# 6 Contradictions Between Energy and Climate Change Mitigation Policy in a Country with Oil Reserves: The Case of Mexico

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## 6.1 Introduction

Mexico's present-day heavy dependence on fossil fuels rests on the discovery and exploitation of national stocks in the twentieth century. The Cantarell field, discovered in 1958, was of predominant importance here. Its vast reserves incentivized the consolidation of an oil-based energy policy. As a consequence, the energy matrix became weakly diversified. On the other hand, the discovery of the Cantarell field generated steady revenues from crude oil exports, topping 40% of overall federal revenue in the 1980s and averaging roughly 22% between 2012 and 2021.[1] To a very large extent, these rents were used to finance running public expenditure (Campos, 2016). Consequently, investment in exploration and restitution of fossil reserves fell far behind, and even more so, the improvement of energy resilience through the diversification of the energy matrix.

These realities, heavy fossil-fuel dependence and run-down discovered stocks, will be central in addressing the evolution of energy security in Mexico. We thereby hinge on the current perspective on energy security, which emphasizes the need for low greenhouse gas (GHG) emissions from energies consumption and generation, as well as from extraction processes (World Energy Council, 2018, 2020; Ang et al., 2015; Podbregar et al., 2020; Sovacool, 2013; Cherp & Jewell, 2014), which argues that energy security must be sustainable.

The extant literature finds that Mexico's energy security has declined in recent decades (Puyana & Rodriguez, 2020, 2022; Rodríguez, 2018). This is explained firstly by a fall in oil production owed to declining reserves, secondly by a high dependence on oil derivatives, and thirdly and foremost by a high dependence on natural gas.

Looking at the current energy matrix from a climate policy perspective, the poorly diversified energy matrix translates into high and persistent levels of GHG emissions. Complying with international commitments to curb GHG emissions will thus be hard and mitigation objectives could be at risk, even when these merely consist of halting the growth of GHG emissions as in the case of Mexico. Mitigation policies spare large parts of the energy sector despite its heavy impact on

Disclaimer: The authors take the full responsibility for the content of this publication.

[1] Author's own calculations based on Banco de Mexico (2022).

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emissions. This may be due to a lack of policy integration between the energy and climate change policy, as well as a lack of collaboration by policymakers involved in either one of the policy domains, see Ortega and Casamadrid (2018).

In this context, the objective of this chapter is to analyze the nexus of energy and climate-change policy on the one hand and the policy goals of energy security and climate-change mitigation on the other hand. The hypothesis we propose is that the disconnection of both policy areas causes severe contradictions, which in turn hinder the achievement of policy goals. For the part of the energy policy, the disconnection can be explained by the oil reserves that were added with the discovery of the Cantarell field. This situation has led to a lack of interest in diversifying the energy matrix and significantly increasing renewable energies. Therefore, it seems that energy policy has been focused on strengthening fossil fuels, even today and due to the recent energy reforms in 2013. Meanwhile, climate policy mainly saw advances in institution building and, as of now, fails to lead to a turnaround in GHG emission trends. However, this may be so because climate policy came into being much more recently than energy policy.

We chose the interaction of these two policies, because, historically, the energy sector is the leading $CO_2$ emitter in many countries. In the case of Mexico, the energy industry contributed 68% of net emissions and is therefore critical when it comes to mitigation efforts. For the analysis, we took up the methodological proposal of the Energy Trilemma (World Energy Council, 2018, 2020), which proposes a vision of energy security and gives an essential role to sustainability through the promotion of renewable energies. Its approach to evaluating the evolution of energy security consists of three dimensions (energy security, energy equity, and environmental sustainability). However, for our analysis, we redefined the trilemma into four categories to consider the Mexican context (Energy Independence, Energy Resilience, Energy Affordability, and Reduction of emissions). Qualitatively assessing how policy measures contribute to each of these categories enables us to evaluate to what extent the instruments of both policy fields are aligned. To do so, we searched public documents and academic literature to gather evidence of the impacts of single policy actions. The analysis considers the energy policy at three levels (Upstream, Midstream, and Downstream). It is expected that some of these strategies trigger changes in one of the most polluting sectors, thus reducing $CO_2$ emissions.

After this brief introduction, the chapter is organized as follows. The following section presents a short review of the bases of the energy security concept to take up the approach proposed by the World Energy Council (2018) and define the categories that we will consider to carry out the qualitative analysis of the energy sector and environmental policies. In Sects. 6.3 and 6.4, we present a brief review of the evolution and conformation of the energy sector and environmental policy. Section 6.5 applies the four categories to analyze the alignment of both policy fields. The last section brings together the main findings of this research.

## 6.2 Concept of Energy Trilemma and Methodology

Energy is central to any nation, regardless of its development, hence the importance of energy security. Evidence can be found in the OPEC supply cuts of the 1970s, causing oil prices to rise sharply and high inflation in various countries, especially developed oil-import-dependent countries. By means of its strategy, OPEC caused significant economy-wide and energy-sector-specific impacts prompting political changes. In the affected countries, the discussion focused on oil due to its predominance in energy matrices around the globe. The International Energy Agency (IEA) – in its beginnings a club of oil-importing countries – defines energy security as uninterrupted access to energy sources at an affordable price. To guarantee energy access, strategies focused on avoiding unplanned interruptions in oil supply that could bring economies out of balance by affecting the entire supply chains (IEA, 2022). To guarantee energy security in the 1970s, the measures implemented by most of the oil-dependent nations, especially the United States, were (1) to diversify oil markets with new domestic and foreign suppliers in order to limit imports from OPEC; (2) to promote other energy sources: coal, gas, and nuclear energy; (3) to reduce energy consumption and the energy intensity of the national economy, and only in the 1990s renewable energies began to be promoted (APERC, 2007).

The foundations of energy security between the 1970s and the end of the twentieth century focused on maintaining access to energy at affordable and fair prices. However, at the beginning of this century, discussions broadened toward environmental sustainability in response to environmental movements that associate temperature increase with fossil energy extraction and consumption processes (World Energy Council, 2018, 2020; Ang et al., 2015; Podbregar et al., 2020; Sovacool, 2013; Sovacool, & Mukherjee, 2011). In this context, current views on energy security make reference to (1) global factors that affect all countries and that are largely immune to policy responses, (2) country-specific factors such as the resource base, stage of economic development, population density, climate, and others, (3) technological innovation and adoption, and (4) energy policies.

Taking into consideration this new vision of energy security, for the present analysis, we consider the Energy Trilemma's methodological proposal, which is a concept developed by the World Energy Council starting in the 2000s, and much of its underpinning was the early reports of the International Panel on Climate Change (IPCC). This methodology states that for an energy system to become sustainable, its three axes must be considered: energy security, energy equity, and environmental issues. It should be noted that all of these are interrelated, and in order to achieve sustainable and fair energy security, an optimal point between the three must be found. Figure 6.1 shows the three categories of the analysis and the variables included in each.

