers, and initially demands guarantee for employment alternatives given the loss of jobs resulting from the end of these resources exploitation. (Monge and Olivera, 2022). However, the justice variable has a wider scope and also points to a comprehensive change towards "models that articulate social and environmental justice, towards economic and productive practices based on reciprocity, complementarity and care; towards a new covenant with nature that warrants the sustainability of a dignified life". (Svampa, 2022, p.3)

A just energy transition should bring about a shift in the energy paradigm, question power relationships between governments, corporations, consumers, and populations in the territories, and aim at overcoming people's energy poverty[9] In Mexico, 36.7% of Mexicans live in energy poverty conditions (García-Ochoa, 2016). This number is added to the almost 800 million who have no access to electrical power, and a third of the world's population (2.600 million), who have no access to clean fuels for cooking (Ogunbiyi, 2023).

[9] A household is in a situation of energy poverty when its inhabitants do not satisfy absolute energy needs, associated with a series of economic satisfactions and goods deemed essential, according to social and cultural conventions in a given place and time." Source: García-Ochoa, 2016.

The roadmap to a just energy transition should have human rights at its core. Energy projects that ignore or infringe peoples' and individuals' rights should no longer be designed. It is not possible either to abstain from adopting measures to face climate change. Therefore, when designing and implementing public policies and energy investment, production, distribution, and consumption agreements, the State must ensure, regulate, and oversee public and private corporations' compliance and due diligence regarding human rights standards. (Derechos humanos para una transición energética justa, 2022)

A just energy transition demands active and strategic participation from people in the territories where new energy projects are to be executed; participation from State and municipal governments, community councils, town, neighborhood, or popular assemblies, both rural and urban, is fundamental.

A national planning process is required for a just energy transition to occur. To this effect, the Federal Government should set forth, in the most specific way possible and in national planning instruments, such as the National Development Plan, The Energy Sector Program, and the National Electric System Development Program (PRODESEN), a roadmap toward a just energy transition, as well as the actions and programs needed to attain it. Since it is a planning process, it should be subject to a monitoring and evaluation process at least once a year, to identify its progress and setbacks.

Strategic and effective participation of people in the territories where projects are to be executed is relevant and necessary for a just energy transition. Populations, in their diversity, should undertake leadership roles and make decisions on energy generation, economic diversification, and on all policies and development routes that affect them, thus reaffirming respect for indigenous, rural, and urban populations' collective rights. It is the communities themselves that, through community assemblies, frequently discuss and make decisions regarding projects with potential impact over them. The federal government should, in any case, promote and ensure the best conditions (such as access to quality information or ethnic perspective) so that this participation is carried out equally between men and women and has cultural significance.

From this standpoint, the concept of a just energy transition is primarily dependent on the indigenous populations and people in general's right to define their own development, to their free determination, as well as to previous free and informed consent.

Women's organizations and movements[10] are also willing to wager on a just transition. Although women have a crucial role in household and community energy resources' management and use, they face challenges related to systemic discrimination, energy poverty and lack of representation in the energy sector. A just energy transition must place in its center the voices of women who have historically been excluded from decision making. (Monge and Olivera, 2022).

To journey towards a just energy transition, the energy system must be decolonized, and thus understand rural and indigenous territories where energy is often produced as wagers for life and not for capital.[11] Resistance from governments anchored in the past, that foster extractive policies based on hydrocarbons and whose energy future only leads to a climate catastrophe, must be overcome. Green capitalism which, disguised as various greenwashing practices, seeks to make energy renewables a new form of capital accumulation based on dispossession, benefiting only big energy corporations, and

[10] Women worldwide face the worst consequences from lack to modern energy. They spend more than 40% of family income on candles and kerosene, dangerous and inefficient forms of lighting. They walk long distances to gather wood. They light babies in the dark, they worry in smoke-filled kitchens and wonder in the night to use external latrines without proper lighting. Girls are left behind with no education opportunities due to lack of reliable light. (Source: Energía sostenible para todos: el empoderamiento de las mujeres. ONU)

[11] Marcela Torres Wong´s presentation in Cámara de Diputados en el foro: México hacia un futuro libre de combustibles fósiles, realizado el 13 de septiembre de 2023.

completely ignoring people's rights and environmental health, must be resisted. On the contrary, private capital can embrace other models and imagine other possibilities, investing in technologies that favour life and people's needs above industry needs". [12]

The current political class can imagine, design, and set the foundations to achieve a transformation of the predominant energy model that may contribute to tackle the climate emergency that threatens humanity, through diversifying energy sources and democratizing local level decision making, so that women, men, indigenous people, rural and urban populations can take decisions regarding their own territories.

