Climate Transparency

# ACCELERATING THE ENERGY TRANSITION IN LATIN AMERICA

## HOW ARGENTINA, BRAZIL AND MEXICO ARE ADDRESSING CLIMATE CHANGE AND THE ENERGY TRANSITION

POLICY PAPER

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## INTRODUCTION

The purpose of this paper is to give a broad overview of how Argentina, Brazil and Mexico are addressing climate change through the energy sector. The landmark signing of the Paris Agreement in 2015 and the subsequent adoption of the Escazú Agreement in 2018 demonstrate the urgency of addressing climate change and the implications this holds for Latin American countries. The energy sector plays a key role in each country and the region, however as new sources and technologies become more accessible and available, decisions over how to incorporate those technologies into the energy mix imply that political decisions and policies will have to be implemented. The question of how just what these decisions will be and how will they be distributed among different groups is the basis for this paper, as we analyze and compare the energy transition process in each country.

**About this Policy Paper:**

This paper is the outcome of interactions between the Center for Integrated Studies on Climate Change (Centro Clima), the Foundation for the Environment and Natural Resources (FARN) and the Iniciátiva Climática de México (ICM) as partners of Climate Transparency, an international partnership of 14 research organizations and NGOs comparing G20 climate action. The arguments presented here come, in the most part, from the 2018 Brown to Green Report and three country-specific different policy papers on accelerating the energy transition developed for each country (available on www.climate-transparency.org). The content of this document does not reflect the official opinion of all the partners of Climate Transparency. Responsibility for the information and views expressed therein lies entirely with the authors.

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## EXECUTIVE SUMMARY

The Paris Agreement set the target to limit global warming to well below 2°C above pre-industrial temperatures and pursue efforts to limit it to 1.5°C, urging more ambitious international commit-ment and collective action at a global level. Additionally, the latest report from the United Nations' scientific panel on climate change advises that climate action must be increased fivefold to limit warming to the 1.5°C rise. Nonetheless, despite the many positive developments that have occurred in G20 countries since the Paris Agreement was signed, the emission range needed to keep global temperature rise below the 1.5°C limit is large, and the continued burning and dependence on fossil fuels, represents the highest share of energy-related CO2 emissions in the G20.

Consequently, the transition from a fuel-based economy towards a low-carbon and climate resilient economy has become the heart of the response to the climate change threat. Even so, the diverse range of technological solutions to progressively substitute fossil fuels for new renewable energy, has had important environmental, economic, social and political consequences with certain partic-ularities amongst the G20 countries. **Therefore, the purpose of this paper is to give a broad overview of how Argentina, Brazil and Mexico are addressing climate change through the energy sec-tor, by analyzing and comparing the energy transition process in each country.**

Argentina, Brazil and Mexico are among the biggest emitters of GHG emissions in Latin America, with 323, 1,090 and 683 $MtCO_2e$ emissions respectively and with national climate policies that place the three countries on an emissions pathway that is incompatible with the 1.5°C temperature limit. At the same time, the three countries share vulnerabilities and costs related to addressing climate action. The overall impact of climate change effects in Latin America is estimated to reach as high as US $100 Billion per year by 2050 (UNEP, 2016). For the Paris Agreement to be achieved, all the three countries will have to present updated and more ambitious NDCs by 2020 with the clear goal of maintaining efforts to achieve a 1.5°C limit.

It is also crucial to understand how technologies, policies and property regimes are designed, envisioned and framed within the energy system of the three countries. As the energy transition process implies new socio-technical and socio-spatial configurations of society, recognizing the social, institutional, organizational, economic and political configurations that constitute the energy system as well as the particularities on the way renewable energy integration is planned, regulated and incentivized is discussed throughout this document. This paper places considerable emphasis on issues relating to the distribution of costs and benefits and to the representation and recognition of usually marginalized groups in the energy transition process in all the three countries.

This paper identifies shared challenges, opportunities and policy recommendations that would lead towards mitigating and adapting the impacts of the energy sector towards a just energy transition, and at the same time, reduce emissions to address the 1.5°C limit:

1. Harmonize climate and energy policies through a long-term and sectorial decarbonization strategy, particularly for the energy sector.
2. Redirect investments and rapidly eliminate fossil fuels subsidies.
3. Assess the opportunity to implement a progressive tax on fossil fuels based on the social and environmental cost of carbon.
4. Accelerate renewable energy integration in the power sector and avoid the lock-in to carbon-intensive technologies that infrastructure plans in all three countries currently entail.
5. Avoid the exploitation of non-conventional oil and gas reserves due to their social and environmental impacts. This would send clear signals to the market to enhance the integration of clean and renewable technologies.
6. Redirect investments from Exploration and Production in the oil and gas sectors to promising renewable energy sources, such as energy storage, smart grid technologies and recognize the value of social innovation.
7. Increase solar distributed generation through a comprehensive national plan that addresses regulation and tax issues. This provides clear benefits for the poorest sector of the population and lower risks for private banks and investors.
8. Adequately incorporate the social and spatial dimensions of the electricity sector through planning and governance instruments, strategies and policies.
9. Address and redistribute the cost and benefits of the energy transition by incorporating locally determined needs into national and international energy planning; adapting technologies through social innovation; and recognizing social and environmental limits in energy sector planning.
10. Increase the participation of citizens, neighborhoods, indigenous rural and urban communities, and small businesses in the design, ownership and deployment of renewable energy projects.

## INTRODUCTION

On October 8th, 2018 the Intergovernmental Panel on Climate Change (IPCC) presented its long-awaited Special Report of 1.5°C (SR1.5). The report underpins the urgency of climate action and the catastrophic effects of limiting global warming to 2°C, despite the fact that the Paris Agreement recognized this as a safe limit. SR1.5 shows that countries need to increase their ambitions to limit GHG emissions and how, despite the necessary reductions, the effects of climate change will have an impact on the physical environment and the livelihoods of millions of people. Based on the SR1.5, Latin America is particularly vulnerable, making the region a relevant actor in global mitigation efforts (IPCC, 2018).

Globally, Nationally Determined Contributions (NDCs), which are the operating instruments for each country's emission reduction pathways that contribute to the 2 and 1.5°C temperature limits set in the Paris Agreement, would lead to a global temperature increase of around 3.2°C. According to the Brown to Green Report (Climate Transparency, 2018), none of the G20 NDC targets for 2030 is in line with the Paris Agreement and while most of the countries might be unable to fulfill their commitments in the current policy climate, some might achieve or over achieve them. This is mainly due to a lack of ambition. Similar to this assessment is the fact that the emissions gap between the reductions needed and the national pledges made in order to contribute to the Paris Agreement is alarmingly high (UNEP, 2018). Based on the Emissions Gap Report (EGR) of 2017, the gap between the pledged conditional and unconditional Nationally Determined Contributions to reduce emissions by 2030, was of 11 to 13.5 Gigatons of Carbon Dioxide equivalent ($GtCO_2e$) respectively for a 2°C pathway. The gap for a 1.5°C pathway on the other hand was of 16 to 19 $GtCO_2e$ between the conditional and unconditional pledges. However, the EGR of 2018 indicated that, while the 2°C gap increased only slightly, the gap for 1.5°C increased substantially, reaching a 29 to 32 $GtCO_2e$ between conditional and unconditional pledges by 2030.

Overall, Latin America has around 590 million inhabitants, with a GDP of $5,655 billion (World Bank, 2014), contributing 9% of the global greenhouse gas emissions (ECLAC, 2015). According to the UN Economic Commission for Latin America and the Caribbean (ECLAC), Brazil, Mexico, Venezuela and Argentina contributed 80% of the total emissions of the Latin American region (ECLAC, 2015). In 2017, Argentina contributed 0.9% of global emissions, Brazil accounted for 2.8% while Mexico contributed 1.5% of global GHG emissions (Gütschow J., 2017). Despite the small contribution relative to other countries, and compared to global emissions, Argentina, Brazil and Mexico are among the 25 biggest emitters of GHG emissions globally and the top emitters, along with Venezuela, in Latin America (World Bank, 2016).

Likewise, it is projected that the costs related to climate change effects in Latin America will reach US $100 billion per year by 2050 (UNEP, 2016). This scenario will exacerbate inequities in employment, health, and access to food, water and other resources, with adverse impacts on energy, transportation and distribution infrastructures. In this sense, similar to other Latin American countries, the increasing vulnerability to climate change in each of Argentina, Brazil and Mexico has led to a rapid discursive shift to advocate for strong climate change mitigation goals, and the comprehensive adaptation of long-term plans. Yet these compromises are still insufficient to address the Paris Agreement temperature limits of 1.5°C and to safely adapt to the impacts of global climate change.

Therefore, while SR1.5 sets a clear urgency to limit global warming to a 1.5°C temperature increase, with a series of measures that might lead towards a manageable future, the adoption of the Escazú Agreement for the Latin-American region presents a useful tool to strengthen climate action by making environmental information transparent and available, increasing spaces for adequate participation and providing measures to protect human-rights activists and access to environmental justice in the region (ECLAC, 2018). However, both the Paris and Escazu Agreements are still under an implementation process and will therefore require continuous commitment by the adopting parties in order to be adequately implemented. That said, a strengthened framework and ambitious goals might set the foundations that will lead towards increased climate policy ambition, and an evenly distributed and low carbon emission future.

It is in this context that countries in Latin America are undertaking the task of implementing the energy transition. Energy transitions involve a complex array of socio-technical and socio-spatial changes that are deeply entrenched with political issues and power. The context in which Latin American countries are addressing energy transitions with the increased participation of renewable energy is deeply woven into issues of climate justice at the local, national and international level. This has led to an uneven distribution of costs and benefits. While the urgency of climate change has paved the way for legitimating climate action, these actions are still presented as trade-off between other activities, development and politics (Burke and Stephens, 2018).

