Climate Transparency

ENERGY TRANSITION IN MEXICO:
THE SOCIAL DIMENSION OF ENERGY AND THE POLITICS OF CLIMATE CHANGE

POLICY PAPER

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EXECUTIVE SUMMARY

This policy paper provides an integral perspective on the challenges and opportunities of addressing climate change that the guarantee of a just energy transition will offer, emphasising on the necessary policies and instruments for enhancing synergies between climate and the energy governmental agendas, to close the gap between Mexico's national pledges and climate action. Nonetheless, the public debates in Mexico have not addressed energy transition issues under a social, environmental and political perspective. This paper therefore includes policy recommendations to both the climate change problem and those within the governance structure of the electricity sector, placing the social and environmental inequalities into the center of policy making with the aim to guarantee an adequate distribution of costs and benefits of the deployment of renewable energy technologies and projects in Mexico and accelerate climate action.

About this Policy Paper:

This paper identifies the drivers of the energy transition in Mexico and aims to understand how it has been framed, imagined and constructed. It seeks to broaden the scope of this discussion in Mexico by incorporating the socio-spatial dimensions of energy into the decision-making process. The paper has been produced as part of the efforts of Climate Transparency, an international partnership of 14 research organisations and NGOs comparing G20 climate actions, and is part of a series examining the social, economic and political dimensions of energy transitions in Argentina, Brazil and Mexico. Synthesis papers, along with those specifically focused on Argentina and Brazil, are available at

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INTRODUCTION

Mexico is in the process of transforming its energy sector. As new sources of technology become more cost-effective, legislation adopted since 2013 has allowed the energy sector to progressively address the transition from fossil fuels to other, cleaner sources of energy (SENER, 2013). However, Mexico faces two important challenges to decarbonise the energy sector.

1. The framing of the energy transition process into narrow configurations such as emission reduction, generation costs and co-benefits (such as job creation) has systematically overlooked the social dimension of the energy sector.
2. The adoption of a new narrative to increase energy security has led to a progressive legitimation of discourses and actors advocating for more fossil fuel extraction and use. This has reinforced a lack of consideration of the social and spatial dimensions as well as the negative implications of the energy transition process.

This paper identifies the drivers of the energy transition in Mexico and aims to understand how it has been framed, imagined and constructed. We seek to understand the challenges and opportunities the country needs in order to address climate change mitigation targets, while also tackling the transition process through a series of lenses incorporating social, environmental and economic justice, and adequate distribution of costs and benefits of such a shift. It also seeks to identify a socially inclusive outlook in terms of how the energy sector will take shape in the near future, by incorporating a broader set of imaginaries, designs and local politics into the future and understanding of the of the energy sector. These imaginaries are understood as collectively held beliefs that change and shape the outcomes and physical manifestations of energy systems. Using the Brown to Green Report (Climate Transparency, 2018) as a basis for its analysis, this document takes a deeper look at the energy transition process in Mexico and recognises that such processes are not neutral; in other words, switching from predominant technologies and energy resources to other social and technological configurations will inevitably lead to a reconfiguration of social and political structures and, in turn, winners and losers.

In 2018 Mexico underwent a national election, leading to an uncertainty surrounding the New Federal Administration's policies regarding environmental and energy that continues to this day. The fact this paper was revised and presented in April 2019 means that the views expressed within it should only be assessed the first months of the new administration's decisions, as they may be subject to sudden policy changes and uncertainty in the coming months.

The document is divided into the following sections:

1. The first section gives a broad overview of the origins of the energy transition in Mexico and the currently contested political state regarding the rapid participation of renewable energies over the last five years.
2. The second section addresses some of the key Brown to Green 2018 results for Mexico and compares them to Iniciativa Climática de México's (ICM's) in-house analysis of the decarbonisation of the electricity sector.
3. The third section considers some of the key challenges and opportunities for the electricity sector to address.
4. Finally, the paper concludes with a series of policy recommendations geared towards addressing the above issues.

1. DRIVING THE ENERGY TRANSITION IN MEXICO

Based on the energy reform on 2013, the drivers of the energy transition in Mexico have been threefold:

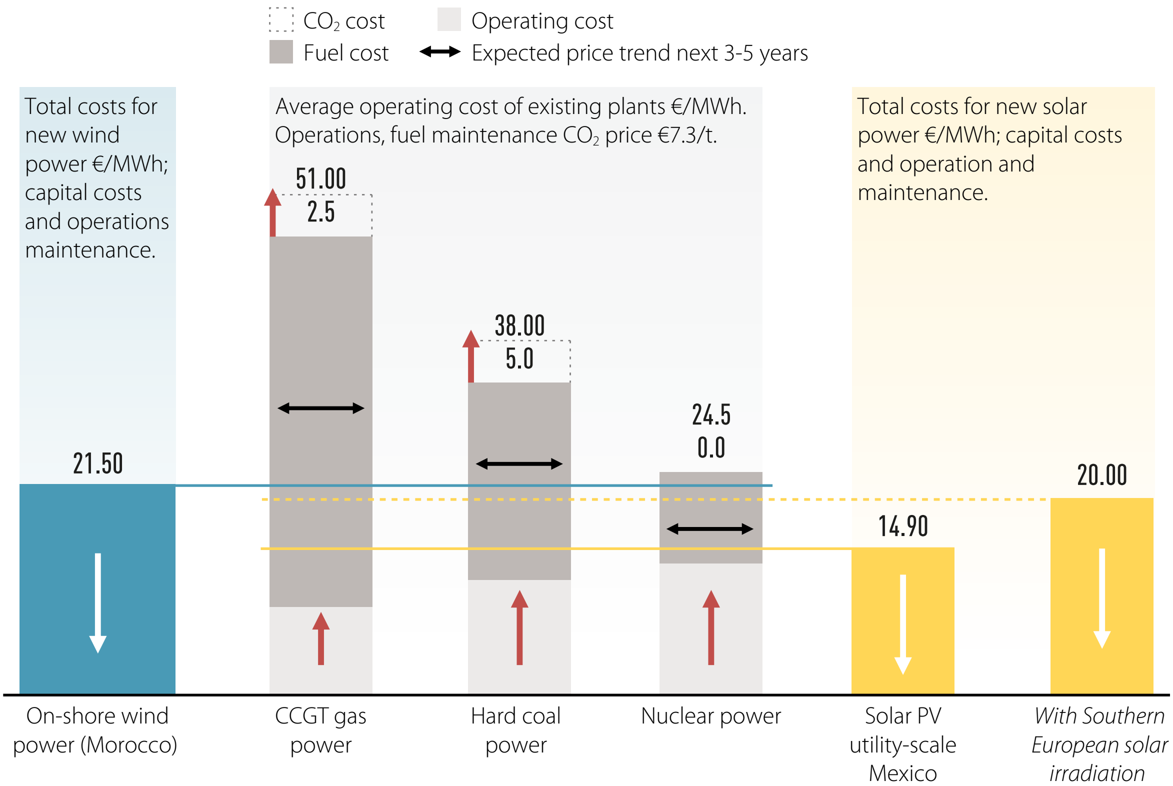
- **Climate change mitigation goals:** According to, Mexico's Nationally Determined Contribution (NDC) SEMARNAT (2015), between 13 and 15% of the territory, 68% of population and 71% of the economy are vulnerable to climate change effects. This increasing vulnerability to climate change has led the country to a discursive shift to pursue strong climate change goals.
- **Reducing generation cost:** The rapid declining costs of renewable energy at the international level has fostered the adoption of market-based policies to allow new investments in the electricity sector.
- **Social and environmental impacts of transition:** An increasing social pressure to address the social inequalities produced by the electricity sector in its generation and use has been at the core of the policy agenda in the last decade (Esteves, 2012).

The three main drivers can be explained in greater detail as follows:

→ **Climate change mitigation goals:** Emission reductions and decarbonisation efforts, to address climate change, largely depend on the adoption of clean energy sources to generate electricity. The NDC presented before the Paris Agreement in 2015 has aimed to unconditionally reduce at least 22%, followed by a 36% emissions reduction conditioned to international support by 2030 (SEMARNAT, 2016). The unconditional goal amounts to a reduction of 211MtCO_2e[1], of which the Electricity sector must reduce 63MtCO_2e.

Mexico emits 683 MtCO_2e, of which, 64% comes from fossil fuel consumption. The energy sector is the main source of emissions, where 25.1% (171 MtCO_2e) come from the transport sector, 24.1% (165 MtCO_2e) from the electricity sector, 9.3% (64 MtCO_2e) from the industrial sector, 5.4% (37 MtCO_2e) from the residential and agrarian sectors and 6.5% (44 MtCO_2e) from fugitive emissions in the oil and gas sector (INECC, 2018). The electricity sector is constituted mainly from fossil fuels (which account for 80% of energy generation), while the rest is supplemented with hydropower (10%) and nuclear power and renewables (10%) (SENER, 2018).

Figure 1: **Renewable energy costs compared to 'traditional' generation technologies**



Source: Adapted from Stockholm Environment Institute (SEI), 2018.

1 Megatons of carbon dioxide equivalent.

2 The definition of clean energy stated in the Energy transition law includes highly efficient combined cycle plants, carbon-capture and storage (CCS) technologies and nuclear power.

- **Reducing generation cost:** Despite a heavy dependence on fossil fuels, the Mexican government has sponsored a transition towards natural gas and 'clean energy'. The former has been pursued through a systematic retirement and retrofitting of fuel-oil thermoelectric power plants in favour of natural gas-based Combined Cycle Turbines (CCGT). This has led to natural gas projections to account for this fuel as the main source of future emissions (Islas, 2017). On the other hand, the adoption of the Energy Transition Law (ETL) has set another driver to increase 'clean' energy into the electricity grid[2]. The ETL has established an energy transition goal to generate at least 35% of electricity through clean energy sources by 2024. This goal has set a clear path towards the reduction of fossil fuels in the electricity sector, mainly by recognising the lower cost of renewables and their subsequent competitiveness.

  Since 2014, Mexico has undertaken three long-term energy auctions (LTEAs) (2016, 2017 and 2018) that have, so far, achieved 56 projects, accounting for a 3% increase of the total generation needed to meet the 35% clean energy goal. These auctions have systematically lowered the levelised costs of energy for large-scale wind and solar projects, reaching costs of $43.65, $33.84 and $20.57 USD/Megawatt hours (MWh) respectively (SENER, 2018).

Figure 1 shows the latest cost assessment of renewable energy projects worldwide. As the columns in yellow show, the cost of solar power has dropped significantly and to more competitive levels than wind and fossil fuel-based generation. Even without considering environmental and CO_2 externalities in the generation process, costs have allowed for solar and wind power to reach record-breaking low generation costs. Despite these advances and the social and environmental implications these projects have had, these prices only cover the price allocated through auctions, and not necessarily the 'real cost' of large-scale renewable energy projects, in terms of including social and environmental impacts (SEI, 2018).