Each category includes the following topics: Energy security consists of guaranteeing that the

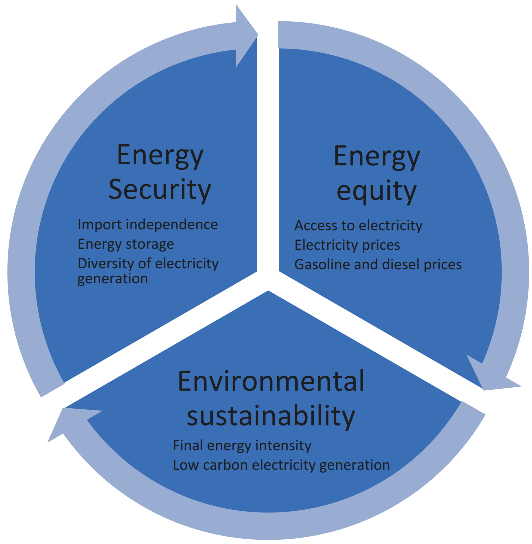


**Fig. 6.1** The Energy Trilemma. (Source: Authors Elaboration based on World Energy Council, 2022)

energy system is highly reliable from all points of view, from the supply of primary energy to the delivery to the end user, that it is resilient to climatic phenomena and cybernetic attacks, etc. On the other hand, energy equity refers to ensuring that the entire population has physical access to commercial energy, as well as economic access, that is, ensuring costs that allow accessible prices to the entire population (Heffron, McCauley, & Sovacool, 2015). And the environmental issue is to minimize, as far as possible, emissions of GHGs and local pollutants. These three vectors must be balanced, moderating existing trade-offs such as affordability on the one hand and energy transition toward renewable energy sources on the other.

This new energy security vision specializes in the inclusion of energy equity and sustainability issues. In this way, a holistic concept of energy security is proposed, in which each category is related, and their related mechanisms are created to guarantee energy security. For example, the diversification of sources and, mainly, the promotion of renewable energies allow reducing emissions from one of the most polluting sectors. Additionally, it positively affects energy independence, especially if the country is an importer of fossil energy sources. Other factors, such as energy intensity and efficiency improvements, are strategies that reduce energy consumption and help improve energy security.

Based on the notion of the Energy Trilemma and in the 4 A's (Availability, Accessibility, Acceptability, and Affordability) proposed by the Asian Pacific Energy Research Centre (APERC, 2007), we define four categories of policy goals: (1) Energy Resilience, (2) Energy Independence, (3) Energy Affordability, and (4) Reduction of Emissions (see Fig. 6.2). The first category is formulated from the most basic view of energy security, which considers the diversification of sources a central element in guaranteeing energy access. In this case, it is of utmost relevance that the energy system ensures access to energy through renewable sources. This vision of resilience, based on increased renewable sources, allows for better integration between energy and environmental policy. The second category is justified by the strategies that can be implemented in the energy system to reduce energy dependence; therefore, any policy aimed at reducing energy imports will have a positive effect. The third category addresses the issue of access by cost, so any measure that puts upward pressure on the price of energy can have a negative impact. In this case, the collateral effects of environmental policy can have significant repercussions on access to energy due to the (excess) financial burden incurred by the energy transition, which ultimately has to be paid for by society at large. Finally, the sustainability category reinforces the basis of the new vision of energy security based on increased consumption of renewable energy. Therefore, any progress in improving the share of renewable energies positively relates energy policy to environmental policy.

We performed a screening of the extant literature strictly concentrating on the Mexican context on the one hand and on policy instruments of both domains (energy and climate) on the other hand. Based on the evidence presented in the selected literature, we qualitatively assess each instrument as to whether it supports or compromises any of the policy goals. Based on our find-

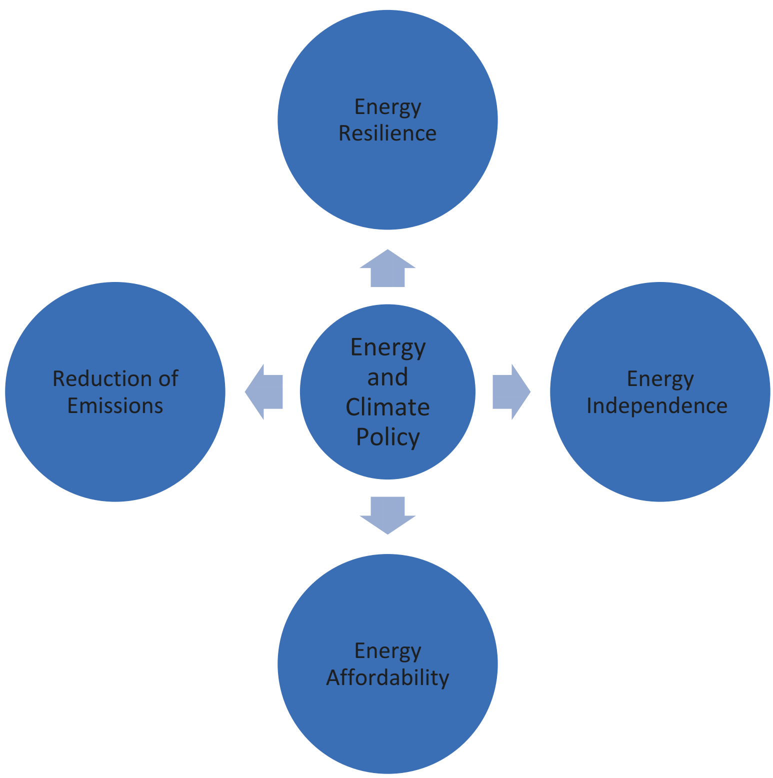


**Fig. 6.2** Four categories of policy goals. (Source: Authors' elaboration)

ings, we synthesize by identifying inconstancies of across the totality of instruments.

## 6.3 Structure of the Mexican Energy Sector

In the introduction, we mentioned that a large part of the evolution of the energy sector and energy policy is explained by the discovery of the Cantarell field in the 1970s. Figure 6.3 shows that despite a downward trend over the past two decades, in recent years, the share of oil still exceeds 50%. On the other hand, the share of natural gas has grown about seven percentage points in the period under analysis. For electricity generation, it has even become the most important source (SIE, 2022). Lastly, renewable energy sources constitute for barely more than 10% of the energy mix, despite the implementation of dedicated policies, including the 2013 energy reform. In sum, in terms of energy production, no considerable changes have occurred and less polluting primary sources, in this context natural gas and renewables, continue to occupy minor shares.