Although Brazil and Mexico have pledged important mitigation contributions through their NDC to address the Paris Agreement, the emphasis in each country is different. Mexico has focused on decarbonizing the energy sector, paying less attention to other sectors such as transport, forestry and agriculture. Brazil has focused more of its efforts on reforestation and Land Use and Land Use Change and Forestry (LULUCF), while Argentina has distributed its emission reduction efforts across all sectors. While for Argentina and Brazil the energy transition is a long-term goal, for Mexico, in contrast, it is main outcome of its NDC pledge (CAT, 2018). Despite this, the socio-technical configurations and energy-future visions are still heavily informed by the use and exploitation of fossil fuels, which means that while the energy transition presents opportunities, it also presents challenges for each country.

The energy transition process is not neutral. The way the energy transition is framed, and tools as well as solutions are implemented to achieve a progressive substitution of fossil fuels for renewable energy, has important environmental, economic, social and political implications. Therefore, an energy transition without the consideration of environmental- and social justice will inevitably lead to an uneven distribution of power, costs and benefits (Jasanoff, 2018).

There are a series of feasible alternatives futures for the energy sector that need to be thoroughly analyzed and incorporated into the energy decarbonization process. Decisions on how the transition will be framed, who will get to frame it, and the implications of these decisions will lead towards a particular energy future, one that will likely lead to an uneven distribution of costs and benefits. These conditions are not normally considered while designing energy policy. Technologies and techniques such as hydraulic fracturing (or fracking), large hydropower plants, nuclear energy and carbon capture, storage and removal which are normally seen as necessary but still economically unviable solutions to address climate change, and yet they have been placed at the center of the imagined energy future (Cotton, 2017; Caradonna et al., 2017). Yet most technologies, policies and property regimes are designed, envisioned and framed under the influence of global centers of power (Jasanoff, Kim, 2015) which normally value certain interests such as financial and economic value over others (i.e. local needs and livelihoods). Therefore, energy futures must be addressed politically at an international, national and local scale, taking into account the interests of all stakeholders. Envisioning a democratic and just energy future is key in determining which technologies, designs, policies, instruments and groups will be incorporated into the various energy transitions.

**This paper is divided as follows:**

- **The first section** gives an overview of the three countries - **Argentina**, **Brazil** and **Mexico** - and their comparison with some key indicators of the G20 based on the Brown to Green Report.
- **The second section** gives a broad overview of the energy matrix of the three countries and shows the link between the electricity sector and climate change. This section also gives a brief overview of the vulnerabilities these countries have with regard to climate change.
- **The third section** compares the three countries by taking the analysis and identifying the main challenges and opportunities that would lead towards mitigating and adapting the impacts of the electricity sector in the framework of a just energy transition. This section incorporates most of the contributions of this report, mainly by arguing that while the energy transition process is enabling the expansion of new commodity frontiers, it is also producing important contributions that could lead towards a new socio-technical and socio-spatial configuration of the use of renewable energy.
- **Finally, the fourth section** outlines a series of policy recommendations that can help lead Argentina, Brazil and Mexico towards a just energy transition and at the same time, reduce emis-sions to address the 1.5°C limit. This section draws from the comparison and the detailed analy-sis of each challenge and opportunity developed in the two previous sections and argues that an emphasis on the social and spatial aspects of the energy transition is just as urgent and necessary as a focus on the technical and physical characteristics of the energy sector.

Our aim is that this document provides an important analysis to fill in the knowledge gaps and stimulate peer learning between countries, particularly in a south-south context to (re)think, (re) imagine and (re)formulate how different approaches towards a just transition are not only necessary but possible.

## 1. ARGENTINA, BRAZIL AND MEXICO IN THE G20

As members of the G20, Argentina, Brazil and Mexico share most of its problems in addressing long-term decarbonization. Energy-related $CO_2$ emissions of the G20 countries continue to rise, despite a relative stalling due to renewable energy integration during 2015 and 2016. In Mexico, emissions from the energy sector have continued to rise, despite the growing integration of renewable energy, as investment in renewables is still dwarfed by investment in the natural gas sector (SENER, 2018). While Brazil still continues to invest and expand the use of ethanol, wind and hydropower, it also continues to subsidize fossil fuels, adding a subsidy for diesel consumption in 2018. Mean-while, while Argentina has launched a US $5.7 billion investment program to push renewable energies, it will continue to provide subsidies for gas exploitation (particularly through unconventional methods such as fracking) until 2021 (Climate Transparency, 2018).

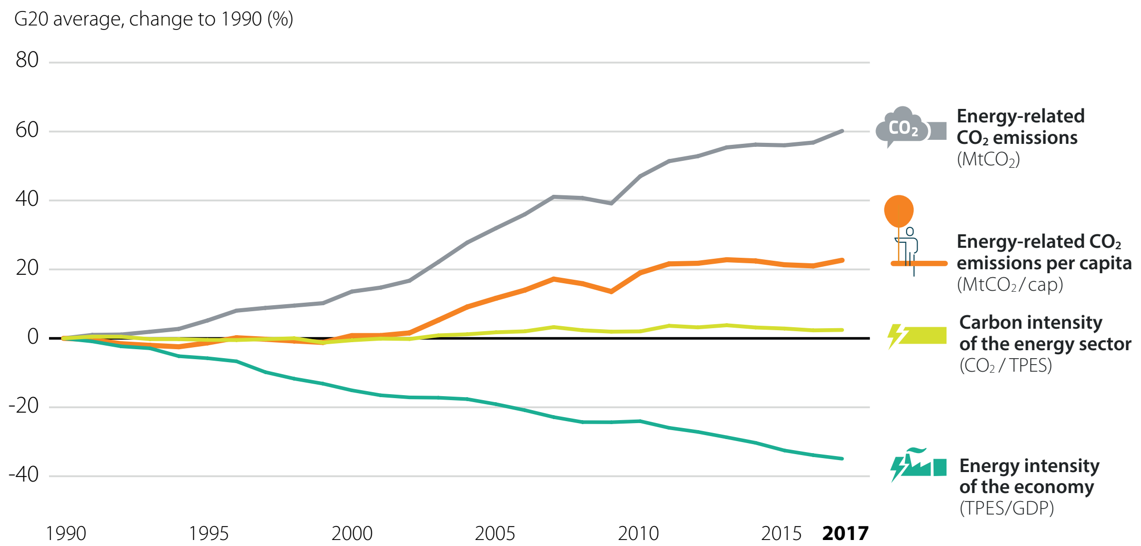
Climate change requires collective action at a global level; major change must come from the biggest emitters and economies, that is, the G20 countries. The G20 accounts for 79% of global GHG emissions and about 81% of global energy-related CO2 emissions (Climate Transparency, 2018). It is in the national interest of countries to take climate action, which coincides with other social needs, supports the implementation of Sustainable Development Goals (SDGs), and offers substantial economic benefits.

Ambitious climate action could create more than 65 million new low-carbon jobs worldwide and prevent 700,000 premature deaths from air pollution by 2030, according to the Brown to Green Report 2018. Globally, government revenues could increase to US $2.8 trillion by 2030 due to subsidy reform and carbon pricing alone (Climate Transparency, 2018). Argentina, Brazil and Mexico must increase their respective efforts to lead a just and swift energy transition towards a decarbonized society, thereby contributing to the international effort to place the world on a 1.5°C pathway (Climate Transparency, 2018).

The cost of inaction is potentially huge. Stranded assets of US $20 trillion of upstream energy and power generation constitute a financial risk that can be minimized if capital is shifted away from carbon-intensive investment. Similarly, climate impacts will lead to higher costs in the future (IRENA, 2017). In 2017, global economic losses from natural disasters and man-made catastrophes were the highest ever amounting to US $337 billion. G20 countries, particularly the emerging economies, are increasingly exposed to the impacts of climate change. According to the Notre Dame Global Adaptation Index (ND-GAIN) India, Japan, Indonesia and Brazil are the G20 countries most exposed to such risks (ND-GAIN, 2018).

The Brown to Green 2018 analysis of the G20 shows that although Argentina, Brazil and Mexico represent a low percentage of the emissions that make up the total amount of the G20 - roughly 5.2% of global emissions (PRIMAP-hist, 2017) - each country's particular vulnerabilities and costs of addressing climate action will be exacerbated by the compounding impacts of climate change. This places considerable emphasis on how each country aims to (re)design, (re)frame, and modernize the energy sector. This implies a redesign of both the fossil fuel and the electricity sector, where in case of the latter, a redesign would imply a reformulation of the electricity grid to increase the adoption of new renewable, storage and distributive technologies, paired with a redesign of the social metabolisms, demand and consumption patterns based on a progressive decarbonization (Schneider et al., 2010).

Figure 1: **Emissions from Energy sector in the G20 economies**




Source: Enerdata, 2018

Figure 1 shows that the energy-intensity of the economy has dropped in the G20. This means that less energy is needed to produce a unit of GDP. But this development is outweighed by the growth in GDP, and an increasing carbon intensity in the energy sector. As a result, energy-related $CO_2$ emissions in the G20 continue to grow – both in absolute and per capita terms. An equitable energy transition would not only require a significant drop in energy-related GHG emissions, but it would also require taking into consideration the Energy Return on Investment (EROI) that these changes might imply: this means addressing issues of consumption and demand and not only increasing efficiency and substituting polluting sources with cleaner ones (Grass, 2017).

The challenge for the G20 economies is to build a solid foundation for a just energy transition, which would entail long-term planning with rapid decarbonization strategies. The global expansion of commodity frontiers due to the social metabolism of developed countries has increased the demand for non-renewable resources and at the same time has produced important social and environmental conflicts, particularly in the global south (Martínez-Alier et al., 2009). The energy transition in which these countries find themselves is burdened with the need to rapidly and sustainably decarbonize. This will require addressing the social and environmental impacts and conflicts, while at the same time addressing social and environmental needs globally, nationally and locally.