- **Social and environmental impacts of transition:** Social inequalities persist within the electricity sector. At least 36% of households suffer from a degree of energy poverty, where almost 12 million people are not able to meet their electricity needs (García-Ochoa and Graizbord, 2016). Despite almost universal coverage, and a large subsidy assigned to residential tariffs by the Federal Government (CFE, 2016) electricity costs are not accessible to a considerable number of families. In the last official statement, the subsidy to residential electricity prices reached $5 million USD (Presidencia de México, 2013); based in calculations developed by the International Energy Agency, this could reach a total of $13 million USD by 2030 (IEA, 2016).

At the same time, there has been a lack of recognition of the social dimensions of the energy system, both in the development and planning of the electricity sector and in the deployment of large-scale renewable energy projects. This has rendered much of the decision-making top-down and state-lead.

Since the adoption of the LTEA in 2014, Mexico has systematically reduced the levelised cost of energy for wind and solar (IRENA, 2017). However, the adoptions of market mechanisms lack a coherent approach to address the social, political and justice implications of the energy transition. The nationwide deployment of large-scale, privately owned and internationally financed renewable energy projects has led to an important series of political contestations over the role of scale, location and the transformation of landscapes and territories where these energy projects are located (Articulación Yucatán, 2016). These projects increasingly become competitors for land use and become new sources of reconfigurations for landscapes. As this occurs, critiques over the following factors have prompted discourse over a Just Energy Transition (JET):

- land occupation
- accumulation by dispossession
- lack of adequate democratic decision-making into the electricity sector
- new forms of land-grabbing in the name of climate change and the energy transition.

The above means that adequate mechanisms over participation, consultation and co-design have to be taken into account by policy-makers and project developers (CEMDA, 2014, Avila-Calero, 2017, Del Pozo Martínez and Gutiérrez, 2019).

Since 2014, Social Impact Assessments (SIA), Indigenous Consultation and Free, Prior, Informed Consent (FPIC) processes have been incorporated, respectively, into the legal and regulatory structures of the electricity sector. However, these instruments have proved to be framed under a post-political structure, where issues are rarely debated and decided with local communities but where, instead, the process is used as a source of information, foreclosing disagreement and avoiding effective participation in the design, development and benefits from the project (Avila-Calero, 2017). This has left an important gap in addressing the social dimensions of both renewable energy projects and governance structures of the electricity sector. In turn, this has produced significant delays in the following:

- incorporating new renewable energy projects
- developing more inclusive governance structures, institutions and organisational networks that are constructed around the electricity sector, in order to not only meet clean energy goals but also address the distributional effects of the energy transition.

2. DATA AND INDICATORS OF THE ENERGY SECTOR

Mexico approved an Energy Reform in 2013, with an ambition to increase Mexico's hydrocarbons production, reduce the cost of electricity and integrate renewable energy into the power grid. This energy reform was developed with three main objectives in mind (Presidencia de México, 2013):

1. Increase the production of crude oil.
2. Reduce electricity and gas prices.
3. Increase the penetration of renewable energy.

Consequently, the Mexican government approved 11 new laws and modified another 11, of which the most relevant are the Electricity Industry Law (LIE for its acronym in Spanish) and the Hydrocarbons Law (LH). The Electricity Industry Law (EIL) established a new framework to address the electricity sector, with this incorporated into a wholesale electricity market including a clean energy certificate scheme (CER) and price-based auctions as means to address increasing demand for electricity.

Figure 2 shows the main shifts in the energy sector starting from the Constitutional Energy Reform. This is followed by the subsequent implementation of federal laws and finally includes additional policies that affect and interact with the electricity sector in Mexico.

One of the key instruments used to plan and address the energy sector is the Ministry of Energy's National Programme for the Development of the Electricity Sector (Programa de Desarrollo del Sistema Eléctrico Nacional (PRODESEN) is its acronym in Spanish). This includes an overview of the electricity sector for the next 15 years. The latest programme (2018-2032) includes an emission reduction calculation for the electricity sector. PRODESEN incorporates the NDC 22% emission reduction equivalent for the energy sector, which mandates a reduction of 63MtCO2e to reach a total of 139 $MtCO_2e$ (SEMARNAT, 2016).

To address this, the latest PRODESEN aims to retire almost 7,426 MW of conventional thermoelectric generation, which includes combined cycle and fuel oil generation, being that PRODESEN estimates that the total installed capacity of the Mexican Electrical System will amount to 130,292 MW by 2032. This means a 73% increase of the 2017 capacity. This additional capacity will come from 45% clean energy and 55% conventional fossil fuel-based energy development (SENER, 2018).

These estimates are important in the reduction of highly polluting fuels such as oil and carbon, as they will effectively reduce by about 2% by 2032, while the participation of natural gas increases rapidly to account for the retirement of these plants. PRODESEN has estimated the development of 48 new natural gas-based power plants and the retirement of eight fuel-oil plants by 2032 (2018). The new investment required for additional capacity amounts to approximately $25 billion USD (SENER, 2018). This estimate does not include expenses and estimates for the transportation, storage and distribution of natural gas (SENER, 2018).