The depletion of oil reserves, coupled with the fall in the production of this resource, which is still central to the energy structure, has caused a setback in energy security (Puyana & Rodríguez, 2020). This is explained by the exploitation of 85% of its proven reserves between 1990 and 2018 and a decline of 45% in crude oil production between 2008 and 2020 due to the depletion of Cantarell and the lack of investment in exploration (SIE, 2022). This situation was the main reason behind the formulation and implementation of the energy reform in 2013, which aimed to increase oil production to 3.0 million barrels per day, thus continuing the role of Mexico as a crude oil net exporter. It should be noted that after 10 years since the energy reform of 2013 was signed (Peña Nieto Administration, 2012–2018), the private investments in exploration have been meager, and PEMEX continues to be the largest investor in exploration and production. On the other hand, the lack of investment in petrochemicals and natural gas has increased the dependence on gasoline and natural gas imports for power generation. This situation also contributes to the loss of energy security, since, on the one hand, imports increase and, on the other hand, these imports come from only one country, the United States.

Natural gas has occupied a central place in the energy matrix, and this evolution has to do with its participation in electricity generation.

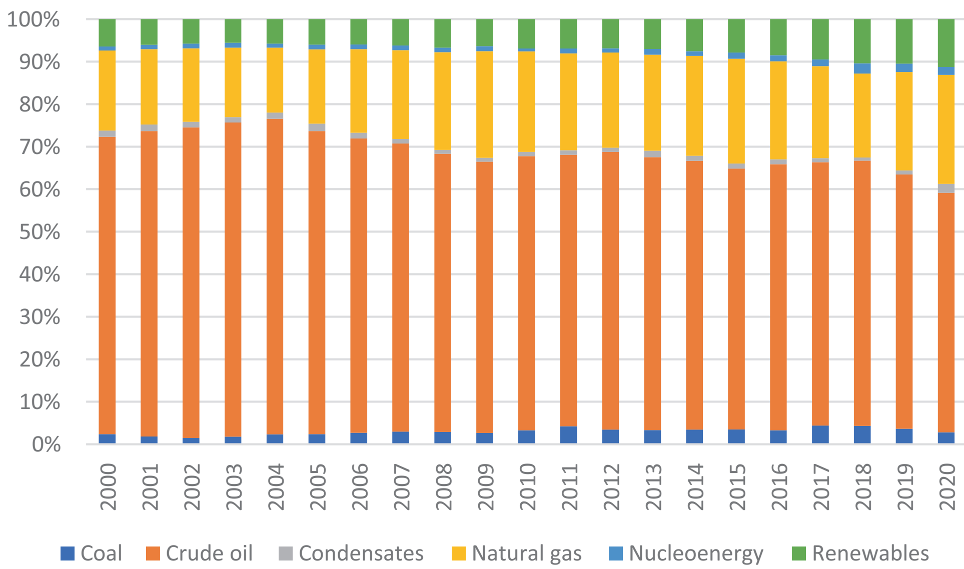


**Fig. 6.3** Composition of energy supply by source. (Source: Author's elaboration based on SIE, 2022)

According to SENER (2021), electricity generation rests to 81% on fossil fuels (60% natural gas, 11% coal, 10% oil), to 3.8% on nuclear power, and the rest is composed of different renewable energy sources (10% hydro, 2.6% wind, 2% geothermal, 0.5% biofuels and waste, 0.1% solar). The growth of natural gas consumption in Mexico has been possible thanks to imports from the United States. Until 1990, domestic production of and demand for natural gas were in balance in Mexico. From that year onward, consumption began to grow at high rates and skyrocketed from 2010 onward, without domestic production being able to keep up in the same pace. Between 2014 and 2018, imports from the United States doubled to an average of 4.9 billion cubic feet per day, mostly from South Texas (SIE, 2022). Statistical evidence clearly shows the extent of import dependency: In 2017, 94% of natural gas imports in Mexico depended on a single country, the United States, and by 2019, this figure had risen to 96% according to data from the National Hydrocarbons Commission (CNH). The growth of imports from the United States and the construction of infrastructure have run in parallel: interconnections and pipelines, as well as processing, storage, and distribution facilities. According to EIA (2018), the pipeline capacity between the United States and Mexico increased by 226.47% between 2011 and 2018, from 3.4 billion cubic feet per day (MMcfd) to 11.1 MMcfd.

Despite a higher share of renewable energies at present (19%), the composition of the energy matrix shows a higher percentage of gas and little reduction in coal consumption. Additionally, oil still represents more than 50% of the energy matrix. Thus, the few changes in the energy matrix in the last decades show little energy transition in the country, even though Mexico has recognized and ratified every international agreement against global warming (the following section breaks down the various environmental policies applied in the sector).

Specialized information shows a very slow transition in the energy matrix, and something similar happens in electricity generation. According to SENER data (2021), the largest source of electricity generation in 2019 is of fossil origin, 81% (this percentage includes fuel oil and gas), and renewable energies, 19%, generate only a minor proportion. It is worth noting that of this proportion, hydropower (10%) has the largest share, while solar and wind combined only contribute 2.1%. In the best-case scenario, the share of the latter two sources is expected to grow to 8% by the end of 2022. From the perspective of climate policy, the origin and evolution of greenhouse gas (GHG) emissions are central. According to the Mexican national GHG emission inventory, total emissions have grown from some 466 $MtCO_2e$ in 1990 to 736 $MtCO_2e$ in 2019. However, the increase slowed down in recent years. While in the 1990s and 2000s, the running 5-year average for overall emission growth was between 1.6% and 3.3%, in the 2010s it dropped to 0.1–0.5%. Looking at the sources of emission, it becomes clear that Mexico's GHG emissions are driven by energy-intensive economic growth (Pulver, 2009). The national emission inventory reveals that energy production, as well as transportation, had a higher share of total emissions in 2015–2019 (26% and 22% respectively) than in 1990–1994 (23% and 21% respectively). Moreover, industrial processes, as well as waste treatment, gained, while the share of agriculture (gross emissions) diminished.[2]

## 6.4 Climate and Energy Policy in Mexico

**Energy Policy** As outlined above, Mexico's energy policy was and still is based on oil extraction and consumption because it possessed abundant and cheap oil reserves. Therefore, oil becomes and consolidates as the primary energy source for the energy matrix and as a source of economic resources to sustain economic and social development. Despite being at the center of energy and fiscal policy, oil was not given the treatment of a strategic resource, as reflected in

[2]For the emission data, which also permitted the authors calculations of the emission growth rate, see INECC and SEMARNAT (2021).

the lack of restitution of reserves due to the low level of investment in exploration.