Important debates have risen over what exactly should be understood as an energy transition. Two opinions stand out: on the one hand, the energy transition is seen as a process of global propor-tions, where large quantities of renewable energy, paired with a series of climate-fixes (e.g. Carbon Capture and Storage), efficiency gains and other non-renewable technologies (such as 'clean' nuclear energy) are developed to rapidly reduce emissions and maintain economic growth unchanged. (Nordhaus et al., 2016; Huesemann and Joyce, 2011). The other view is to focus on integrating renewables while recognizing the limits of these technologies, particularly in the context of the Energy Return on Investment (EROI) of renewable energy which is substantially lower than that of fossil fuels. (Grass, 2017) This latter focus aims to foster and propose changes in social behavior that will help to reduce energy consumption (Kallis, 2017; Kallis and Kostakis et al., 2018).

In this paper, we advocate for a long-term decarbonization project for Argentina, Brazil and Mexico in which the energy transition plays a key role to rapidly reduce GHG emissions in order to address climate change. We argue for an accelerated phase out of fossil fuel use through a policy and political based strategy to recognize the global amount of burnable fossil fuels and thereby reduce the social and environmental costs of the expansion of commodity frontiers. Although renewable energy integration is key to address and meet these commitments, the way that the integration is framed, planned, regulated and incentivized must also be a key part of a fair energy transition.

In this sense, we argue that an energy transition must:

a) Pay attention to democratically determined energy futures. This would imply recognizing the social dimension of energy systems and including neglected issues such as the role of communal practices, knowledge and recognition in design, ownership and scale in renewable energy projects (Jasanoff, 2018);

b) Effectively incorporate renewable energy technologies into different cultures, histories and traditions (Stirling, Smith, 2017);

c) Restore normative concerns to energy policy deliberations, especially issues of distribution, fairness and justice (Jasanoff, 2018);

d) Increase the spaces for participatory planning and design to offer publics greater access to scientific resources and official political institutions at all levels of policymaking (Jasanoff, 2018).

## 2. THE ENERGY MATRIX AND CLIMATE CHANGE

This section gives a broad overview of the energy sector and its relationship with the climate change mitigation measures of Argentina, Brazil and Mexico, which are among the biggest emitters of GHG emissions in Latin America. Although the energy matrix in each country is different, they are all vulnerable to the effects of climate change. While Mexico and Brazil are highly vulnerable, Argentina is normally ranked as a less vulnerable country, yet it still has a significant degree of vulnerability (OECD, 2015; Climate Transparency, 2018). Some of the key efforts to reduce emissions in the three countries have been focused in the energy sector where both Argentina and Mexico are still heavily dependent on fossil fuels for their energy. Brazil, in contrast, is highly dependent on hydropower, with big dams supplying more than half of its electricity. While this implies less emissions, land-intensive energy production could present a concerning environmental challenge for Brazil.

Recognizing that there are several methodologies that aim to assess the progress of each country to meet their NDC's and their respective compatibility with the Paris Agreement temperature limits of 2°C and 1.5°C, this document makes use of the Carbon Action Tracker methodology (CAT, 2018) to evaluate each country's performance. So far, the three countries have pledged NDCs before the UNFCCC. On the one hand, Brazil's and Mexico's NDCs are currently rated as 'insufficient' by the Carbon Action Tracker (CAT, 2018) because both countries' contributions are not high enough to comply with either the 2°C or 1.5°C pathway as laid out in the Paris Agreement. On the other hand, and despite a recent revision, Argentina's NDC is still considered to be 'highly inadequate', even though it is the only one of the three countries that has presented a more ambitious NDC since the Paris Agreement was signed in 2015 (CAT, 2018).

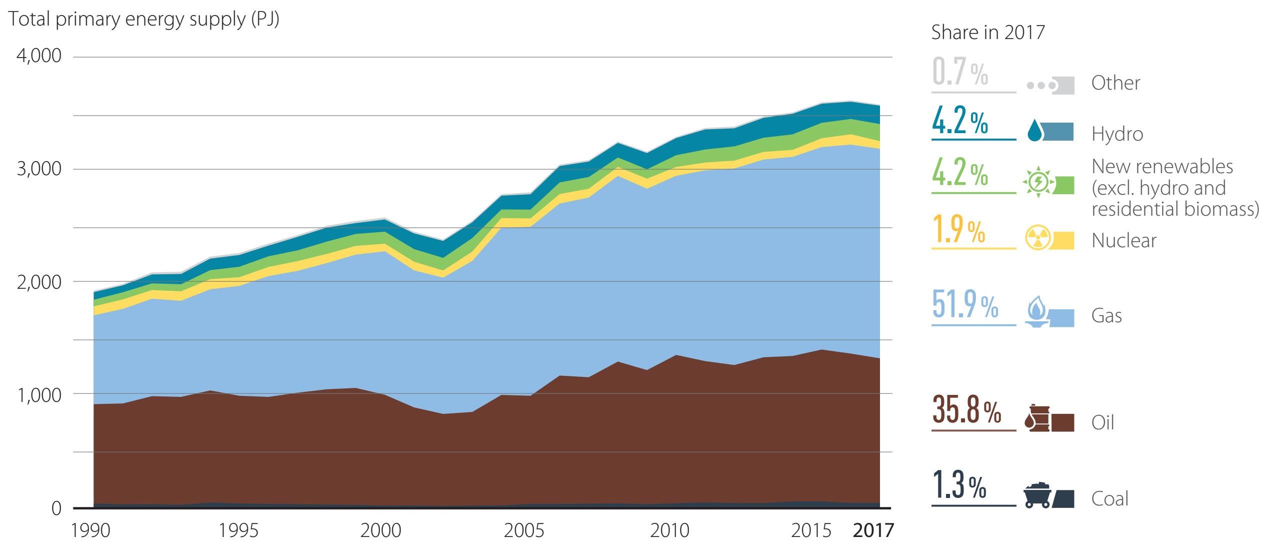
# ARGENTINA

### i. Energy and climate change in Argentina

Argentina's GHG emissions (excluding forestry) increased by 43% between 1990 and 2014, and this trend is expected to pick up speed in the run up to 2030. Argentina's energy mix is heavily dominated by fossil fuels, with nearly 89% of the energy mix coming from hydrocarbons. A further 6.1% of is supplied by nuclear power and large hydropower dams, as shown in figure 2, making the energy mix highly concentrated in just a few energy sources and in a narrow ownership base. The trend is expected to pick up speed towards 2030. The energy (including transport) and agriculture sectors contribute most to overall emissions. Emissions from the energy sector increased in Argentina by 4% during the period 2012–2017. This trend was mainly driven by emissions from power generation and transport. Argentina's energy sector was responsible for 193,5 $MtCO_2e$ in 2014 compared with total GHG emissions of 368,3 $MtCO_2e$. The production of conventional extraction methods for oil and gas has progressively decreased since 2004, while imports of natural gas from Bolivia and other oil derivatives have increased, as well as the exploitation of oil and gas through non-conventional methods in the Vaca Muerta reservoir (MEM, 2017).

Figure 2: **Argentina's Energy Mix 2017**

Source: Enerdata, 2018



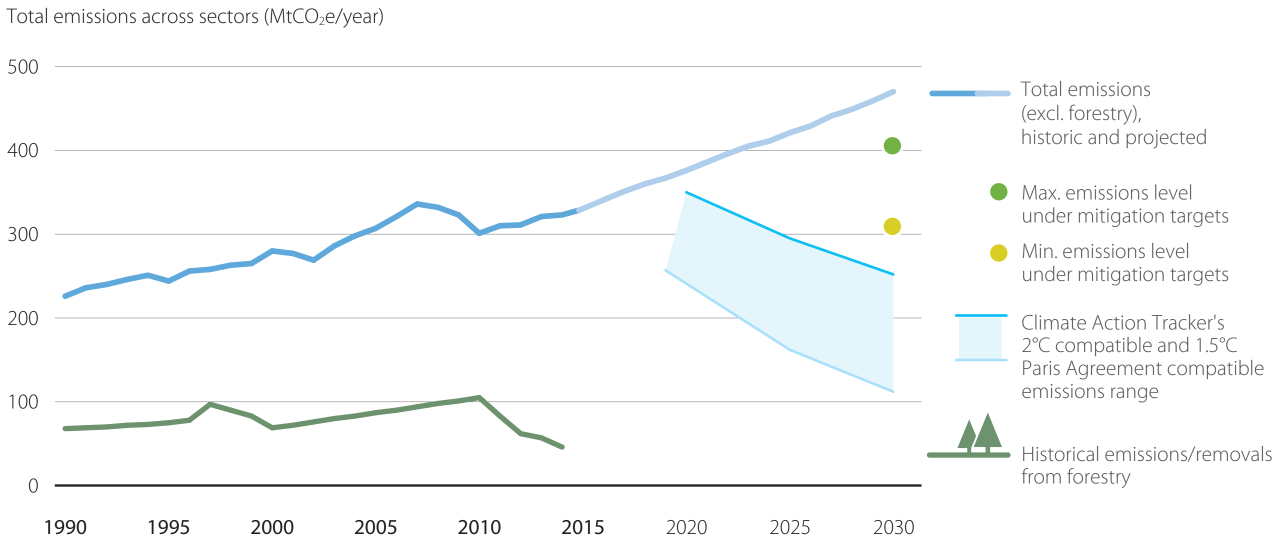
Argentina presented its Nationally Determined Contribution in 2015, and subsequently presented a revised version in 2016. In December 2017, the country released a new set of energy scenarios based on a set of new policies and measures, which would lead to lower emissions compared to current policy projections. Assuming a more modest growth of energy demand and assumptions on new renewables, hydropower and nuclear power additions, Argentina could achieve its unconditional climate target on the revised version of the NDC. The country has moved in this direction by adopting policies such as the Biofuels Law and the new Renewable Energy Law, and implementing a carbon tax since 2017 (CAT, 2018).