Figure 2: **The Mexican Electricity Legal and Policy Framework**

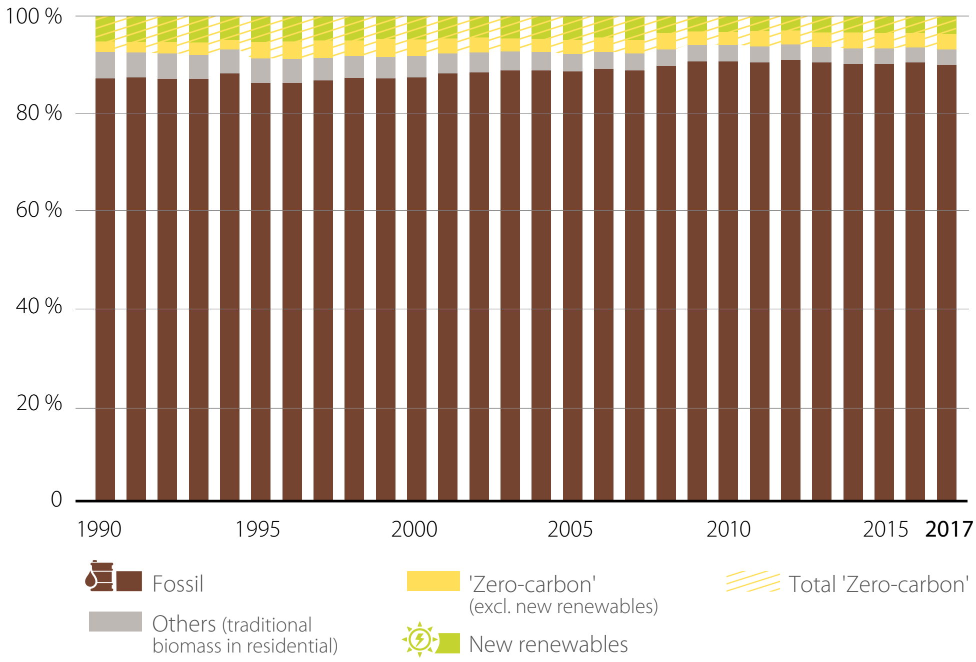
Electricity Industry Law (2014) ↓	■ Increase oil production from 2 to 3 million barrels a day. ■ Reduce electricity and gas prices. ■ Increase the penetration of renewable energy and address the environmental implications of the electricity sector.	**Energy Transition Law (2015)** ↓
■ Definition to Clean Energy. ■ Wholesale Electricity MKT, Long term auctions, Distributed Generation and Celan Energy Certificates. ■ Includes social impact assessment and Indigenous Consultation.	↑ **Energy Reform (2013)**	■ Established clean energy generation targets. ■ Mandated a clean energy roadmap with intermediate goals. ■ Fostered Distributed Generation. ■ Methodology to account for externalities and GHG emissions of the sector.

Additional policies in place.

- Carbon Tax: The fiscal reform of 2013 included a proposal to incorporate a price on Carbon. Although the original proposal set the price to about $7 USD per ton of CO2. The approved reform reduced the price to $3.5 USD per ton and excepted natural gas from the levy.
- Emission Trading System (ETS). In 2018, the government approved a pilot for an ETS that will end in 2021, when Mexico will have to establish a functional ETS.
- Mexico has presented a Mid Century Strategy but with little to no consequence for the policy and emission reduction scenarios.

Source: Our own adapted from: DOF, 2013; 2014; 2015; 2018; (Muñoz Piña, C. 2015; SEMARNAT, 2016.

Figure 3: **Carbon Intensity of the energy supply and share of renewable energy in the energy supply**



Source: Climate Transparency, 2018 based in data from SENER, 2018 and Enerdata, 2018

Figure 3 shows that the carbon intensity of Mexico's energy sector decreased only slightly by 2.6% (2012–2017), reflecting the constantly high share of fossil fuels in the energy mix. However, it shows that zero-carbon fuels include nuclear, hydropower and new renewables, which account for only 7% of the energy mix: only half of the G20 average. It also indicates that the energy transition to zero-carbon technologies is still incipient, while the carbon intensity of the energy sector has more or less continued since the year 2000 (Climate Transparency, 2018).

Regarding the energy sector's emission reduction goals, ICM's analysis (2017) of the electricity sector shows that the reductions of GHG emissions estimated by SENER (2016, 2017, 2018) are still not enough to place the electricity sector within a 2°C/1.5°C scenario. The electricity sector must achieve a total of 100 $MtCO_2e$ by 2030 to accomplish the Paris Agreement's target of 2°C (Chacón, 2016 quoted in Villarreal and Tornel, 2017). An additional 25+ $MtCO_2e$ could be achieved through distributed generation; paired with household energy efficiency measures, this could reduce up to 32 $MtCO_2e$ (SENER, 2017a). Other reductions could be achieved by increasing renewable energy penetration, mainly by boosting small and medium size projects and promoting community involvement in the design, development, operation and ownership of the electricity sector.