SENER's reports reflect a concern about the loss of energy security. Additionally, the importance of investing in exploring new areas, the non-conventional resources found in shale basins and deep waters, has been recognized by policymakers to reverse the reserve trend. However, one of the characteristics of this type of resource is that it requires more significant technological, financial, and execution potential to extract this type of hydrocarbons. Given this situation, the energy reform in 2013 consisted of modifying the institutional framework to open the sector to private investment and thus obtain the resources to finance the exploration of more expensive wells. In addition to opening the sector to private investment, the following objectives were also added to the energy reform: (1) To maintain the Nation's ownership of the hydrocarbons in the subsoil; (2) to modernize and strengthen, without privatizing the state-owned companies PEMEX and the Federal Electricity Commission (the Spanish acronym is CFE); (3) to reduce the country's exposure to financial, geological, and environmental risks in oil and gas exploration and extraction activities; (4) to allow the nation to exercise, in an exclusive manner, the planning and control of the national electric system, to benefit a competitive system that allows reducing electricity prices; (5) attract more significant investment in the Mexican energy sector to promote the country's development; (6) to have a sufficient supply of energy at better prices; (7) to guarantee international standards of efficiency, quality, and reliability of supply, transparency, and accountability; (8) to effectively fight corruption in the energy sector; (9) to strengthen the administration of oil revenues and promote long-term savings for the benefit of future generations; (10) to promote development with social responsibility and protect the environment.

Each of these proposals had the following objectives (according to the executive summary of the reform)[3]: (1) To lower electricity fares and lower natural gas prices; (2) to achieve restitution rates of proven oil and natural gas reserves higher than 100%; (3) to increase oil production to 3.5 million barrels per day by 2025. In addition, it will increase natural gas production to 10.4 billion cubic feet in 2025; (4) to generate nearly two percentage points more economic growth by 2025; (5) to create close to half a million additional jobs in this six-year term, reaching 2.5 million jobs by 2025; and (6) to replace the most polluting power plants with clean technologies and promote the use of natural gas in electricity generation. As can be seen, the envisioned outcomes of the energy reform in the medium term can be summarized as increasing reserves and extraction of crude oil and, to a lesser extent, of natural gas through public or private investment. On the other hand, renewable energies are mentioned, but the strategy to increase their participation in electricity generation is unclear.

Two elements were central despite the breadth of the energy policy proposed in the 2013 reform and the attempt to shift towards renewable energies to incorporate environmental issues. On the one hand, the participation of the private sector in extraction and, on the other hand, the integration of long-term auctions and clean energy certificates in electricity generation (Alpizar-Castro & Rodríguez-Monroy, 2016; Comisión Reguladora de Energía, 2017). In both cases, the results were meager. The current administration under President Andres Manuel Lopez Obrador has made its position clear: the oil industry must be revived as a trigger for the nation's development (DOF, 2020). In the same line, the energy policy supported by the current administration comprises (SENER, 2021) (1) a (partial) departure of the energy reform of 2013; (2) a commitment with OPEC Plus to maintain production of 1.753 million barrels per day of crude oil without cuts; (3) a rehabilitation of the National Refining System and the construction of the Olmeca refinery in Dos Bocas; and (4) allocating some 54% of electricity generation through renewables is granted to the CFE and

[3]For further details of the executive summary, please visit the following link: https://embamex.sre.gob.mx/suecia/images/reforma%20energetica.pdf

46% to private companies. The oil sector is considered a critical sector for the country's development. According to the abovementioned points, we can argue that the current administration's energy policy is to strengthen fossil fuels again (greater oil extraction and gasoline production). This strategy is justified by two arguments. On the one hand, more gasoline production will reduce imports of these and thus advance energy security. On the other hand, with the strengthening of PEMEX and CFE, the "Rescue of the energy sector" is sought. One of the sectors seen as a lever for national development is the promotion of economic growth and employment (National Development Plan, 2019–2024).

**Climate Policy** Mexican politics has embraced questions concerning climate change since the 1990s and shows nearly continuous action until the present day. It took part in the run-up of the 1992 Rio Earth summit, saw the beginnings of policy integrations via an "intersecretarial committee" at the federal level, ratified the Kyoto Protocol in 1998 as a Non-Annex I country, saw a formalization and increasing steadiness culminating in the General Law on Climate Change (GLCC) in 2012 and most recently announced its 2020 Nationally Determined Contributions (NDC's) before the UNFCCC (Pulver, 2009; Gobierno de México, 2020).

As part of the mechanism of the UNFCCC Paris Agreement of 2015, the Mexico presented NDC's in 2016 and 2020 (Gobierno de Mexico, 2020), where in the latter it unconditionally pledges a 22% reduction of GHG emission in 2030 vis-à-vis the business-as-usual (BAU) scenario (conditionally 36%). A short overview of targeted emission levels and a change from the 2016 NDCs to the 2020 NDCs can be seen in Table 6.1. It shows that Mexico has not increased its ambition. On the contrary, based on a more pessimistic BAU scenario from 2020, the pledges of the NDC 2020 would lead to higher GHG emissions in 2030.

Amid moderate ambition levels, Mexico has implemented several climate policy measures, comprising monitoring, mitigation, and adaptation instruments at all levels of government. However, the implementation status, especially at the state level, is slow, see Lopez and Laguna (2020). This text will concentrate on the measures closely related to the energy sector for obvious reasons. Among these, perhaps most prominently, are the steps taken as part of the 2014 fiscal reform. From a climate policy perspective, it mainly consisted of a change of the motor fuel tax and the introduction of a carbon tax.[4] The latter, which taxes different types of fossil fuels except for natural gas, currently imposes an average charge equivalent to 1.56 EUR/t$CO_2$ on average and covered some 58.1% of national $CO_2$ emissions (OECD, 2021). The motor fuel tax was transformed from a (fuel) price smoothing instrument into one with fixed rates aiming at excise taxation, thereby contributing to phasing out fossil fuel subsidies.[5] Moreover, it may be interpreted as an implicit carbon tax, which in 2021 exerted a carbon price equivalent to 25 EUR/t$CO_2$, covering some 31.1% of national emissions (OECD, 2021).

Thus, in Mexico, there currently is a carbon tax with relatively wide coverage and a rate that is comparable to other countries in Latin America, yet low in contrast to the European Union or regulated regions in North America and Europe.[6]

[4] Both taxes, the motor fuel tax and carbon tax part of the Law on Special Taxes on Production and Services (IEPS – Ley del Impuesto sobre Producción y Servicios), see DOF (2021).

[5] A fiscal stimulus, which could be applied ad-hoc and would reduce the tax rate on a % basis, was phased out in 2017, see Arlinghaus and van Dender (2017). However, it was reintroduced in the wake of the pandemic and reinforced during the war in Ukraine in 2022. During March 19–25, 2022, it consisted of a 100% reduction of the fuel tax (IEPS) for gasoline and diesel alike. Moreover, an additional stimulus was granted ranging from 1.30 MXN to 2.10 MXN, depending on the type of fuel. See http://www.dof.gob.mx/nota_detalle.php?codigo=5646110&fecha=18/03/2022 (accessed March 24th, 2022).