By 2018 Argentina had elaborated plans for the energy, transport, forestry and industrial sectors, however, a plan for the agricultural sector, which is an important area to address in terms of emis-sion reductions, is still missing. Since 2016 Argentina, has implemented a National Law for the Promotion of Renewable Energy (Ley 27191), and as of today 5,000 MW of renewable energy has been allocated, which is half of the installed capacity mandated by this law for 2025. But although the regulatory framework is in place, concrete action on the ground has been lacking.

Based on implemented policies, Argentina's GHG emissions are expected to increase to around 470 $MtCO_2e$ by 2030. According to the Brown to Green Report (2018) and based on the Climate Action Tracker methodology (CAT, 2018), this emissions pathway is not compatible with the Paris Agreement. However, Argentina is one of the few countries that has increased its NDC targets, improving content and reflecting national policies. According to CAT's methodology, the revised NDC is still inconsistent with the Paris Agreement's temperature limit and would lead to a warming consistent with a 3°C and 4°C. pathway. That said, some progress on renewable energy is visible. Argentina's revised NDC aims to reduce 18% of emissions, before increasing to 37% in its conditional pledge, which is equivalent to 114 $MtCO_2e$ (as shown in Figure 3).

Figure 3: **Emission reduction targets of Argentina's revised NDC**

Source: CAT, 2018



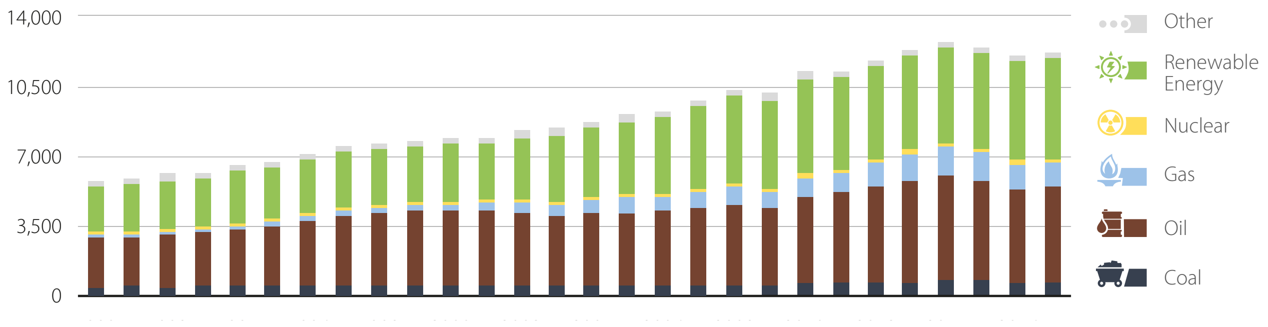
# BRAZIL

## ii. Energy and climate change in Brazil

Brazil is the biggest GHG emitter in the Latin-American region with 1,090 MtCO2e in 2015. Total GHG emissions have actually only increased slightly since 1990 when historically high emissions from forestry, which have fallen significantly over the past decade, are included. However, when excluding forest emissions, GHG emissions increased by 81% between 1990 and 2015, mainly due to growing emissions from agriculture and energy. Based on current policies, Brazil's GHG emissions are expected to increase to 1,095 MtCO2e by 2030 (excluding forestry). This emission pathway, although slightly higher than current emissions, is not compatible with the Paris Agreement's temperature limit and would lead to a warming consistent with a 2°C and 3°C pathway. The same can be said about sectoral policies, which are still falling short of being consistent with the Paris Agreement, especially with respect to transport and deforestation, although the country's renewable energy policy is a promising sign (Climate Transparency, 2018).

Brazil is highly dependent on hydropower, with big dams supplying more than half of its electricity. While this implies less emissions, land-intensive energy production presents an environmental and social challenge for Brazil. Low-interest incentives and financing policies, as well as fair prices made possible by electric power auctions, have led the wind power industry to grow significantly in recent years. Distributed solar generation is currently expanding, but there is still a concern about the regulation of these new sources, especially in the financial markets. The large use of flex-fuel cars makes ethanol widely used (27.5% blend mandate on the gasoline plus the possibility of running on 100% ethanol), and biodiesel blending policies that had already reached 10% during 2018 (as shown in Figure 4). Studies show that natural gas might be a transition fossil fuel by 2050, aiming to reduce the use of coal and oil in the country.

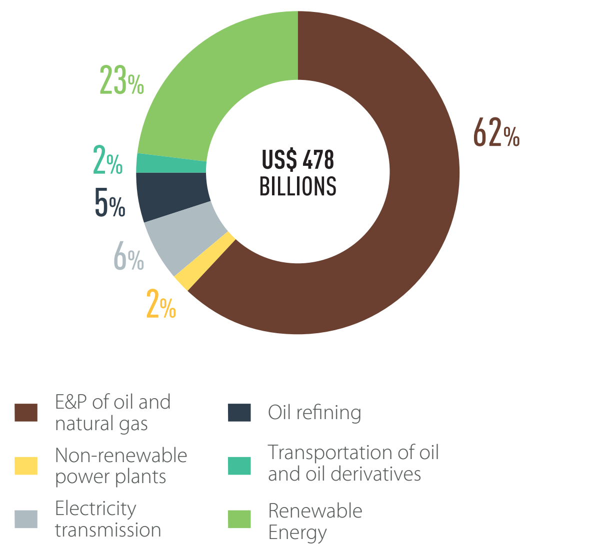
Figure 4: **Total Primary Energy Supply in Brazil**




Due to its extensive territory and natural resources, Brazil has relied for a significant part of its energy mix on hydropower, biomass, liquid biofuels and wind. With the invention of the flex-fuel car, ethanol production regained importance after 2004. Today, flex-fuel cars represent about 90% of new sales and around 80% of the light vehicle fleet. But after the discovery of large oil reserves in the pre-salt layer (2007), the federal government redirected its investment efforts in exploration and production, and subsidized the consumption of oil derivatives in order to reduce inflation at the beginning of the 2010´s. As a result, oil consumption grew fast after 2010, while the share of renewables remained stable.

With greater political support and the launch of the Program for the Incentive of Alternative Energy Sources (PROINFA), more than 40% of total investments in the power sector between 2000 and 2013 were in renewable energy. Between 2014 and 2016, wind power attracted the highest share of investments in the power sector. In 2016, investments in solar energy increased significantly to around 35% of total investments in the power sector. According to the WRI (2014), 62% of the investments in the Brazilian energy sector from 2014 to 2023 will be directed at fossil fuels, compared with 22% for renewables, as shown in Figure 5.

Figure 5: **Investments in the Brazilian energy sector from 2014 to 2023**




Source: Adapted from WRI (2014)

# MEXICO

## iii. Energy and climate change in Mexico

Mexico's GHG emissions increased by 54% between 1990 and 2015 and are expected to grow at a similar rate towards 2030. The last GHG inventory shows that the country emitted 683 $MtCO_2e$ in 2015, with the energy sector by far the largest contributor, accounting for 70.4% of GHG emissions excluding forestry. Based on current policies, Mexico's GHG emissions are expected to increase to a level of 844–852 $MtCO_2e$ by 2030 (excluding forestry). This emissions pathway is not compatible with the Paris Agreement. Mexico's unconditional NDC is not consistent with the Paris Agreement's temperature limit and would lead to a warming consistent with a 2°C and 3°C pathway. Mexico's sectoral policies still fall short of being consistent with the Paris Agreement, especially with respect to fossil fuel dependency on energy and industry (oil and gas), however its deforestation policies are a promising sign (Climate Transparency, 2018).

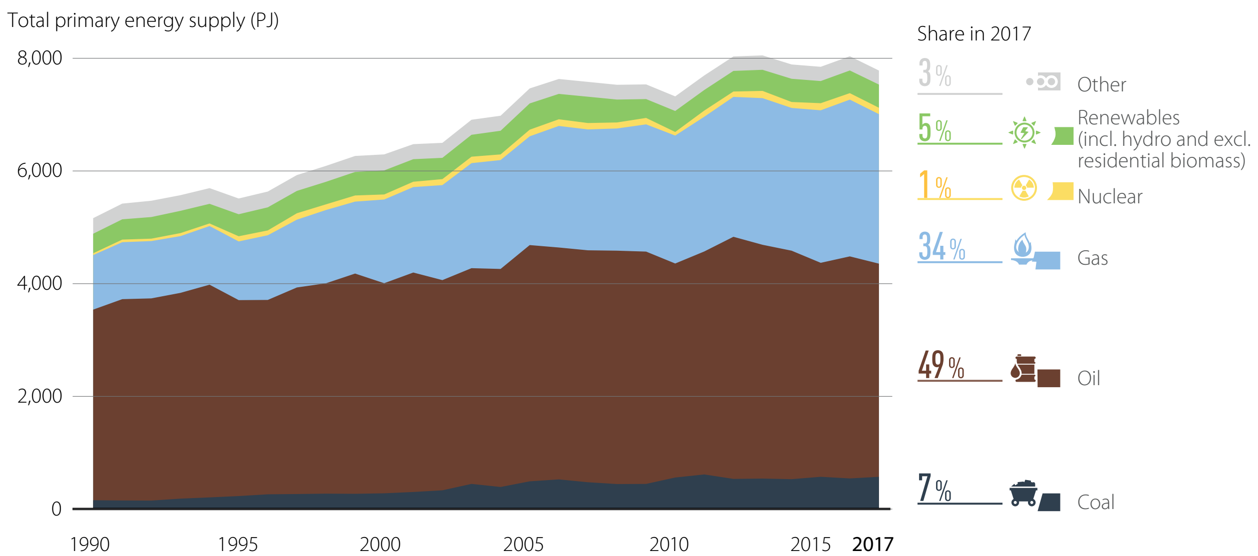
The Constitutional Energy Reform of 2013 framed the energy transition in Mexico under three main conditions: 1) carbon dioxide emissions reduction, 2) clean energy participation and cost-effectiveness, and 3) cost savings for households and businesses (Presidencia, 2013). However, decision-making has been incorporated solely as a technical, top-down and state-led development. While private companies are now able to participate in the generation of electricity and the retail development of transportation, the transmission and system operation remains under state control, albeit with a third-party independent regulator and an operator (DOF, 2013). As a consequence, this situation has pushed other issues, such as addressing energy poverty, burden and benefit-sharing and the co-ownership and design of renewable energy projects, to the sidelines.