Regarding emission reduction, Mexico's NDC states that the country will unconditionally reduce 22% of emissions by 2030. Yet, according to the Carbon Action Tracker (CAT, 2018), Mexico will not meet its NDC target under current policies unless additional ones are implemented, reverting the direction of fossil fuels and increasing renewable energy (Climate Transparency, 2018). This lack of completion is associated with, among other issues, a lack of policy implementation and consideration of the social and justice dimensions in planning the energy transition. In that same spirit, both the conditional and unconditional NDCs that Mexico has submitted before the United Nations Framework Convention on Climate Change (UNFCCC) are not in line with a 1.5°C pathway. This last point is important because, as indicated by the Special Report on 1.5°C presented by the Intergovernmental Panel on Climate Change (IPCC) in October 2018, the 2°C goal can no longer be considered to be a safe limit. (IPCC, 2018)

Despite the integration of climate change targets into the electricity sector, Mexico has experienced slow progress in addressing climate targets. Hence, under current emission trajectories, it is highly unlikely that the country will be able to meet the 2020 pledge. Emissions have decreased from 714 $MtCO_2e$ in 2010 to 683 $MtCO_2e$ in 2015 (SEMARNAT, 2013; 2015; 2018). Nevertheless, the pledge for 2020 requires Mexico to have an overall emissions count of 453 $MtCO_2e$, that is, 261 $MtCO_2e$ under the 2010 emissions and with a baseline of the year 2000. This leaves a current gap of 230 $MtCO_2e$ to meet this goal (INECC, 2017).

The 2030 conditional goal of 36% emission reduction is the only pledge in place that is consistent with the 2˚C pathway (CAT, 2018). However, there is uncertainty regarding how the country will be able to increase ambition to meet the conditional goal. The same uncertainty prevails for the 2026 peak emissions target in the NDC. Furthermore, Mexico's long-term goal (50% reduction by 2050) is now insufficient to meet the 2˚C pathway (CAT, 2018). Therefore, not only is more ambition needed to meet these targets, but there will also need to be an increase in transparency, accountability, monitoring and evaluation of the implementation of climate change policy if Mexico's emission pathways is to be placed towards a 2˚C and a 1.5˚C route (based on the pledges developed by the Mexican government, in the NDC and the General Climate Change Law). The electricity sector plays a key role in addressing this reduction, as it currently holds the most cost-effective measure to be address in order to reduce emissions.

The following table presents the feasibility of these targets being met:

Figure 4: **Likelihood of achieving Mexico's Climate Change Goals based on different analyses and official statements**[3]

NDC and GCCL Targets	Progress until 2018	Likelihood of being met*	Source
30% Emission reduction by 2020	Progress up to 2018 estimates a reduction of 83 Mtco2e, which amounts to only a third of the 288 MTCo2e required to meet the target.	Very unlikely	PECC, 2014, INECC, 2017.
Peak emissions by 2026	Despite the 2018 reforms to Mexico's 2012 General Law on Climate Change, no roadmap has been established to address the emissions peak.	Very unlikely	CAT, 2018.
22% Reduction by 2030 (Unconditional NDC)	INECC has published a cost estimate for the 22% emission reduction target and has identified 40 actions to carry it out.	Somewhat likely	CAT, 2018, INECC, 2018
36% Reduction by 2030 (conditional NDC)	No official document has been produced to address how the pathway reduction will be met, the costs or the actions/ programmes needed.	Very unlikely	CAT, 2018
50% by 2050	Given that the emission reductions are unlikely to reach 22%, there is uncertainty about how they will be met in the long run. The Mid-Century Strategy sheds no light on how to achieve the 50% reduction.	Unlikely	CAT, 2018; SEMA-RANT, 2016.
Increase ambition to meet the 2/1.5°C Scenario of the PA.	Mexico has presented an insufficient NDC to meet the 2°/1.5°C pathway of the Paris Agreement.	Unlikely	CAT, 2018.
Emission reduction of 22% of the electricity sector.	The electricity sector is the only sector that has established a decarbonisation route. However, the route is set until 2024.	Likely	SENER, 2018; SE-MARNAT, 2016.

3 Likelihoods are estimated according to assessments developed by international think tanks such as the Carbon Action Tracker and the United Nations Environment Programme's (UNEP) Emission Gap Report, and the official documents presented by the Mexican federal government regarding the climate change goals and the evaluations developed to assess the climate policy instruments in Mexico. For more information please see:

https://climateactiontracker.org/countries/mexico/; http://www.unenvironment.org/resources/emissions-gap-report-2018; https://www.gob.mx/inecc/acciones-y-programas/evaluacion-de-la-politica-nacional-de-cambio-climatico; https://www.gob.mx/cms/uploads/attachment/file/330857/Costos_de_las_contribuciones_nacionalmente_determinadas_de_M_xico__dobles_p_ginas_.pdf

3. CHALLENGES AND OPPORTUNITIES

Historically, Mexico has built a strong national identity associating the use of hydrocarbons with national sovereignty and nationalism (Meyer, 2008). However, since 2004, Mexico has experienced a steep decline in hydrocarbon reserves, after oil production reaching its most important peak, with a steady decline since 2012, reaching a historical downfall of 1.3 million barrels a day, dropping from the 3 million barrels per day reached in 2004 (CNH, 2018). This has led the federal government to invest in cheaper alternatives to address Mexico's increasing energy demands (Presidencia de México, 2013). As a result of this policy, public investment since 2012 has been focused on combined cycled plants. Beside this, CFE and SENER have developed at least 14 new gas pipelines to import and distribute natural gas from the United States and increased interconnection points, adding 3,329 Km to the 8,867 Km transportation grid (SENER, 2017).