[6] Among the growing number of countries that have implemented carbon pricing instruments, Mexico is located at the lower end of the spectrum. While in Latin America, carbon prices are of same order of magnitude as in Mexico (Argentina, Chile, and Colombia have carbon prices of are around 5–6 USD/tCO2), in the United States and Canada, we find a range of 7–36 USD/tCO2 and in Europe of 1 to 137 USD, with the majority of countries having prices of

**Table 6.1** Mexican greenhouse gas emission pledges 2016 and 2020

| | NDC 2016 | | NDC 2020 | |
|---|---|---|---|---|
| | Reduction relative to BAU | GHG emissions in $MtCO_2e$ | Reduction relative to BAU | GHG emissions in $MtCO_2e$ |
| BAU scenario GHG emissions in 2030 | – | 973 | | 991 |
| Unconditional pledge for 2030 | 22% | 758 | 22% | 773[a] |
| Conditional pledge for 2030 | 40% | 538 | 36% | 644 |

Author's own calculations based on Gobierno de Mexico (2020)

[a]Author's calculations deviate from the report of the Mexican Government (Gobierno de México, 2020), where it states that GHG emissions in 2030 would amount to 781 $MtCO_2e$

The fuel tax, on the other side, has a considerably higher rate but relatively limited coverage, that is, it mainly targets the transport sector. This relatively weak environmental stance in fiscal policy goes back to strong opposition against carbon pricing in Mexico. Industry groups lobbied against the instruments and for reducing policy ambition, see Dibley and Garcia-Moron (2020) and López Pérez and Vence (2021). On the other side, Mexico departed from an even weaker carbon pricing regime, and the tax reform commenced a change of direction in that sense. Arlinghaus and van Dender (2017) show that the total fiscal burden (VAT, motor fuel tax, and later the carbon tax) per $tCO_2$ increased from 10 EUR in 2012 to almost 150 EUR in 2016.

Next to the federal taxation of carbon, which is concentrated on fuels, some federal states have recently begun to tax GHG emissions directly, that is, from fixed sources. Thus, these subnational carbon pricing initiatives aim at the industrial sector, including electricity generation, and fill a gap left by the national carbon tax. Starting in 2019, to the best of our knowledge, there have been initiatives in 8 of the 32 states, out of which 6 (successfully) enacted their carbon taxation; see Table 6.2, for an overview. What is remarkable is that most states are imposing rates far beyond the national carbon tax. Among these are the heavily industrialized entities of the State of Mexico (Estado de México), Querétaro, and Nuevo León. Baja California's fuel-based carbon tax was ruled unconstitutional.[7] Likely, this is why other states turned to tax emissions rather than the carbon content of fuels.

Lastly, the national level is currently implementing the trial phase of an emissions trading system (ETS). Since the 2018 amendment to the GLCC foresees an emission trading system as mandatory, this was implemented in January 2020, starting with a pilot phase that lasts until December 2022.[8] Currently, the Mexican ETS comprises the energy and industry sectors (Pérez, 2022). There are 300 firms that participate on a mandatory basis – large emitters with 100,000 $tCO_2$ emissions per year. The emissions cap is determined by historical levels (2016–2019), and permits are allocated freely. After all, the main goal of the pilot phase is to establish a functioning and robust mechanism, thereby laying the groundwork for a mechanism to attain the Paris pledges cost-efficiently. Pérez (2022) comments that among the many challenges connected to fully developing the Mexican ETS are firstly aligning it with existing policies (e.g., the carbon taxes) and achieving coherence with other policy aims, such as the promotion of hydrocarbons in the energy sector by the Ministry for Energy under the administration of President López Obrador (2018–2024).

Elizondo (2022) notes that there has been an extensive consultation process with key actors, such as the national electricity commission that

25 USD or higher (World Bank, 2021).

[7]The supreme court (PODER JUDICIAL DE LA FEDERACIÓN) ruled in 2021 that states have no right to tax crude oil or derivatives, since this is a right exclusive to the federal jurisdiction, see https://www.tlcasociados.com.mx/impuesto-ambiental-por-la-emision-de-gases-a-la-atmosfera-en-baja-california-es-inconstitucional-pjf/ (accessed March 20th of 2022).

[8]See SEMARNAT (2021).

**Table 6.2** State carbon taxes

| State | Carbon price MXN/tCO2e 2022 | Carbon price USD/tCO2e | Comment |
|---|---|---|---|
| Querétaro[a] | 539 | 25.70 | Enters into effect in 2022<br>Inflation-indexed tax rate |
| Tamaulipas[b] | 288 | 13.70 | Enters into effect in 2021<br>Inflation-indexed tax rate, 25 $tCO_2$ tax allowance |
| Nuevo Leon[c] | 268 | 12.80 | Enters into effect in 2022<br>Inflation-indexed tax rate |
| Yucatan[d] | 259 | 12.40 | Enters into effect in 2022<br>Inflation-indexed tax rate |
| Zacatecas[e] | 250 | 11.90 | Enacted in 2019<br>Constant tax rate |
| State of Mexico[f] | 43 | 2.00 | Enters into effect in 2022<br>Constant/indexed |
| Jalisco[g] | (NA) | – | Legislative initiative in 2020, as of 2022 not implemented |
| Baja California[h] | (170) | (8.10) | Fuel based<br>Ruled unconstitutional by Mexican Supreme Court |

Calculation by authors (Some tax rates depend on official (economic) measurement units (UMA – Unidad de Medida y Actualizacion). These are yearly updated to account for inflation. The rate for 2022 can be found at URL: https://www.gob.mx/fovissste/articulos/comunicado-actualizacion-uma-2022?idiom=es)

[a]Diario de Querétaro (December 21st, 2021), "Cobrarán Impuestos ecológicos, van contra empresas", https://www.diariodequeretaro.com.mx/local/cobraran-impuesto-ecologico-van-contra-empresas-7598569.html (Accessed March 15th, 2022)

[b]Gobierno de Tamaulipas (2020), Periodico Oficial, 29 de julio de 2020, URL: http://po.tamaulipas.gob.mx/wp-content/uploads/2020/07/cxlv-91-290720F-EV.pdf (Accessed March 15th, 2022)

[c]Gobierno de Nuevo León (2021) Periódico Oficial, Monterrey, Nuevo León, Jueves - 23 de Diciembre 2021, pp. 54–58, URL: http://sistec.nl.gob.mx/Transparencia_2015/ (Accessed March 15th, 2022) Archivos/AC_0001_0007_00170072_000001.pdf

[d]Líder Empresarial (January 3rd 2022) Año nuevo: nuevos impuestos y aumentos, URL https://www.liderempresarial.com/ano-nuevo-nuevos-impuestos-y-aumentos/ (Accessed March 15th, 2022)

[e]Diario Oficial del Estado de Zacatecas DOF:20/03/2019, Ley de Hacienda de Zacatecas. Its constitutionality was approved by a ruling of the Mexican Supreme Court, see https://www.mexico2.com.mx/noticia-ma-contenido.php?id=345

[f]El Sol de Toluca (January 29th, 2022) "Empresas contaminantes pagarán por tonelada de gases en el Edomex" URL: https://www.elsoldetoluca.com.mx/local/empresas-contaminantes-pagaran-por-tonelada-de-gases-en-el--edomex-7797046.html (Accessed March 15th, 2022)