Figure 6 shows the composition of the Mexican energy mix. As of 2018 renewables only make up 5% of total generation, while other fuels such as oil and gas still make up more than 83% of total energy generation. Currently, Mexico emits 683 $MtCO_2e$ of which, 64% comes from fossil fuel consumption (INECC, 2018). Despite the fact that Mexico has strong potential for mitigating GHG emissions form the electricity sector through the use of renewable energy, emissions are expected to increase substantially, mainly through the addition of natural gas power plants and recent moves to increase fuel oil and coal generation (Proyecto 18, 2018). The electricity sector plays a key role in addressing the reduction as it currently holds the most cost-effective measures that need to be addressed in order to reduce emissions. The sector is made up mainly of fossil fuels, which account for 80% of power generation, hydro-power, which accounts for 10%, with nuclear power and renewables accounting for the remaining 10% (SENER, 2018).

The Energy Transition Law (ETL), mandates that at least 35% of electricity has to come from "clean energy" sources by 2024, and it includes large hydropower, nuclear plants and carbon capture and storage[1]. However, Mexico's Program for the Development of the Electricity Sector (PRODESEN), which forecasts the future development of the sector over the next 15 years, shows that

Figure 6: **Mexico's Energy mix**

Source: Enerdata, 2018




1 Based on the Brown to Green (2018) methodology, we differentiate large hydropower from new-renewable energy and nuclear. We classify these particular technologies as "zero carbon". Other technologies such as carbon capture and storage (CCS), while also "zero-carbon", may come with significant social and environmental risks, challenges and/or costs.

emissions from the sector still fall short of addressing Mexico's pathway towards meeting the Paris Agreement 2°C and 1.5°C threshold. PRODESEN states that at least 48 new natural gas-powered plants will be added by 2032, which will account for at least 24 GW of installed capacity, which will then be around half of total additional capacity (Chacón, 2018a). This would also mean that emissions would continue to increase substantially, surpassing the current levels by 2030 (Chacón, 2018a).

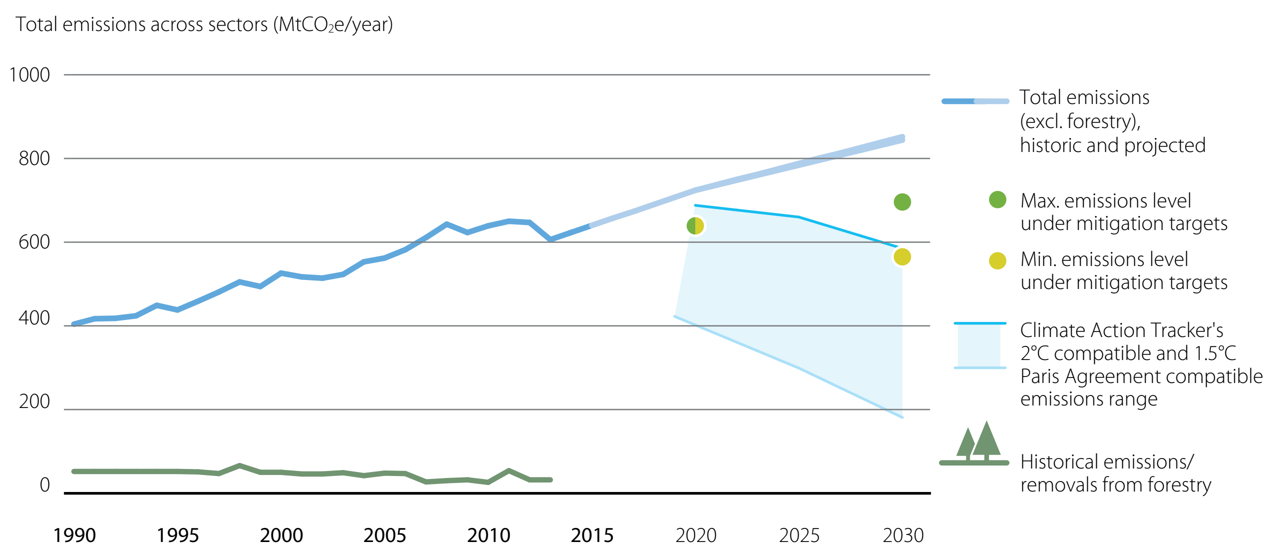
Given the current definition of clean energy in the Mexican law, it is projected that Mexico will meet the clean energy generation goals through large-scale renewable energy projects and reducing emissions by substituting fuel-oil generation with imported natural gas and other technical fixes within the electricity sector, such as carbon capture and storage (CCS) and nuclear power. These scenarios lack a recognition of the solar distributed renewable energy potential of the country, which has been estimated to reach over 20 GW with the current state of the electricity system (Chacón, 2018a). Finally, it is also worth mentioning that although renewable energy targets will most likely be met by 2024, no planning instrument, policy measure or model considers emissions from the sector beyond 2024, hampering future efforts and policies to plan beyond that date.

The Mexican Nationally Determined Contribution (NDC) presented under the UNFCCC in 2015, aims to reduce emissions by at least 22% unconditionally and to reach a 36% emissions reduction condi-tional on international support by 2030 (SEMARNAT, 2016). Mexico's climate policy implementation compromises the decarbonization actions necessary to meet the conditional and unconditional NDC targets as well as the Paris Agreement's goals. For example, the Mexican government has sponsored a transition towards natural gas by reducing fuel-oil and phasing out thermoelectric plants from the generation sector, substituting them for natural gas-based Combined Cycle Turbines (CCGT), while limiting renewable energy penetration. Consequently, there is a big risk of carbon emissions lock-in and a real emissions reduction will depend heavily on the decisions that the next administration takes regarding fossil fuels phase out, especially regarding the future of natural gas and renewables penetration.

Mexico's long-term goal (50% reduction by 2050) is neither in line with an emissions pathway compatible with the Paris Agreement nor with Mexico's General Climate Change Law. The 2030 conditional goal of a 36% reduction in emissions is the only pledge in place that is consistent with the 2°C pathway (CAT, 2018). However, there is some uncertainty as to how the country will be able to increase its ambition to meet the conditional goal. The same uncertainty prevails for the 2026 peak emissions target in the NDC. This lack of completion has to do with, among many other issues, the implementation of contradictory public policies nationally and the lack of recognition of the social and legal dimensions within energy planning and sectoral governance.

Figure 7: **Mexico's GHG emission gap**

Source: Enerdata, 2018



## 3. CHALLENGES AND OPPORTUNITIES

The use of energy is seen today as a problem of global proportions and implications, especially in the context of climate change, yet policy in the energy sector is currently developed under the lens of other issues, mainly based in national and global politics, while the impacts of energy generation are usually felt disproportionately by the poor, and local communities who experience the impact on their environment, the quality of water, land or air pollution, among others. The framing of the energy transition, as both a local and global problem points towards solutions that place important ethical considerations on the table, mainly because the global energy transition is being imagined at the centers of global power and within certain economic, social and political structures (Jasanoff, 2017).

These framings lead to a series of solutions that are linked to structures such as economic growth and linear narratives of development and progress that place energy transitions as a straight arrow of decision-making (Jasanoff, 2017), despite the clear contradictions of inequality and unsustainability that have emerged from this way of thinking. As conventional resources are exhausted, commodity frontiers are progressively expanded by commodifying previously unmodified land, re-sources, minerals and resources, normally through new technological developments that enable new extraction methods and with the support of large quantities of financial capital (Conde, Walter, 2014). These frontiers are expanded in order to satisfy the increasing demands of energy to maintain the social fabric of industrialized economies (Conde, Walter, 2014).

Argentina reached peak oil in 1998, while Mexico reached peak production in 2004 (Resilience, 2018). Brazil on the other hand, has maintained a steady increase in production since 2005, with a few years of stagnation between 2010 and 2013 (USEIA, 2018). This situation has resulted in a rise in non-conventional extraction in each country. Mexico has around 7,000 oil production wells that were drilled using hydraulic fracturing (fracking) (Cartocrítica, 2019), while 25% of gas production in Argentina is based on this method, and at least 8% of total oil production (Shale En Argentina, 2018). In Brazil, biofuels, natural gas and other liquids contribute around 0.7 million barrels of oil a day, the rest being supplied by conventional production (USEIA, 2018).

Plans for future energy use can become easily embedded and colonized by the lock-in condition of fossil fuel extraction and use. Carbon entanglements in Argentina, Brazil and Mexico make it particularly hard to incorporate renewable energy at the required pace, mainly because of the increased social, institutional, organizational, economic and political make-up of the energy system (Unruh, 2002). As a result, bringing about a just energy transition will necessitate addressing the shortcomings of the current system and paying more detailed attention to issues such as decentralization, reducing energy poverty through access to renewal energy systems and schemes, while paying particular attention to normative concerns over distribution, fairness and justice (Villarreal and Tornel, 2017).