Simultaneously, natural gas production in Mexico has declined rapidly: since 2010, Mexico has produced 7.3 billion cubic metres of natural gas daily (BCFD); in 2018, this production accounted for 4.8 billion (CNH, 2018). At the same time, imports from the United States have increased proportionally. Mexico imports 4.1 BCFD of natural gas, with a yearly increase of 17.5% during 2015 and 2016 (SENER 2018). This has accounted for 54.66% of Mexico's demand (which is 7,618.7 BCFD). Currently, the electric sector is responsible for 52.1% of that demand (SENER, 2017). Based on government projections, the demand will increase dramatically reaching a total of 9.67 BCFD by 2031, of which 65% will be imported from the US. The electricity sector will demand a total 61.6% of those imports, accounting for 7.24 BCFD (SENER, 2017). By 2032, Mexico will have invested $25 billion USD in the construction of 48 new combined cycle power plants that rely on natural gas, amounting to 28 gigawatts (GW) (SENER, 2018a). However, this estimate barely includes renewable energy in the electricity generation mix (Chacón, 2018a).

The Mexican government has subsequently set two agendas to meet and address energy demand. The first is through the expansion of commodity frontiers, which has led important investments to the natural gas sector. By 2018, at least 7,000 oil deposits were exploited though the technique of fracking (Cartocrítica, 2018).

This sets a clear outlook in terms of how the energy sector is being imagined, developed and planned. Based only on prices, demand and technical features, SENER's forecasts for the electricity sector show a clear scenario for future technological lock-in, where government lead investments quickly turn into stranded assets (IRENA, 2017b)[4]. For instance, investments in the generation, transportation and storage of natural gas pipelines are quickly being labelled as stranded assets, leaving few alternatives or possibilities for other technologies, actors and networks to address such demand democratically and effectively. IRENA's 2017 study, 'Stranded Assets and renewables' sets a global limit where more than $900 billion USD will be left stranded unless 80% of burnable fossil fuels remain in the ground (IRENA, 2017; IEA, 2016).

Figure 5: **How natural gas is becoming locked into the Mexican economy**

Sources of lock-in	**Examples** (taken from Unruh, 2002)	**Mexican case examples**
Technological	Dominant design, standards of technological architecture and components and compatibility.	One of the key issues is the development and adoption of new power plants. The latest PRODESEN report estimates there will be about 48 new combined cycle plants by 2032.
Organisational	Routines, training, departmentalising, costumer-supplier relations and value chains.	CFE has been developing capacities and competitiveness through the adoption of natural gas power plants. Public Private Partnerships were one of the major business deals of the previous administration.
Industrial	Industry standards, technological interrelatedness and co-specialised assets.	Electricity generation will demand up to 61% of natural gas by 2031. Both public and private industrial plants are becoming more dependent on the use of cheap, imported natural gas.
Societal	System socialisation, and adaptation of preferences and expectations	Households have been equipped with infrastructure and the transport sector is expected to shift to natural gas.
Institutional	Government policy intervention, legal frameworks and departments/ministries.	Government documents fail to integrate the social dimension of energy, focusing on costs and demand in short-term decision-making.

Source: Adapted from Unruh (2002), with information from PRODESEN (2018), CFE (2016) and SENER (2018).

4 Stranded assets are defined as investments that have already been made but that, at some time prior to the end of their economic life (as assumed at the investment decision point) are no longer able to earn an economic return, due to changes in the market and regulatory environment brought about by climate policy (IEA, 2013: 98).

The study states that Mexico has the highest potential of all the countries in the world to experience stranded assets within the power sector, with 50% of Mexican economic infrastructure set to be abandoned by 2050 (IRENA, 2017b). For example, by 2030, the equivalent of 24.4 GW of Combined Cycle Gas Turbine (CCGT) power plants would be stranded, increasing to a total of 36.2 GW by 2050; without taking gas pipelines and storage facilities into account, the investment would be equivalent to $94 Million USD (Chacón, 2018a).

However, renewable forms of energy (mainly solar and wind) are experiencing a meaningful reduction based on the available capacity to address increasing demand, which increases by about 3% each year (SENER, 2016) and will have nearly doubled by 2030 (SENER, 2015). This scenario will raise both the cost of energy generation over time and the expected output of electricity generation, while the estimated cost for natural gas generation is $43 USD/MWh (SENER, 2018). Forecasts indicate that, given the current scenario, Mexico will be able to meet the clean energy generation goals. However, this will be highly dependent on the progressive integration of renewable energy and the reduction of fossil fuel use within the electricity sector.

As figure 5 shows, the Mexican socio-technical configuration of the energy sector has secured considerable investment, resources, capabilities, habits and preferences that have been locked into the economic, political and social characteristics of the Mexican economy. Hence, escaping carbon lock-in and path-dependence scenarios will rest heavily on the decisions that the next administration (2018-2024) takes regarding fossil fuels, especially regarding the future of natural gas. With the proper incentives and institutional amendments, Mexico could rapidly increase renewable penetration. Figure 7 shows the proven, probable and possible renewable energy potential for Mexico based on official estimations developed by the Ministry of Energy. Even in a conservatively estimated scenario, there is still an additional 45.3 GW capacity available (59.6%) from the total installed capacity in 2017 (75.68 GW) (SEN-ER, 2018).

Figure 6: **Renewable energy potential (GW)**

Type of technology	**Renewable energy potential** (proven)	**Renewable potential** (probable)	**Renewable energy potential** (possible)
Solar	6	16.35	650
Wind	20	19.80	870
Geothermal	10	45	52
Biomass	3	5.39	11
Mini-hydro	6.3	23	23
Total	**45.3**	**109.54**	**1,606**

Source: Adapted from INERE, SENER 2018.