[g]Informador.mx (October ninth, 2021) "Archivan nuevo impuesto estatal a empresas emisoras de contaminantes" URL: https://www.informador.mx/jalisco/Archivan-nuevo-impuesto-estatal-a-empresas-emisoras-de-contaminantes-20211009-0090.html (Accessed March 15th, 2022)

[h]Presidencia del Congreso del Estado de Baja California, Comisión de Hacienda y Presupuesto, Dictamen No. 65. URL: https://www.congresobc.gob.mx/Documentos/ProcesoParlamentario/Dictamenes/20200424_65_HACIENDA.pdf; Poder Judicial de la Federación ruled that states have no right to tax crude oil or derivatives, this is a right exclusive to the federal jurisdiction (https://www.tlcasociados.com.mx/impuesto-ambiental-por-la-emision-de-gases-a-la-atmosfera-en-baja-california-es-inconstitucional-pjf/)

runs power stations and grids (CFE), as well as with the hydrocarbon sector, specifically the Ministry of Energy (SENER) and PEMEX, but also the Initiative for Market Readiness (World Bank, 2021) and the German Agency for Development (GIZ) to better design the policy instrument and avoid unintended interference with existing policy measures – a lesson learned from the carbon tax, which was ultimately reduced in scope and effectiveness.

Summing up, we find that climate policy in Mexico has shown little momentum until recently, though politics has shown intentions to leave the path of fossil fuel subsidies. However, in the light of the continuous rise of GHG emissions ever since the commencement of climate policy, Sosa-Rodriguez (2015) deems instruments insufficient. This pessimistic view is supported by the comparative study of Pischke et al. (2019) on the degree of climate policy implementation among large countries in the Americas between 1998 and 2015. While Mexico is in third out of five places, counting the number of laws and regulations, it ranks last regarding policy intensity, though it caught up during the second half of the period studies. And Ortega and Casamadrid (2018) find that actors, who participated in the formulation and enacting of climate policy in Mexico, opine that the debate was centered around economic and fiscal arguments rather than environmental ones. Finally, Octaviano et al. (2016) show that abatement costs for Mexico are substantial and considerably higher than in Brazil since energy production is very carbon intensive for more ambitious GHG reduction targets. This may explain the continued reliance on fossil fuels in the energy sector until the present day.

## 6.5 Analysis of Energy Policy Mexico

In the following, we present evidence concerning the energy and climate policy instruments currently employed and then use this evidence to assess each instrument's effect on the four categories we proposed. We work our way from instruments directed to the upstream, that is, exploration and extraction activities, to the midstream, that is, the use of fossil fuels for electricity production and in industrial processes, to finally arrive at the downstream, that is, household demand.

**Upstream** The analysis and relationship between energy policy and environmental policy will be presented for each resource. In the case of oil, the central element in energy policy shows that the policies implemented could help guarantee energy security because new reserves would be added by opening up to the private sector in exploration or by greater participation of the public sector. However, this has not yet materialized. So proven reserves have not increased and production has not reached the goal of 3.0 million barrels per day established in the energy reform in 2013. Therefore, if the investment is reactivated, progress in energy security would be expected (reflected in the (+) in energy independence). However, this again consolidates an energy policy that prioritizes fossil fuels, hence the (−) in energy resilience in Table 6.3 (Torres, 2020). On the other hand, the consolidation of a policy based on fossil fuels will not allow reducing emissions, as shown by the national emissions inventory, therefore a (−) for reduction of emissions in Table 6.3. Regarding the affordability category, the effect of the arrival of new investments and the addition of crude oil reserves on energy costs is still unclear. In this case, it will depend on the determinants of international oil prices. Regarding gas, the behavior in terms of policies is similar to that of the oil market; it only differs because gas is a fossil source that can be used to reduce $CO_2$ emissions in electricity generation (SENER, 2021). In this case, investment has been directed to exploration, yet here too the reserves have not grown as of now. According to SENER (2020), natural gas production declined over the last few years, going from 6534 million cubic feet per day (MMpcd10) in 2009 to 3842 MMpcd in 2018. The drop in gas production will be reflected, mainly with a (−) sign in the dependence category in Tables 6.3 and 6.4. According to information from the energy information system (SIE, 2022), natural gas imports from the United States represent 94% of total domestic consumption (excluding PEMEX consumption), and by 2019 this proportion increased by 2 percentage points. That is expressed by (−) in the dependency category in Tables 6.3 and 6.4.

Most of the investment has been in pipeline infrastructure to transport and distribute gas imported from the United States, especially from Texas. According to SENER (2020), part of the current administration's strategies consisted in

**Table 6.3** Upstream instruments and contribution to energy security and sustainability

| Resource | Instruments | Energy resilience | Energy independence | Energy affordability | Reduction of emissions |
|---|---|---|---|---|---|
| Oil | Public and private investment in exploration and extraction | (−) | (+) | (?) | (−) |
| Natural gas | Public and private investment in exploration and extraction | (+) | (−) | (+) | (?) |
| | Investment in distribution and infrastructure for gas (pipelines) | (+) | (−) | (+) | (?) |

Legend: (+) positive effect, (−) negative effect, (0) neutral effect, (?) ambiguous effect(s)

**Table 6.4** Midstream and downstream Instruments

| Sectors | Instruments | Energy resilience | Energy independence | Affordability of energy/ avoiding CPI increase | Reduction of emissions |
|---|---|---|---|---|---|
| Electricity | Combined cycle by gas | (+) | (−) | (+) | (?) |
| | Long-term auctions | (/) | (/) | (+) | (/) |
| | Clean energy certificates | (+) | (+) | (?) | (+) |
| Electricity & Industry | Emission taxes for fixed sources | (+) | (?) | (−) | (+) |
| | ETS (currently in pilot phase) | (+) | (?) | (−) | (+) |
| Transport | National carbon tax, | (/) | (/) | (−) | (+ / 0) |
| | Vehicle fuel tax, and carbon tax | (/) | (/) | (−) | (+) |

Legend: (+) positive effect, (−) negative effect, (0) neutral effect, (?) ambiguous effect(s), (/) no evidence found

adding 1224 km of gas pipelines, which translates into a growth of 7.7% in just 1 year. In addition, between 2020 and 2021, three new gas pipelines have started operating, adding 988 km to the network. With this new infrastructure, Mexico will have an import capacity of approximately 13,00015 MMcfd (millions of cubic feet per day). The last idea is represented in table 6.4 with a (−) for dependence and (+) for affordability and resilience. As far as sustainability is concerned, it will be analyzed in the following paragraphs.

Another element to consider in the gas issue is the price difference between Mexico and the United States; according to EIA data, the average gas price in the United States has been below 2.00 US Dollars per thousand cubic feet in the last decade. In Mexico, the average gas price has averaged over 2.50 US Dollars per thousand cubic feet. It is reflected in energy affordability with a (+) (SENER, 2021) in Tables 6.3 and 6.4. Hence, the growing use of gas through combined cycle power generation (see Table 6.4) has had an important advance in terms of affordability (+) and resilience (+), since it helps to diversify the energy matrix.