12 Ibid.

3. CAPACITIES AND CHALLENGES IN SCIENCE AND TECHNOLOGIES FOR ACHIEVING A JUST ENERGY TRANSITION [13]

Mexico currently has Programas Nacionales Estratégicos – PRONACES (National Strategic Programs), prioritized by the Consejo Nacional de Humanidades, Ciencias y Tecnologías - Conahcyt (National Council for the Humanities, Science, and Technologies). These programs are a science policy tool aimed at fostering a new form of research designed to address important national problems and offer solutions. They are rigorously methodological, transdisciplinary programs, with an ethical perspective.

PRONACES were conceived as means to organize research efforts around specific national problems. Their purpose is to find out the causes of these problems and serve as scaffolds to generate solutions for them (Conahcyt, 2023). These programs are aligned with UN Sustainable Development Objectives and foster, through multi-actor work, the construction of a dialogue between different kinds of high-quality wisdoms, giving way for a substantive cooperation model between humanist and scientific communities, strengthening public and private sectors concerned with the common good. An addition tool is found in the National Information Ecosystems (ENI), data science's tools generated by Conahcyt, the National Energy, Environment, and Society Platform (PALNEAS) being an example thereof.

The Energy and Climate Change PRONACE seeks to foster a wide reflection and specific actions to attain a more sustainable and fairer energy system. There are currently 24 national projects carried out related to research and advocacy aligned with research in 20 federal states and 84 municipalities, 12 focus on climate change and 72 on energy issues.

[13] n this section, information from Alejandra Straffon, director of CONAHCYT Energy and Climate Change' presentation before the Cámara de Diputados for the forum: Mexico towards a fossil fuel free future, on September 13th, 2023.

The Energy and Climate Change PRONACE also seeks to consolidate a comprehensive world view by dividing the energy transition problematic into four axes:

1. Sustainable mobility
2. Efficient use of low-carbon energy for industry
3. Rural sustainable energy systems, and
4. Distributed, communal energy and energy democratization.

Regarding energy transition, this PRONACE promotes democratization in energy generation and the possibility of triggering local productive processes based on distributed generation of energy and the use of renewable sources. This program's Energy Committee seeks to foster holistic actions from the standpoint of energy's supply and demand, to establish a roadmap towards a sustainable and just energy transition (TEJS) for Mexico. The goal is to promote a dominant participation of renewable energies in the national energy matrix, and simultaneously, achieve an absolute reduction of energy consumption on the side of the demand (Conahcyt, 2023).

The challenges faced are associated, firstly, with the dissemination of science and technology so that knowledge on energy transition and its multiple technologies reaches rural and urban marginalized communities, may be understood by them, and combined with their own realities, may lead them to develop new knowledge and technologies. Other challenges are associated with the transfer of successful public policy local experiences that may be escalated to other contexts of the national reality. These challenges also entail nodal, systemic, and technological changes, as well as an efficient cooperation and the ability to secure financial resources for the acquisition of renewable technologies.

4. DEGROWTH AND CRITICAL, RESPONSIBLE, AND JUST CONSUMPTION.

A social and environmentally sustainable energy transition entails decreasing and limiting world consumption and achieving a distribution that places all countries in a situation of equal access to these resources. To address the climate problem a change of paradigm is needed, as well as an understanding that social justice cannot be separated conceptually from the energy transition. In México, while 10% of its richest population emits seven times more CO2 and consumes seven times more energy per capita than the rest of the population, 10 million people have no access to electric power[14].