However, Mexico's political situation is one of the main challenges facing the energy transition. The newly elected government has stated on numerous occasions that achieving energy security and self-sufficiency is paramount. Therefore, an expected reduction of natural gas imports is expected (Proyecto 18, 2018). However, the substitution of natural gas has been framed as a means to increase national oil production from 1.6 Million barrels a day in 2018 to at least 2 million barrels by 2024 (Ibid.). This increase will also include building two new oil refineries to produce gasoline and increasing fuel-oil electricity generation by (re)boosting thermoelectric power plants. The administration has also vowed to maintain and reduce the price of fossil fuels; although it has not explicitly stated how this will be addressed, it most certainly will not continue taxing emissions in order to keep prices low.

The newly elected government has placed considerable emphasis on the development of smaller scale and locally determined renewable energy projects. It has also set ambitious goals to increase renewable energy – instead of clean energy – integration by 22% by 2024 and increase the share of distributed generation by the same year. However, a framework to address emission reductions from the energy sector overall and increase social participation – both in renewable energy projects and in the planning, designing and future of the energy sector – is still lacking (Proyecto, 18). Despite these announcements, the use of fossil fuels in electricity generation is still likely to play a crucial role in the socio-technical imaginary of the energy sector in the near future.

According to CAT (2019):

> *Mexico will not meet its 'Insufficient' emissions reduction targets for 2020 and 2030 and will need to implement additional policies, and reverse direction on coal to do so.*

Therefore, the prominent political positions on renewables, along with the conditions of climate change, represent the main challenge for energy transition. The new administration under Andres Manuel Lopez Obrador, has taken significant steps backwards in the limited progress made by previous administrations in attempting to address climate change. The new administration seems keen on the development of fossil fuel generation plants over renewable energy and has allocated public resources for the 'modernisation' of coal, diesel, gas and oil-fueled power plants, some of which have already been scheduled for retirement by the previous administration (CAT, 2019).

Similarly, the 2019 national budget has reduced funding for climate change by almost half of the previous year; most of the energy budget only includes a rehabilitation of existing geothermal and hydro power plants. The new administration has also deprioritised the development of other renewable energy projects by cancelling Mexico's 2018 LTEA (CAT, 2019). This particular decision clearly shows a tendency to favour fossil fuel generation, including new investment in coal power plants over renewable energy, puts Mexico on a path that is even more inconsistent with the steps needed to achieve the Paris

Agreement's 1.5°C temperature limit. This is in stark contrast with the Mexican energy transition and climate change commitments, both nationally and internationally.

It is important to stress that electricity consumption in Mexico is highly unequal. In the residential sector, at least 36% of households – roughly 11 million – are unable to satisfy their electricity needs (García Ochoa and Graizbord, 2016), while almost 4 million do not have access to basic energy services (CONEVAL, 2017). These major inequalities in the electricity sector present themselves despite an almost universal connection to the electricity grid and an increasing and onerous subsidy to domestic electricity tariffs. Therefore, an energy transition process must be able to secure access and equity to electricity generated through clean energy sources.

Finally, the adoption of renewable energy projects through the LTEAs has propelled the reduction of renewable energy costs. The three auctions have systematically reduced the generation costs for wind and solar power. However, the 56 projects allocated through this instrument have all been based on large-scale developments, which have systematically failed to recognised the social and spatial configurations that their development will have in the local landscapes and the territory. This issue, although not exclusive to the LTEAS, has generated social conflicts around the use and enclosure of land. Here, the following have prevailed over local interests, needs and demands:

- federal interests to increase renewable energy to meet the energy transition laws targets by 2024 and;
- the General Climate Change Laws's emission reduction targets.

This means a more coherent approach to incorporate the social and spatial dimensions is also required in order to address the energy transition as a socio-spatial and socio-technical issue: a concern that continues to need to be addressed politically. The Federal government should prioritise actions to reduce GHG emissions and accelerate the participation of renewable energy technologies, but this must not be done by placing local interests and needs as secondary issues. If the energy transition is not addressed through a framework of justice, the energy transition's process will produce an uneven distribution of its costs and benefits of the energy transition. This framework should:

- address the adequate distribution of costs and benefits;
- recognise previous uneven patterns of development and injustices; and
- acknowledge the adequate representation and participation of local communities in decision-making procedures.

4. CONCLUSIONS AND POLICY RECOMMENDATIONS

This paper has shown that the energy transition in Mexico is being driven by a threefold set of conditions:

- climate change mitigation goals
- the need to reduce generation cost
- the push to address social and environmental impacts of this transition.

However, the energy transition process still lacks sufficient measures to address the first and third points. This is mainly because of an inadequate framework for incorporating renewable energy as a means to produce social value at the local level and the need to include effective participation measures in the planning and design of energy sector and renewable energy projects.

Even though renewable energy integration has increased rapidly since 2013, the necessary massive deployment of democratically and socially responsible renewable energy projects has not come to fruition. This has mainly been due to a lack of comprehensive approach when it comes to the scales, ownership, temporalities, design and social participation mechanisms that aim to incorporate the social dimension of the electricity sector. Adopting a socio-technical approach to the energy sector could help explain how social structures, such as routines, consumption patterns, social expectations and cultural uses of electricity help shape the energy system. Meanwhile, the technological and physical aspects of the system tend to shape those social structures as well. This process of co-production enables a clear approach to understand how addressing the energy transition purely on the basis of securing more renewable energy integration, without considering the social structures on which such transitions must be supported, can lead to political contestations and patterns of uneven development.