The impact of fostering natural gas on sustainability is ambiguous, hence a (?) in Tables 6.3 and 6.4. Due to its lower $CO_2$-content sustainability is improved on the intensive margin. However, in Mexico, 60% of electricity is generated with gas, this proportion has grown in recent decades; for example, in 2014, the share of electricity generation by combined cycle was 22% and by 2015, this proportion rose to 51% (SIE, 2022). In the end, emissions in the electricity generation sector have grown gradually during the period 2000–2015 going from 121,025 to 170,956 tons per year, according to Mexico's national emission inventory (INECC and

SEMARNAT, 2021; Catalán, 2021). So, through the extensive margins, gas contributed negatively to the sustainability category. In the end, however, gas is replacing oil in the energy matrix in general as well as in electricity production. Its true impact should be assessed through a comparison of the counterfactual situation of not replacing oil by gas, for which we haven't found any assessments in the literature. In conclusion, we remain with an overall ambiguous effect on sustainability for gas.

**Midstream** For electricity generation, since the 2013 energy reform auctions serve to allocate long-term contracts for the supply of electric energy among contenders on competitiveness grounds. The supervising regulatory authority is the Energy Regulation Commission. The contracts awarded will have a duration of 15 years. Between 2015 and 2018, three successful and internationally recognized long-term auctions have been held through which increasingly competitive prices have been obtained (SENER, 2021).

Next to that, there are Clean Energy Certificates CELs. These have been introduced to integrate clean energies in electricity generation at the lowest cost, incentivize the development of new investment projects in clean electricity generation. These may generate and sell CELs participants obliged to acquire CELs, large consumers, and nonrenewable energy producers. The CEL requirement defines the proportion of the total energy supplied to final clients or produced for own consumption during a month to be covered by CELs.[9] The legal requirement has been raised considerably during the past year starting from 5.8% in 2019[10] and getting to 13.9% in 2022.[11]

We find that the measures applied to the electricity market, that is, long-term contracts and CELs, have contributed positively to energy resilience, energy independence, and emission reduction. Each is reflected with a (+) in the table. We find energy affordability affected in an ambiguous way, since much of the technologies for electricity generation through renewable sources are imported.

After having detected the impacts of energy policy instruments, we now turn to climate policy. The literature review conducted by Coste et al. (2018) reveals that the impacts of environmental taxes are moderate, rate short-term, and concentrated on energy-intensive and trade-oriented sectors. These sectors suffer output contractions due to price-induced decreases in demand for their goods and services, which points toward a "(−)" for the affordability of energy. Yet most studies have been carried out for high-income countries in Europe and North America. So, a closer look with respect to Mexico is in order. We will first assess findings with respect to the midstream (electricity and heat production as well as industry) before getting to instruments targeted at final demand, see Table 6.4.

**Fixed-Source Carbon Tax (in some States)** Barragan-Beaud et al. (2018) present an extensive study assessing and comparing the impact of a carbon tax with that of an ETS on the energy sector in Mexico. Their findings indicate that if carbon tax rates strongly increase over time,[12] initially, there would be low cost-

[9] Entities that must acquire CELs are energy suppliers and installations that have their own electricity generation installation (disconnected from the grid). See Comisión Regulatoria de Energía (2022) "Preguntas Frecuentes sobre los Certificados de Energías Limpias", URL: https://www.gob.mx/cre/articulos/preguntas-frecuentes-sobre-los-certificados-de-energias-limpias (Accessed September 24th, 2022).

[10] https://www.gob.mx/cre/articulos/preguntas-frecuentes-sobre-los-certificados-de-energias-limpias

[11] See Diario Oficial de la Federación, Friday, March 29th 2019, Available at: https://www.cenace.gob.mx/Docs/16_MARCOREGULATORIO/CEL/(DOF%202019-03-29%20SENER)%20Requisito%20de%20CEL%20(2022).pdf (Accessed September 23rd, 2022).

[12] Barragan-Beaud et al. 2018suggest in one scenario a carbon tax that increases from 10 to 50 USD per $tCO_2e$ between 2018 and 2025.

efficiency due to the lag caused by necessary investment. Emissions would not be reduced, but costs would be high to tax-paying firms and might have to be shifted forward to consumers. On the other side, carbon taxes yielding medium run levels of 15–50 USD per $tCO_2e$ would yield abatement levels vis-à-vis the baseline scenario of roughly 40% and 57%, respectively – significantly more than Mexico's conditional NDC. Hence, fixed-source carbon taxes receive a (+) for their effectiveness in emission reduction (Huesca & López, 2016).

On the other hand, electricity prices are projected to increase by some 10% – considerably more than for an ETS, which results in "(−)" for electricity/energy affordability. Finally, Barragan-Beaud et al. (2018) find that the energy mix would evolve toward higher volumes of solar PV and wind plants, while mostly coal would be reduced, which can be neglected given its minor initial share (see Sect. 6.2 of this Chapter). So, the energy mix would diversify, hence a (+). In contrast, the contribution to energy independence is ambiguous, with domestic renewables up and no clear sign of degrowth for the share of natural gas, hence a (?).

The findings of Landa Rivera et al. (2016), who assess carbon taxation in Mexico in a comprehensive numerical model, point in the same direction. They show that a carbon tax reaching emissions of 75% would come at a high cost if tax receipts are not recycled to private households. On the other hand, revenue recycling would lead to a double dividend of increased growth if revenue recycling is implemented. However, with state-level tax revenues and a national electricity market affected, it is hard to see how tax receipts are redistributed to affected households in all of Mexico. Yet, these schemes are just at their starting, and with all states participating eventually, the picture could change.

Bös and Vrolijk (2021) point toward the selectiveness of the Mexican carbon tax of 2014, where natural gas is excluded. They estimate that including natural gas and the heavier taxation of coal – which would convert more into an instrument directed at the midstream – could lead to higher cost-effectiveness (different trade-offs between emissions and output). According to Bös and Vrolijk (2021), taxing coal and gas could particularly be beneficial, since electricity production depends on these sources, offers a relatively low trade-off between output and emission reduction, and represents a large chunk of overall emissions.

Finally, the contribution by Mardones and Mena (2020), showing evidence from Chile, is to be considered due to the similarity of the policies implemented in Chile and Mexico. In both cases, fixed sources are targeted rather than the carbon content of fossil fuels. The Chilean tax consists of a rate equivalent to 5 USD/$tCO_2$ plus additional tax rate components depending on the emission of local pollutants and the affectedness of a region (the local component of the tax). It thus features a similar rate as in Mexico. Consequently, Chile experiences a low emission reduction effect going back to its carbon tax. Furthermore, indicative for our assessment in the context of the Energy Trilemma is their finding that there is a substantial rise in the price of electricity and a lesser, albeit positive, effect on industrial products and water supply. The authors estimate the overall change of the CPI to be 0.1–0.2% for the prevailing rate of 5 USD/$tCO_2$ and a 0.2–0.35% increase for a hypothetical carbon tax of 10 USD/$tCO_2$.