It is clear, on the other hand, that unlimited economic growth and the prevailing consumption model are untenable, even if productive processes are based on renewable energies. The planet's limited natural resources and the joint exhaustion of fossils fuels, uranium, and metals that may occur during the XXI century require a dramatic reduction of energy, materials, and product consumption, which should entail a grater energy efficiency, sustainable

[14] Data from Luca Ferrari's presentation before the Cámara de Diputados for the forum: Mexico towards a fossil fuel free future, on September 13th, 2023.

mobility, decrease in the economy's material sector, and critical, responsible, and just consumption (Carvajal, 2023).

Degrowth suggests, as a response, that some sectors of the economy could be eliminated or limited (fossil fuel extraction, arms industry, car production, among others), and, in contrast, foster growth of those economic sectors oriented to the common good and the preservation of the environment (renewable energies, collective transport, among others). Additionally, there are also proposals for energy saving and efficiency.

Energy saving or energy efficiency consists in using energy in the best possible way, that is, obtaining the same results with less energy expenditure. This may be achieved through a change in consumers' habits, the use of more efficient technologies, or a combination of both; needless to say, saving energy is much cheaper than producing it. Some recommendations contributing to reducing energy consumption are the following:

14 Data from Luca Ferrari's presentation before the Cámara de Diputados for the forum: Mexico towards a fossil fuel free future, on September 13th, 2023.

- Desing energy systems that favor technological adaptation to local contexts. This entails developing regional economies that allow local production and consumption. 47% of the energy consumed in Mexico is used in the transport system.
- Prioritize agroecology to stop fossil fuel dependence in food production.
- Create policies to limit or eliminate product-designed obsolescence and give way to objects designed to last and be repaired.
- Modify regulations to promote the use of solar energy. Thermic use of solar energy shall reduce the need to burn gas for sanitary hot water.
- Promote solar photovoltaic energy through distributed, communal, and cooperative generation. Also, rates should vary according to social stratification and a limit to consumption should be established.
- Create policies and regulations related to construction that favor use of solar light and energy, as well as from public lighting.
- A collective reflection on the use of the Gross National Product (GNP) as an indicator of progress, while the idea of economic growth as the only solution for, or as a synonym of welfare should be left behind.

Consequently, public policy decisions taken regarding the energy transition, energy saving and efficiency, shall not be exclusively technological but social, so that they point to the implementation of a completely different socioeconomic model, "that is not based on the absurd idea of aspiring to unlimited growth in a finite planet" (Turiel, 2022).

REFERENCES

(2022). Derechos humanos para una transición energética justa. Informe de monitoreo con recomendaciones. https://redtdt.org.mx/wp-content/uploads/2021/11/211108_Informe-DH- transicion-energetica.pdf

Ardila-Gomez, Arturo, Bianca Bianchi Alves, and Joanna Moody. 2021. Decarbonizing cities by improving public transport and managing land use and traffic. Washington D.C.: The World Bank Group.

Bertinat, Pablo; Jorge Chemes y Lyda Fernanda Forero (2020): Transición energética: aportes para la reflexión colectiva, Taller Ecologista/ Transnational Institute (con el apoyo de Fundación Heinrich Boll Cono Sur), Argentina. https://tallerecologista.org.ar/wp-content/uploads/2020/11/TransicionEnergetica-Reporte-comp.pdf

C40 (2022) Climate Positive Development. London, New York &Rio de Janeiro. Carvajal, E. (2023). Transición energética y crecimiento o decrecimiento.

CONAHCYT (2023). ¿Qué son los Pronaces?

Fransen, T., et. al. 2019. "Enhancing NDCs: Opportunities for Transport." Working Paper. Washington, DC: World Resources Institute. Available online at www.wri.org/publication/enhancing-ndcs-transport.