There seems to be no common principle about how to think or understand a common energy future, especially if the point of action of such a transition is to address different dimensions of social justice. The contours of such decisions are explicit and implicitly developed in countries like Argentina, Brazil and Mexico, where the energy transition and environmental policies have been fundamentally reactive to such power and technological shifts. This section presents the main challenges and opportunities for the energy transition in the context of Argentina, Brazil and Mexico, and places considerable emphasis on the need to recognize the way that energy innovation, policy and actions are framed and the ways in which other dimensions of the energy transition, such as the social and political approach, must be taken into account in order to address issues as complex as climate change from a representational, distributional and procedural justice approach.

One of the issues that has not been taken into account by policy makers is the fact that renewable energy integrations imply new socio technical and socio-spatial configurations of society. As past energy transitions (i.e. through switching fuel, from wood to coal, or from coal to oil) have implied different social configurations, the energy transition process implies that social relations around the use of renewable energy will have to change (Bridge, 2015). This process is normally understood as a process of co-production, where social issues shape the use of such technology, while technology itself leads to different social configurations. This is particularly important considering the spatial role of renewable energy. Large-scale renewable energy projects such as solar and wind, which have reduced levelized costs of energy (that is the cost of installation and operation) in each country, are now more competitive with other traditional generation resources (Lazard, 2018). However, large-scale renewables are space intensive and normally require vast amount of lands that must be enclosed for generation purposes, ruling out other kinds of productive land-use, such as crop production.

Spatial configurations, which is the costs and benefits of such land configurations, tend to be unevenly distributed among different social groups. In Brazil and Mexico these projects have had important social impacts and have led to widespread social mobilizations and opposition mainly by indigenous and local communities that are affected negatively by these projects and have little access to the benefits (Dunlap, 2018). The impacts of these projects range from displacements and human rights violations, to lack of adequate indigenous consultation processes and land grab-bing in the name of mitigating climate change (Baker, 2016; Amazon Watch, 2016; ALFF, 2015). Considering the socio-spatial and socio-technical components of the energy transition is therefore a key principle that must be taken into consideration by policy makers, placing considerable emphasis on issues relating to the distribution of costs and benefits (e.g. spatial and economic), and the representation and recognition of usually marginalized or groups (e.g. indigenous peoples and rural communities).

Finally, fossil fuel subsidies are still a reality in all three countries. According to the Brown to Green Report (2018) - 2018, G20 countries still spend as much as US $147 billion on subsidies for coal, oil and gas. In Argentina, fossil fuel subsidies reached US $6.9 billion in 2017 (Climate Transparency, 2018).

While Mexico has implemented a carbon tax it only amounts to aggregated US $3.5 per tonne of $CO_2$, recovering less from explicit carbon pricing than oil revenues (Climate Transparency, 2018). Emissions trading schemes have been proposed in Mexico and Brazil, yet the administrative costs of such schemes have proven to be costly and complex, which could hinder efforts to accelerate emissions reduction (Swyngedouw, 2011). 2018 Nobel Laureate in Economics William Nordhaus estimated in 2017 that the social cost of carbon in the US is close to US $31 per tonne of $CO_2$ (Nordhaus, 2017).

Similarly, a recent study for *Nature* (Ricke et al., 2018) estimates that the cost of carbon should be US $417 per tonne should the world seek to comply with the 1.5°C temperature limit. The Global Social Cost of Carbon (GSCC) captures the externality of $CO_2$ emissions (Ricke et al., 2018). However, this estimate shows that about 90% of the world's population has a positive Country-level Social Cost of Carbon (CSCC) which places a much higher burden on higher emitters such as the United States and China. Brazil and Mexico hold a similar estimate (US $24 (14–41) per $tCO_2$), while Argentina would have a lower cost, below US $20 per $tCO_2$.

Despite the wide application of carbon pricing schemes, price levels are often too low, therefore recognizing the need to reduce fossil fuel subsidies must be proportional to the implementation of a higher carbon tax. In summary, a carbon price can be a good tool to be implemented to incorporate the externalities of emissions, but a lot more study is needed to reach a global consensus on the right price.

## 3.1. Challenges

### *Argentina*

In Argentina, issues ranging from lack of financing for renewable energy to the lack of adequate norms for new technologies and value chains has effectively hindered the energy transition. That said, fossil fuel subsidies still present the main challenge for the country in terms of renewable energy integration. Subsidies for the transport and electricity sectors during the last decade have effectively distorted prices leading to a slow integration of renewable energy. As of 2017, the lowest cost of generation for renewable energy in Argentina is about US $55/MWh (MEM, 2017), compared to prices as low as US $20.53/MWh in Mexico and US $46.70/MWh in Brazil (IRENA, 2017).

Fossil fuels, nuclear energy and large hydropower dams represents 95% of primary energy in Argentina. These three energy resources present characteristics that are similar to each other. Each resource and its transformation technologies present a high concentration of physical, geographical and political power which can be seen in which capital is mobilized and invested for their extraction. This in turn yields an important control over the framing the energy sector and curtails policy decisions. This is particularly relevant considering the abuses of power and the involvement of energy officials and companies in corruption scandals and the lack of transparency in accountability that have perpetuated and maintained the use of fossil fuels.[2]

Issues surrounding non-conventional fossil fuel extraction technologies such as fracking, large hydropower dams and nuclear energy are framed under this context as a necessary condition to progressively phase out fossil fuels or produce a 'soft transition' towards a diversified energy mix with a greater role for renewables. The main arguments to maintain this discourse is that the energy grid still needs to rely heavily in "base loads" of energy, which cannot be delivered by the inter-mittence of renewable energy. However, in places like Argentina, large infrastructure projects and large capital investments represent long-term investments that might jeopardize the energy transi-tion for years to come, producing a technological lock in that would condition the country to sus-tain such negative practices.

Experiences such as this place an important role in the way that the energy transition must be designed by fostering the adoption of disruptive technologies (such as wind, solar and storage), paired up with a series of democratization schemes (such as the large scale deployment of distributed solar generation) and supported by adequate public financing and private risk-reduction mecha-nisms that could support grid modernization, user integration with renewable energy and give credits and reduce risks for citizens and for small and medium businesses to invest in renewable energy generation.

2 This issue is also reflected in Brazil and Mexico, with cases such as the Odebrecht Scandal. See: Proceso, 2018.

### *Brazil*

In Brazil, between 2013 and 2017, fossil fuel subsidies reached US $91 billion in the form of tax exemptions and government funded subsidies towards oil, natural gas and coal production as well as for the final consumption of gasoline, diesel and cooking gas. This represents an average of 1% of GDP (INESC, 2018). About 8% of this amount is in the form of financial support with the remaining 92% as tax exemptions. Although the themes of fiscal reform and the reduction of inefficient fossil fuel subsidies have been discussed since Rio+20 as one of the Sustainable Development Goals; subsidies remain and continue to expand with schemes, including the extension of REPETRO until 2040 and the creation of the Special Tax Regime (MP 795/17).

According to the WRI (2014), 62% of investments in the Brazilian energy sector from 2014 to 2023 will be directed at fossil fuels, compared with 22% for renewables. The most recent official plan for the energy sector (IEA, 2017) estimates that until 2026, the largest share of investments in the energy sector will still be directed towards the oil and natural gas sector (71.4%), while the power sector will receive 26.2% (including renewable and non-renewable) with the liquid biofuels sector will receive only 2.4% of total investments, estimated as US $423 billion from 2017 to 2026. To foster the energy transition in Brazil, and to meet the targets of the Paris Agreement, it is necessary to redirect investments and reduce subsidies for fossil fuels.

While some disincentives have been designed to discourage the use of fossil fuels in the power sector, the strategies appear contradictory. The Brazilian Development Bank has announced that it will no longer finance coal-based power plants, yet the country continues to receive a poor rating for phasing out coal as the government plans to increase coal power to 3.5 GW of installed capacity by 2026. And although the Brazilian government sets ambitious new renewable targets, current financial policies and regulations incentivize a dependence on fossil fuels. Brazil's fossil fuel subsidies as a share of GDP are well above the G20 average. Also, public finance favors the lock-in in carbon-intensive technologies, especially in long lifespan infrastructure projects such as refineries and fossil-fuel fired power plants, while the investment on renewable energy projects is three times lower (Climate Transparency, 2018).

The future role of renewable energy in Brazil is uncertain. Carbon-intensive technologies, especially in long-lifespan infrastructure projects such as refineries and fossil-fuel fired power plants, are still part of the policy agenda. The debate around a fair transition is not yet popular in Brazil, and most of its traits have focused on job creation, renewable energy integration and access to electricity. A more robust framing of justice, that focuses on a better cost distribution and the benefits of increasing renewable energy into the grid is still lacking. This framing must be supported by a clear narrative that advocates for a rapid reduction of fossil fuel subsidies and GHG emission reductions from other sectors.

### *Mexico*

Energy Reform in Mexico has transformed the structures that have governed the energy sector for over 80 years. The approval of the Electricity Industry Law (LIE) involved the creation a wholesale electricity market which included a clean energy certificate scheme and price-based auctions. The Energy Transition Law (LTE) established energy transition goals to generate at least 35% of electricity through clean energy sources by 2024. However, the Ministry of Energy's National Program for the Development of the Electricity Sector (PRODESEN) proposes the development of 48 new natural gas-based power plants and the retirement of 8 fuel-oil plants by 2032 (SENER, 2018). Also, the PRODESEN estimates that the Mexican Electrical System will increase capacity by 73% compared with 2017 and this additional capacity will consist of 45% of clean energy and 55% of conventional fossil fuel-based energy projects. The current future scenarios of the energy matrix are still far from fulfilling the Mexican Conditional NDC (a reduction of 36%), which is the only commitment in line with a 2°C pathway by 2030.