**Emission Trading Scheme (ETS)** To begin with, there aren't many contributions assessing the impact of an ETS on the Mexican economy. In fact, to the best of our knowledge, the only contribution that does so is the one by Barragan-Beaud et al. (2018) mentioned earlier. They assess a cap that implements Mexico's conditional NDC of 2015, which represents a GHG reduction of roughly 25% in 2030 compared to 2018, and find this would result in permit prices of 2–4 USD/tCO2e by 2024/2025, thus very moderate levels and comparable to today's (selective) carbon tax. This shows that if the cap is chosen based on an (overly) potentially pessimistic scenario, its actual emission reduction effect is low yet still positive – hence a "(+)." In that respect, Barragan-Beaud et al. (2018) explore a more ambitious cap that is better compared to their tax scenarios. It roughly consists of reducing today's emissions in the electricity sector by 50%, resulting in permit prices evolving from 4 USD/tCO2e in 2018 to 15 USD/tCO2e in 2030. So, if the political will is there, the abatement potential of this instrument can be considerable. However, as with the carbon taxes, this would come at a cost estimated to amount to a surge of 3% in electricity prices – hence a "(−)" in the category of energy affordability. Yet, this is much less than the impact caused by a carbon tax while yielding similar abatement levels. The authors' findings with respect to the energy mix and the energy independence mentioned above for the case of carbon taxation basically carry over.

**Downstream** On the downstream end of the energy value chain, households are subject to direct effects, for example, taxes on motor fuels, and indirect effects shifted down from the midstream. There are several model-based, numerical, and empirical assessments of these direct and indirect effects. The impact of increasing prices on the consumption basket is found in most studies, see Renner (2018). He reports an average price hike of 0.25% going back to the fuel-based (national) carbon tax. Hence, we may put a (−) for "Energy Affordability."

In Mexico's economic inequality context, more important is whether environmental- or energy-related taxes are progressive or regressive. Labeaga et al. (2021) estimate the effects of the 2014 tax reform and find that it led to reduced energy consumption (26%) due to tax-induced price hikes and observe a progressive impact. Assessing a much wider-reaching carbon tax, including natural gas, Renner et al. (2018) find that its effect would be generally progressive, yet it would be regressive for motor fuels. On the other hand, Chapa and Ortega (2017) employ an social accounting matrix (SAM) model and find that the implemented version of a carbon tax would be regressive. And Gonzalez (2012) points out that the scheme of revenue recycling is critical for progression. Using the carbon tax's revenues to reduce an industrial tax would render the carbon tax regressive. Yet, he finds the carbon tax to be progressive in case food subsidies are provided. To the best of our knowledge, revenue recycling has not taken place. Moreover, since several studies report a regressive effect of the national carbon tax, we have another motive to assess the federal carbon tax's impact on energy affordability as negative.

On the other hand, there is evidence that $CO_2$ emissions might fall as a consequence of households' response to the energy taxes, see Gonzalez (2012), Labeaga et al. (2021), and Renner et al. (2018). A crucial aspect is that some of these results assume a widely applicable carbon tax. Yet, the currently implemented tax, together with the motor fuel tax, mainly hits the transport sector, and while in Mexico, demand for motor fuels is found to be less price-elastic than electricity demand, see Labeaga et al. (2021), Ortega and Medlock (2021) and Renner et al. (2018). Due to the low current carbon tax rate, we put a "(0)" for reducing emissions. This also means that taxing electricity production may improve the trade-off between economic costs for households and climate change mitigation.

On the contrary, the motor fuel tax has a non-marginal tax rate. There is evidence that demand for motor fuels is unit-elastic: for instance, Ortega and Medlock (2021). We, therefore, conjecture that the current motor fuel does have a deterring effect on demand and thus on $CO_2$ emissions, hence a "(+)" for emission reduction. In the same vein, we may conjecture that the deterred demand occurred due to a rise in fuel prices, see Arlinghaus and van Dender (2017). Thus, there is evidence that the strongest, albeit transport-biased carbon pricing instrument in place caused energy prices to rise. Thus, the assessment is "(−)." As the studies directed at private households are often employing some form of an input-output model, no conclusions can be drawn with respect to the categories of energy resilience and energy independence (hence "(/)" for no evidence).

## 6.6 Conclusions

Our assessment of impact of policy measures on the four categories representing the Energy Trilemma is summarized in Table 6.3 and Table 6.4. Without exception, the four categories experience impacts from various policy tools and in different directions – positive and negative ones. This even applies to the impact only from energy policy or climate policy. So, from a global perspective, policies do not seem to consider their incoherent impact on (sustainable) energy security. Yet, looking a bit beyond the tables and taking into consideration specific aspects of policies outlined in the text, we come to four main conclusions.

Firstly, we find that policies directed toward the upstream, that is, oil and gas supply policies, predominantly focus on affordability and independence, compromising on emission reduction. Yet, at the same time, climate policy lacks a mechanism that would counteract its negative effects on affordability. Thus, energy and climate policies should be altered to soften existing trade-offs. Energy policy could be amended by stricter regulatory mechanisms to curb emissions on the intensive margins, that is, emission intensity of fossil fuel extraction. In the same vein, the market mechanisms of climate policy, which aim at the extensive margin, could be amended by revenue recycling mechanisms dedicated to vulnerable groups of society or earmarked for transition efforts to soften the instruments' impact on price by means of easing the substitution mechanisms.

Secondly, looking at the energy sector from a macro-perspective, we find that energy policy aims at increasing the supply of energy resources, while climate policy sets price signals to disincentivize consumption of energy. What seems a contradiction at first could be a wise combination of policy tools helping with energy security in the wider sense while decreasing the energy intensity of the Mexican economy.

Thirdly, the policy for natural gas seems to be coherent across both energy and climate policy, at least when buying into the idea of natural gas as a bridge fuel in the process of completing the greening of the economy. Energy policy is dedicated to increasing supply (mainly via imports) and converting it into power helps with the decoupling of end-users from any type of natural resource, while climate policy on the other hand spares natural gas from carbon taxation and thus does not apply a disincentive on its use.

Lastly, the long-term auctions on the electricity wholesale market not only help with energy affordability by being a catalyzer for cost efficiency. Raising efficiency in electricity generation, the auctions also alleviate pressure to provide more (fossil) fuels for growing energy demand.

To conclude, we find that while the largely disconnected policy fields of energy and climate change mitigation, at first sight, seem incoherent, we could identify some areas of (apparent) alignment. Yet, it remains to be said that policy integration is in order to heal shortcomings such as an energy policy agenda largely short of directly and strongly promoting renewable energy sources or timid climate policy shying away from stronger price signals due to a lack of easing the energy transition by positive financial instruments.

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