Gabbatiss, J. (2021). Perfil Carbon Brief: México. https://www.carbonbrief.org/perfil-carbon-brief- mexico/

García-Ochoa, R y Graizbord, B. (2016). Caracterización espacial de la pobreza energética en México. Un análisis a escala subnacional. México, disponible en http://www.scielo.org.mx/pdf/est/ v16n51/2448-6183-est-16-51-00289.pdf

Hickman, R., Hall, P., & Banister, D. (2013). Planning more for sustainable mobility. Journal of Transport Geography, 33, 210–219. https://doi.org/10.1016/j.jtrangeo.2013.07.004

ICCT (2022) , Proyecto de modificación de la norma mexicana de rendimiento de combustible para vehículos ligeros - NOM-163-SEMARNAT-ENER-SCFI-2013 https://theicct.org/region/mexico/

ICM (2022) NDC desde la Sociedad Civil. Anexo técnico, México, 583 pp. https://iniciativaclimatica.org/ndc/

IEA (2023), Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach 2023 Update. xhttps://www.iea.org/reports/world-energy-outlook-2022/an-updated-roadmap-to-net-zero- emissions-by-2050

INECC. (2021). Estimación de costos y beneficios asociados a la implementación de acciones de mitigación para el cumplimiento de los objetivos de reducción de emisiones comprometidos en el Acuerdo de París. Instituto Nacional de Ecología y Cambio Climático (INECC), México. https://www.gob.mx/cms/uploads/attachment/file/756201/157_2021_Costo_Beneficio_Mitigacio n_Acuerdo_Paris.pdf

INECC & SEMARNAT (2018), Sexta Comunicación Nacional y Segunda Informe Bienal de Actualización ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático. https://cambioclimatico.gob.mx/sexta-comunicacion/introduccion.php

RENA (2015).A Renewable Energy Roadmap 2030. México. https://www.irena.org/media/Files/IRENA/Agency/Publication/2015/IRENA_REmap_Mexico_repo rt_2015.pdf

Jaramillo, P., S. Kahn Ribeiro, P. Newman, S. Dhar, O.E. Diemuodeke, T. Kajino, D.S. Lee, S.B. Nugroho, X. Ou, A. Hammer Strømman, J. Whitehead, 2022: Transport. In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade,

A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi,
A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.012.

Leo, A., Morillón, D., & Silva, R. (2017). Review and analysis of urban mobility strategies in Mexico.

Case Studies on Transport Policy, 5(2), 299–305. https://doi.org/10.1016/j.cstp.2016.11.008

Monge, C., Olivera, B. (2022). Documento base por una transformación energética justa en América Latina y el Caribe en el marco de una transformación equitativa y democrática del sistema energético. Documento sin publicar

Ogunbiyi, D. (2023). Acabar con la pobreza energética salva vidas y salva el planeta. Entrevista a Damilola Ogunbiyi. Naciones Unidas. https://www.un.org/es/climatechange/damilola-ogunbiyi-ending-energy-poverty

PRODESEN de SENER (2023), Programa de Desarrollo del Sistema Eléctrico Nacional 2023 - 2037. https://www.gob.mx/sener/articulos/programa-de-desarrollo-del-sistema-electrico-nacional- 2023-2037

SEMARNAT (2022), Contribución Determinada a nivel Nacional: actualización 2022 https://unfccc.int/sites/default/files/NDC/202211/Mexico_NDC_UNFCCC_update2022_FINAL.pdf

SENER (2023a). PRODESEN 2023-2037

SENER (2023b). Sistema de Información Energética. Sitio web. 2023. https://sie.energia.gob.mx/bdiController.do?action=cuadro&cvecua=DIPS_SE_C33_ESP

Svampa, M. (2022). Dilemas de la transición ecosocial desde América Latina. En: Documentos de trabajo nº especial (2). Madrid: Fundación Carolina; Oxfam Intermón. https://doi.org/10.33960/issn-e.1885-9119.DTFO02.

Turiel, A. (2022). La única solución a la crisis energética pasa por el decrecimiento de nuestro consumo de energía. Entrevista a Antonio Turiel realizada por Eva Carnero.

WRI (2019). Eligiendo el camino correcto: Opciones de bajo costo para fortalecer las metas climáticas de México logrando beneficios sociales a largo plazo. https://wrimexico.org/publication/eligiendo-el-camino-correcto

PARLIAMENTARIANS FOR
A FOSSIL-FREE FUTURE