The current definition of clean energy in Mexico includes nuclear power, big hydropower and carbon capture and storage. This framing of the future of the energy sector has at least three main characteristics. First, it sends a clear signal to the market that decarbonization strategies will still support fossil fuels and controversial technologies (Caradonna et al., 2017). Second, it reinforces the carbon lock-in that will lead to stranded assets; and third, it does not consider the national or international carbon budget to meet the Paris Agreement's temperature limits. Mexico's energy related GHG emissions reductions are framed under a definition of clean energy that fosters and promotes a technocratic management of the energy transition process. However, the social and environmental impacts of large-scale energy projects in Mexico have become too apparent, and calls for a political and social framing of the energy transition are now part of the political debate.

Short term-planning remains focused on fossil fuels as the main source of energy generation. The latest prospective planning of the energy sector aims to invest US $25 billion in the construction of 48 new gas-fired combined cycle power plants totaling 28 GW by 2032 (SENER, 2018). The incoming administration is also considering increasing electricity generation through other fossil fuel and highly pollutant technologies such as fuel-oil and coal-fueled power plants. (Proyecto 18, 2018) This strong emphasis on natural gas and coal places Mexico as a country with high potential to experience stranded assets in the power sector by 2050 (IRENA, 2017). By 2030, the equivalent of 24.4 GW of Combined Cycle Gas Turbine (CCGT) power plants would be stranded, increasing to 36.2 GW by 2050. This investment would be equivalent to $94 million excluding gas pipelines and storage facilities (Chacón, 2018).

Production of natural gas has been declining since 2005, which is closely related to the Mexican oil production decline which peaked in 2004. Since 2011 Mexico has started building gas pipelines mainly with the focus on importing natural gas from the United States. Natural gas currently constitutes close to 55% of electricity generation, and Mexico has constructed 14 new pipelines and based on the Program for the Development of the Electric Sector (PRODESEN), the country will add 48 new combined cycle plants, which will effectively hinder its capacity to meet the 22% reduction in the NDC, not to mention the 36% conditional goal.

Finally, the framing for the energy transition has placed an important emphasis on technocratic management while little attention has been paid to the social impacts. Although Mexico has a high electricity connection rate - according to the Federal Commission of Electricity (CFE) 99% of households are connected to the grid - about 36% of households, that is more than 11 million people, lack adequate access to energy services and are considered energy poor (Graizbord, García-Ochoa, 2016). At the same time, of the 56 projects allocated by the last three Long-Term Auctions developed by SENER, at least 66% of the projects have faced some sort of delay, mainly because of local social conflicts surrounding the planning, development and/or operation of the projects (El Financiero, 2017).

## 3.2. Opportunities

### *Argentina*

Argentina's Renewable Energy law establishes goals for 8% renewable energy integration by the end of 2018 and 20% by 2025, including hydropower and biomass. The law also obliges companies with a high energy consumption to achieve a similar ratio. The cost of renewable energy in the allocated projects is $55/MWh, which is still high compared to other projects in Latin America. Nevertheless, Argentina's thorough review of its NDC could send a clear signal of the need to shift towards other forms of energy generation and reduce the social, environmental and economic consequences of maintaining risky practices such as fracking, nuclear power and building new hydro-power dams.

To place Argentina in a climate compatible transition path, it would be necessary to increase renewable energy penetration, but at the same time, change the commodification and centralized logic that has guided the exploitation of energy reserves in the country. An adequately framed energy transition would require incentives to increase distributed generation and foster other forms of electricity generation and grid modernization.

It is important to state that until 2018, none of the three countries analyzed had effectively addressed the energy transition from a justice perspective, nor adequately incorporated the social and political dimensions accurately in the framing, planning, development, operation and design of the energy sector. Governance for the energy sector has been heavily reliant on technical management and technological development, which has systematically depoliticized decisions over the energy sector, or rendered inherently political problems into technical solutions. However, the social and environmental costs of some large-scale infrastructure projects have systematically raised awareness of the need to frame this issue as a problem with social, political and justice implications and solutions.

According to REN21 (2018), during 2017 the renewable energy sector employed, directly and indirectly approximately 10.3 million people globally. IRENA estimates that this number will continue to grow to 24 million people worldwide by 2030. Currently, most of the employment is in China, Brazil, the United States, India, Germany and Japan. Around 17,000 people are currently employed by the renewables sector in Argentina and this could rise as high as 60,000 in the next five years given current policies.

### *Brazil*

In Brazil, the value chain of wind energy has been growing with the incentives provided by the federal and state governments (Tax exemption, long-term financing, etc.). In recent years, Brazil has evolved significantly its industrial model for the wind power sector, and wind turbine assembly and the manufacture of components (towers, blades, subcomponents of the hub and nacelle) are all carried out in Brazil, with a reduction in the number of imported items compared to previous years. However, progress in local knowledge has not kept pace. The knowledge that is most widespread in the country covers mainly the technology for the processing of goods: the assembly of wind turbines, steel making (cutting, bending, welding and painting), concrete manufacturing processes and the manufacturing of large components. The specific knowledge for the design of most of these components is still small and, given the potential for technology generation in the country, could considerably increase (ABDI, 2014).

Brazil has high solar potential throughout the year and has reserves of important raw materials for the solar industry such as silicon, aluminum and acrylic. Few components (cells, thin films etc.) are imported. However, Brazil continues to face technological and economic barriers to large-scale production. It is still about 60% more expensive to produce photovoltaic modules in Brazil than to import them, because of lower productivity in the Brazilian workforce and the cost of electricity, according to SEBRAE (2017).

Since the 1980s, Brazil has been encouraging energy efficiency measures. Although there has been a National Energy Efficiency Plan in place since 2011, enacting it has proven difficult. Brazil needs to invest more in energy efficiency programs and focus on the modernization of industry, the diversification of the transportation network and the implementation of policies to combat energy wastage and establish more stringent energy efficiency standards (Altoé, et al., 2017). The use of fossil fuels will still be essential in Brazil until at least 2035 (Chambriard, 2017) due to economic and technological issues, such as long-term investment and the lock-in conditions of certain technologies. However, to comply with the Paris Agreement's temperature limits, important steps are already being taken to discourage the use of fossil fuels in the energy sector.

In 2016, BNDES, the Brazilian Development Bank, announced that it will no longer finance fuel oil and coal thermopower plants, directing investments with the long-term interest rate for projects with high social and environmental returns (BNDES, 2016); at the same time, the BNDES decided to increase its finance allocation for solar energy wind power plants, biomass, cogeneration and small hydroelectric plants, to between 70% and 80%. Investments in coal and oil fuels, which are more polluting, will not be supported and the participation limit in large hydroelectric plants has fallen from 70% to 50%.

Biofuels continued to be Brazil's main source of job generation, having close to 800,000 jobs out of a total of 1.1 million employed in the renewables sector as a whole. Although the ethanol industry has continued to shed jobs, the biodiesel industry is on the rise. Solar PV represents a significant source of jobs in the renewable energy sectors of several Asian countries, including Bangladesh, Japan, Malaysia, the Philippines, the Republic of Korea and Singapore as well as countries such as Australia, Mexico, Turkey and South Africa.

### *Mexico*

With the proper incentives and institutional amendments, Mexico could increase renewable penetration rapidly and achieve sectoral mitigation targets. Even under a conservative scenario, there is still an additional 45.3 GW of installed capacity (59.6% of new installed capacity of electricity generation) from the total installed capacity in 2017 (75.68 GW) as renewable energy potential. Mexico has also held three long-term power auctions (2016, 2017, 2018), in which renewable energy accounted for 4% of all new energy added and where prices reached world record-breaking lows. The energy sector's emission reduction goals (22% based on the 2013 baseline) could be accomplished by boosting small and medium size projects and promoting community involvement in design, development, operation and ownership of the electricity sector and through including distributed generation paired with household energy efficiency measures. (SENER, 2018a)

Renewable energy projects (mainly solar and wind), are experiencing a significant at the same time that demand is rising by around 3% per year (SENER, 2016) and will nearly double by 2030 (SENER, 2015). That said, the next administration has placed considerable emphasis in the development of smaller scale and locally determined renewable energy projects and 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 pledging to install five million solar rooftops within the same timeframe. Nonetheless, at the same time, the priority for infrastructure projects is to build more gas-based power plants, while the market is still pursuing large investment in large-scale utility solar and wind farms to 2024.

The Mexican Energy Reform of 2013 placed emphasis on the modernization of the electricity sector by increasing the participation of the private sector, turning commercial actors into prominent players in the design, implementation and development of the electric grid, while concentrating power and decision-making in certain and specific actors, sectors and networks. Consequently, a more coherent approach to the governance of the energy sector is urgently needed to address the justice and distributional effects of the costs and benefits of the energy transition.

Framing the energy transition as a low-cost opportunity for private investment has paid off: As of 2018 it is cheaper to invest in renewable energy, where costs for wind and solar are among the lowest worldwide. At the same time, the current investment portfolio in renewable energy will add US $29 billion in the next 15 years and will create more than 200,000 jobs in the renewable energy sector in Mexico, both directly and indirectly (CCE, 2018). Some technical difficulties remain. The modernization and expansion of the transmission and distribution networks to increase renewables integration is necessary but so far remains very limited. At the same time, smaller scale projects are often still to be properly integrated while access to distributed technologies, such as solar for households and small businesses, remains patchy (CCE, 2018). Social issues and local impacts of national renewable energy policies are still the main challenge facing a fair energy transition in Mexico. Addressing these would require more democratic access to electricity, the development of adequate spaces for planning and integrating different future visions where renewable energy plays a key role in maintaining social wellbeing and local practices, while at the same time reducing GHG emissions and caring for the environment.

## 4. CONCLUSIONS

The IPCC Special Report on 1.5°C issued a clear warning of the consequences of the increase of global temperature, pointing out that an increased warming of 0.5°C by 2040 would have catastrophic consequences. It is only fitting that a few weeks before the publication of this report the Latin American continent adopted the Escazú Agreement, which not only fosters the need to effectively increase ambition levels to meet the Paris Agreement's temperature limits with transparency and accountability but is also a supporting instrument in Latin America's drive to foster a just energy transition.