The Mexican government's framing of the energy transition process under the discourse of energy security and independence (Presidencia de México, 2013; Proyecto 18, 2018) has had two main consequences:

- It has paved the way for an expiration of commodity frontiers in the fossil fuel sector, providing support and a market to venture into extraction of fossil fuels through unconventional methods such as fracking and deep-water exploration (Cartocrítica, 2018).
- The substantial cost reduction of solar and wind technologies, through mechanisms like the LTEAs, have also effectively increased renewable energy participation. However, these mechanisms tend to focus only in price reduction.

Policy that recognises the social dimension of energy systems is therefore a consideration that needs to be accounted for in the design of both planning mechanisms and renewable energy projects themselves.

One of the key conclusions we've reached in this paper is that energy transition goals are not in line with climate targets at the national level. Forecasts for the electricity sector are envisioned for 15 years (PRODESEN, 2018-2032) and therefore lack a comprehensive measure of how the electricity sector could contribute to the climate change long-term goals by 2050. Likewise, the ETL's goal to have at least 35% participation in clean energy by 2024 is the only target established by law in the current regulatory framework. Similarly, the NDC presented before the UNFCCC is not in line with the Paris Agreement's 2°C and 1.5°C pathways (2015), hence the Mexican government will have to present a more ambitious NDC, where decarbonisation of the electricity sector will have to play a much bigger role. This could be achieved through a long-term plan to increase distributed generation and grant access to electricity through decentralised means.

Nonetheless, the risk of turning towards fossil fuel extraction through unconventional means is still a viable policy measure to follow. However, the stringent carbon-budget has demanded maintenance of temperatures below 1.5°C; making this a reality will mean that no more fossil fuel-based infrastructure can or should be built. As our analysis has shown, Mexico is among those with the highest potential to produce stranded assets in the near future, mainly because of large-scale investment in fossil-fuel intensive infrastructure in the electricity sector. Furthermore, the increasing trend for incumbent administration to shift towards more polluting sources will undoubtedly risk producing more stranded assets, particularly if coal, fuel-oil and new refineries are built.

Therefore, a transformation of the energy sector will require a paradigm-shift that fundamentally questions how the energy sector is governed, to develop a new reconfiguration including spaces for participation and engagement with the electricity sector regarding its infrastructure, ownership, project design and development. A mere shift from market trends has proven not to be enough to effectively and timely decarbonise the energy sector. Considering energy as a social construction that entails different understandings, meanings, politics and distributions of power is a key departing point for developing a more coherent approach to the governance of the energy sector.

Hence, while Mexico still holds a high potential for renewable energy integration, the following recommendations could help increase that participation, while at the same time addressing issues such as justice and the distributional effects of the costs and burdens of energy transition:

1. México should avoid the construction of fossil intensive infrastructure that would a) perpetuate a carbon lock-in, b) increase the probability of stranding important public investments and c) further increase emissions that are responsible for climate change. These impacts could be avoided through a massive deployment of renewable energy projects, with state lead finance and challenging the concepts of scale, ownership, design, effective participation and representation. It would also require a conscious approach towards burden distribution among different social groups.
2. Similarly, the development of renewable energy must take account for the social and spatial nature of energy systems. Addressing energy transition purely in terms of costs, efficiency and technological development overlooks the spatial implications of building new land-intensive projects. Equally, it also avoids addressing issues over what changes in the use in technology and its energy services will yield for societies with different social needs.
3. There is a need to develop long-term energy transition goals that are in line with national and international targets to reduce emissions and comply with the Paris Agreement's 1.5°C pathway. This could be done by considering energy transition as a comprehensive cross-cutting issue, as policies must tackle energy poverty, reduce GHG emissions and address social and spatial concerns over renewable energy projects.
4. There should be an increase in new socially inclusive spaces that build participation in and politicisation of the energy sector (i.e. local and community-led councils, state led spaces for planning and discussion, and national state consultations).
5. An institutionally supported growth in solar-distributed generation through state-led reinvestment in the domestic electricity subsidy is necessary. This should be incorporated into a national plan to reduce energy poverty, democratise energy access and give energy users a more active role in energy use and management. ICM's Solar Bonus Programme aims to develop this scheme.[5]

In the face of growing urgency to limit the impending increase of the global temperature to 1.5°C, based on the provisions of the Paris Agreement, it is vital that the energy transition in Mexico is accelerated. Nonetheless, the discussion cannot only be limited to economic and technological considerations. The social aspect of energy transition should have a central role in energy planning and throughout the formulation of more ambitious climate policies. This document emphasises that guaranteeing a just energy transition requires several legal and institutional adjustments. It also necessitates a decisive reconfiguration of how the energy transition is being interpreted and understood in Mexico. To this extent, in consideration of Mexico's renewable energy potential, the newly elected federal government in Mexico has an opportunity to carry out this paradigm shift in decision-making. It also has the chance to position the need to tackle climate change as an opportunity to reduce social and environmental inequalities and produce cleaner energy through decentralised and democratic means, while reducing the social impacts of large-scale renewable energy deployment.

5 To learn more from the ICM Solar Bonus Programme, please visit this site: www.iniciativaclimatica.org

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Author

Carlos Tornel, Mariana Gutiérrez and Jorge Villarreal (Iniciativa Climática de México).

Contact: ctornel@iniciativaclimatica.org; mariana.gutierrez@iniciativaclimatica.org; jorge.villarreal@iniciativaclimatica.org

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www.climate-transparency.org

info@climate-transparency.org

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