THE ENERGY MEXICO NEEDS:

Infrastructure, Regulation, and Rule of Law for a Sector that Triggers the Country's Competitiveness

Authors: Jesús Carrillo, Diego Díaz, Sonia Mancera, Oscar Ocampo, Montserrat Ramiro.

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contacto@imco.org.mx

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Executive summary

Energy is key for a country's competitiveness, impacting on all areas and kinds of production chains and needs such as mobility and access to power in homes and businesses. Economic growth and development requires reliable power at competitive prices that foster economic growth. Solving the most pressing social imperative of our time -mitigating climate change- depends on generating power with the lowest possible emissions.

In the context of energy transition —i.e, the path towards decarbonization of economic activity—, the goal is to produce the energy we use from renewable or non-emitting technologies. Therefore, it is necessary to increase the relative weight of electric power generated from sources with a low carbon footprint with the objective of reducing the consumption of fossil fuels.

Where do we stand today?

Since 2018, the energy policy of Mexico's current administration has been directed towards strengthening the market position of both Petróleos Mexicanos (Pemex) and Comisión Federal de Electricidad (CFE) **by means of granting them differentiated and preferential treatment against other participants in the energy markets**.

Those actions go against the global trend towards energy transition, as they close power markets to competition, even when this clearly deteriorates the State companies' profitability and efficiency.

With this policy, Mexican consumers lose in economic and environmental terms, as well as in public health issues.

Which way should we go?

This study argues Mexico **could successfully move from an energy sector anchored on hydrocarbons towards a competitive energy sector with a diversified power generation matrix with a lower carbon print**. This goal is possible if and only if the rule of law prevails, is applied without restrictions and Mexico credibly commits to legal certainty that in turn, favors a healthy investment climate. These conditions foster the development of critical infrastructure needed in all segments of the energy sector; oil and gas transport and storage, renewables and clean power generation as well as stronger transmission and distribution networks.

IMCO proposes the following strategies for Mexico's energy markets:

Oil

- **Restart** and increase the frequency of oil and gas exploration and production bidding rounds.
- **Redesign** the structure and rules of the Fondo Mexicano del Petróleo para la Estabilización y el Desarrollo (Mexican oil fund for stability and development) to favor long term development rather than financing government expenses and budget.
- **Develop** a strategy for refining high value added products and reconfigure petrochemical facilities.
- **Grant** fuel import permits to whomever complies with current regulation.

Gas

- **Develop** natural gas storage infrastructure.

- **Develop** natural gas transport infrastructure.
- **Grant** LPG import and distribution permits to whomever complies with current regulation.

Electricity

- **Restart** the granting power generation permits for electric power generation to whomever complies with current regulation.
- **Relaunch** bids for long-term generation contracts.
- **Publish** rules for collective distributed generation and electricity storage.
- **Invest** in transmission and distribution infrastructure using the regulated income assigned for these purposes.
- **Prioritize** public investment in those business areas that are profitable for CFE **e.g. transmission.**

Most of these proposals are achievable without reforming either the Constitution or modifying current legal and regulatory frameworks. Mexico must choose sustainable economic development and growth. **Without a dynamic energy sector, with competition, regulation, and public and private investment, this will not be possible. This country must make up for the lost years.**

Contents

List of acronyms and abbreviations

BTU	British thermal unit
CCE	Consejo Coordinador Empresarial
CEL	Clean energy certificate (Spanish acronym)
Cenace	Centro Nacional de Control de Energía
Cenagas	Centro Nacional de Control del Gas Natural
CFE	Comisión Federal de Electricidad
CNH	Comisión Nacional de Hidrocarburos
CNIH	Centro Nacional de Información de Hidrocarburos
Cofece	Comisión Federal de Competencia Económica
COP26	2021 UN Conference on Climate Change
CRE	Comisión Reguladora de Energía
DEXPH	Rights on hydrocarbon exploration
DEXTH	Rights on hydrocarbon extraction
DUC	Rights on shared profits
EJ	Exajoule
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
FMP	Fondo Mexicano del Petróleo para la Estabilización y el Desarrollo
GHGs	Emissions of greenhouse-effect gasses
LPG	Liquefied petroleum gas
NPG	Natural petroleum gas
GWh	Gigawatt-hour
IEA	International Energy Agency
IMCO	Instituto Mexicano para la Competitividad
Inegi	Instituto Nacional de Estadística y Geografía
IRENA	International Renewable Energy Agency
Km	Kilometer