While all three countries have increased renewable energy participation slightly in the last decade, there seems to be a lack of discussion over the issue of how these technologies and their benefits must be distributed and integrated into national and local politics. This raises important questions: How should countries in Latin America increase energy generation to address future demands?; What technologies should be used?; What social and environmental impacts will derive from these decisions and what group of society will be most affected, locally, nationally and internationally?

It is also important to mention that by addressing the energy transition as a social and political issue, countries like Argentina, Brazil and Mexico could address climate change in a more democratic way by increasing citizen participation and interaction with the energy transition process. This could happen through large scale solar distributed generation and grid modernization schemes, and at the same time reduce costs, volatility and the climatic and environmental implications for future generations associated with the dependence on fossil fuels, uranium mining and waste. This would also be a fundamental policy to reduce the risk of social, technological, political and economic lock-ins that would condemn the energy future of these countries to the continued building and maintenance of large infrastructure projects, while also perpetuating the use, exploitation and importation (and/or exportation) of hydrocarbons while unevenly distributing the costs and benefits resulting from the energy transition.

Energy transitions are not neutral in the social and political context of Argentina, Brazil and Mexico. In other words, the social, political, economic and technical dimensions of the energy transitions play an important role in blocking, facilitating, delaying or reorienting how the energy transition takes place. It is therefore important to identify and address barriers and opportunities for low carbon energy development. Argentina is dangerously investing in the exploitation of both conventional and non-conventional hydrocarbons associated with high social and environmental impacts, while Mexico and Brazil have both announced plans to build more fossil fuel dependent large-scale infrastructure despite clear signs of renewable energy being inherently more accessible, lower cost, reliable and democratic.

**Argentina** has significant potential to increase its renewable energy to decarbonize and decentralize the energy mix and reduce energy poverty, and yet policy making is still seen through the prism of technical and technological development. A broader approach to address social justice issues through energy innovation could be a significant avenue to explore.

**Brazil** is one of the countries with the lowest emissions in the energy matrix in Latin-America and its energy intensity has remained stable since the 1990s (Climate Transparency, 2018). Among the G20 it was one of the largest investors in renewable energy in the last decade. However, more than half of its energy mix is still represented by fossil fuels, far from what is needed to keep climate change under control. In the power sector, the use of fossil fuels will still be essential until at least 2035 (Chambriard, 2017) due to economic and technological issues. However, to comply with the Paris Agreement (Cop-21), important steps are already being taken to discourage the use of fossil fuels. New forms of political uncertainties regarding climate change and the role that the Nationally Determined Contribution as well as other previous commitments to curb emissions will play in national politics are part of an uncertain future for the energy transitions in Brazil.

In **Mexico**, electricity reform has yielded important results: Distributed generation has been fostered by the Ministry of Energy and is now regulated under a net-metering and net-billing framework (DOF, 2017). The Long-Term Auction process, which allocates future generation, potency and Clean Energy Certificates (CER) within the market has proven to be an important success for energy sector, while the adoption of short-term goals within the electricity sector has sent clear signals to the market, where renewable energy technologies are more cost competitive. Nevertheless, pressure to increase the exploitation of oil and gas, particularly through highly pollutant non-conventional technologies, remains one of the key issues to overcome in the short term (Proyecto, 2018). The technocratically managed energy sector is also a key obstacle to consider in addressing Mexico's climate change targets, and also as a means to effectively address the energy transition from a justice perspective.

**Argentina's** NDC is currently highly insufficient to comply with the Paris Agreement's targets (CAT, 2018) despite being developed and systematically reviewed. To rapidly decarbonize the energy sector and to avoid the extraction of non-conventional sources will definitely address the Paris Agreement's targets and could also hinder Argentina's efforts towards sustainable development.

The **Brazilian** NDC will suffice until 2030 but for the long-term, a low-carbon strategy should be developed as energy is key for economic development. Renewable energy in Brazil is advancing rapidly and the energy transition will inevitably take place along with the country's technological-economic evolution, but the question that remains is: Will it be fast enough?

The **Mexican** NDC has placed most of its focus on the electricity sector while being more lenient to other carbon-intensive practices and sectors such as transport and manufacturing, which also contribute significantly to overall Greenhouse gas (GHG) emissions. Mexico's conditional NDC is currently not on course to meet the Paris Agreement's temperature limits despite Mexico's commitments to reduce GHG emissions in both the NDC and the General Law on Climate Change (GLCC).

Given the growing ambition surrounding the Paris Agreement and the IPCC's Special Report on 1.5°C, all three countries will have to present updated more ambitious NDCs by 2020, which must effectively meet the Paris Agreement's decarbonization pathways to 2°C by the end of the present century, with the clear goal of maintaining efforts to achieve a 1.5°C limit (UNFCCC, 2015). This makes 2020 a threshold year that would require a substantial increase of ambition in all NDCs and, echoing the recently adopted Escazú Agreement, the implementation of measures through a series of transparency, accountability and justice measures and conditions in Argentina, Brazil and Mexico.

Finally, increasing the spaces for social participation and innovation is a key measure to address the energy transition process. All three countries have had reactionary policies towards the adoption of environmental and energy policies and regulatory frameworks. But integrating social innovation, understood here as the process of challenging, altering, or replacing the dominance of existing institutions in a specific social and material context (Haxeltine, et al., 2017), could allow for other forms of renewable energy integration. This could help decentralize and democratize the energy matrix, increase social participation in the design of the energy transition and effectively address social and locally determined needs, while reducing the social and environmental costs (including climate change) associated with intensive resource extraction technologies and large-scale infrastructure development.

### 4.1. Elements for discussion

The energy transition process has been framed as a purely technocratic and economic process in each of the three countries, with few voices from different sectors advocating for a broader approach that includes the social dimension of the energy transition. The IPCC report has placed new and urgent emphasis in the need to accelerate the energy transition, which will include accelerating renewable energy participation in the energy matrix. However, the techno-fixes advocated by the IPCC's SR 1.5°C, again fall under a technocratic management where the accelerated deployment of renewable energy and other climate fixes fails to integrate a social dimension and a justice component to the energy transition process.

In all three countries there is still a need to adequately recognize the social and spatial configurations that result from a transition from fossil fuels to renewable energy. Large scale renewable energy has effectively reduced levelized costs, placing it in a more competitive playing field with conventional fossil fuel generation (Lazard, 2018). This could avoid investments that could lead towards a social, economic, political and technological lock-in that would in turn not only perpetuate fossil fuel use, but hinder efforts to increase climate change ambition to address the Paris Agreement. Here it is essential to increase participatory and representative spaces for a democratic decision-making with regards to the design and planning of the energy sector. Creating such spaces would need to recognize the different scales of renewable energy projects, their impact on the electricity gird and the social configurations that result from their integration (Miller, et al., 2013). At the same time, this would also increase the way in which different publics and/or social groups frame, design and innovate the way in which renewable energy is integrated into their daily lives and their futures.

Although a more thorough approach is still needed to develop specific policies for each country to aim towards a just energy transition in both the short- and long term, some of the recommendations and lessons learned from this paper are presented here. Argentina, Brazil and Mexico could become regional and global leaders in the fight against climate change and in the adoption of a socially just energy transition by implementing the following recommendations:[3]

1. Rapidly accelerate renewable energy integration in the power sector to achieve Paris Agreement objectives and avoid the lock-in to carbon-intensive technologies that infrastructure plans in all three countries currently entail;
2. Recognize and implement a progressive tax on fossil fuels, based on the externalities of GHG emissions. This is a key policy that must be undertaken in each country.
3. Clearly address and redistribute the costs and benefits of an energy transition. This means incorporating locally determined needs into national energy planning; adapting technologies through social innovation; and recognizing social and environmental limits in the planning of the energy sector (i.e through addressing demand, fostering behavioral changes through policy and reducing consumption), this must be paired with a more efficient and renewable-based energy generation.

3 The policy recommendations are not listed in any particular order.

4. Avoid the exploitation of non-conventional oil and gas reserves based on the associated impacts they generate socially and environmentally. This would send clear signals to the market and increase renewable energy penetration in to the matrix, and effectively accelerate the 'transition period' which has effectively prevented actual integration of clean and renewable technologies;
5. Start to redirect investments from Exploration and Production in the oil and gas sectors to other promising renewable energy sources. New public investment should be directed towards the development of a democratized, decentralized energy matrix, which includes energy storage, smart grid technologies and recognizes the value of social innovation;
6. Adequately incorporate the social and spatial dimensions of the electricity sector through planning and governance instruments, strategies and policies. Instruments such as the Indigenous consultation, based on the ILO's 169 Convention and the Social Impact Assessment (SIA) must be incorporated as a preventive planning instruments and not as rubber-stamping activities;
7. Increase the participation of citizens, neighborhoods, indigenous rural and urban communities, and small businesses in the design, ownership and deployment of renewable energy projects. This would effectively help to address the energy transition from a distributive justice approach by spreading risk, costs and benefits among the different sectors of the population;
8. Increase solar distributed generation through a comprehensive national plan that addresses regulation and tax issues; helps the poorest population to invest in its own solar generation with facilitated financing conditions, and reduces risks from private banks and lenders to support such schemes;
9. To foster a just energy transition, and to meet the targets of the Paris Agreement, it is necessary to redirect investments and rapidly eliminate fossil fuel subsidies. The latter point must be supported by a national plan to help mitigate the costs that this would impose on the most vulnerable sectors and actors (i.e. poor households);
10. Harmonize the climate and energy policies, through a long-term and sectoral decarbonization strategy, particularly for the energy sector to comply with the Paris Agreement's temperature limits.

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