KW	Kilowatt
KWh	Kilowatt-hour
LIE	Electrical power industry act (Spanish acronym)
KBPD	Thousand barrels per day
Mdd	Million dollars
MMBD	Million barrels per day
Bd	Billion dollars
Bp	Billion pesos
BBL	Billion barrels of petroleum liquids
MMCFD	Million cubic feet per day
MVA	Megavolt-ampere
MW	Megawatt
MWh	Megawatt-hour
PAMRNT	Programa de Ampliación y Modernización de la Red Nacional de Transmisión y Redes Generales de Distribución del Mercado Eléctrico Mayorista
PEF	Federal Expense Budget (Spanish acronym)
Pemex	Petróleos Mexicanos
PIIRCE	Programa Indicativo para la Instalación y Retiro de Centrales Eléctricas
PJ	Petajoules
MLP	Marginal local prices
Prodesen	Programa de Desarrollo del Sistema Eléctrico Nacional
GDN	General distribution networks
NTN	National transmission network
NES	National electricity system
Sener	Secretaría de Energía
SHCP	Secretaría de Hacienda y Crédito Público
NIS	National interconnected system
Sistrangas	Sistema de Transporte y Almacenamiento Nacional Integrado de Gas Natural
LTB	Long-term bids
NRS	National refining system

PBS	Provider of basic services
USD	American dollars

1. Introduction

Energy is indispensable for everyday life, whether it be transforming, moving, producing, heating, illuminating, or almost any other human activity. Homes, commercial and industrial activities need energy to operate. In other words, **economic growth and development cannot be explained without understanding the evolution of technology in energy generation and its many applications.**

The kind of energy sector a country like Mexico needs must have these three characteristics: it must be reliable i.e.access to it must be uninterrupted, it must be supplied at the lowest possible price and it must be safe to use and generated with the least health impact both locally and globally. The cost of energy has an important impact both on the productive sector's costs and on individuals' budgets; this underscores the importance of cost to meet energy demands in every country. Competitive prices are the solution and are the result of regulated markets with as few distortions as possible.

Currently, besides the previously mentioned characteristics, it is essential that energy comes from clean sources. Climate change is an existential risk for humankind, and societies are required to change the sources from which they produce power. This change is precisely the concept of energy transition: moving from economies anchored on fossil fuels towards lower carbon or net zero economies, with the aspiration that, eventually, all the energy consumed will be produced from renewable sources.

It is essential to prioritize energy with a lower environmental footprint and the lowest possible carbon emissions. Summing up, energy must have three attributes **—reliable, competitive, and renewable—** These are the starting points for the energy sector that Mexico needs to detonate its potential for growth and development.

What needs to happen to meet these requirements? Energy markets are unique when compared with other sectors of the economy, because they are indispensable for all residential, commercial, and industrial activities. They also face extremely complex regulatory challenges, such as the

administration of resources that belong to the nation, as is the case with oil and natural gas, or the natural monopolies that exist in electricity grids.

Besides, regulation in these markets faces the challenge to ensure competition in sectors with high entry barriers, such as liquefied petroleum gas (LPG) and natural gas. To make things even more challenging, markets and their rules must coexist and navigate through the waves of politics, in which energy will always be a sensitive topic because of the impact it has on the economy, individuals and, ultimately, on the very idea of a nation.

Regulated energy markets are essential to detonate competitiveness in other sectors of the economy. For that reason, they are a means as much as an end. By themselves, they are sources of investment and employment with high added value. On the other hand, their adequate functioning is fundamental for the well-being of households and all economic activity. Thus, they stand as the indispensable foundation of all commercial and industrial activities in the economy.

The challenges posed by energy are many and, in years to come, will play a significant role in creating and taking advantage of new opportunities. For this reason, this study puts forward a series of concrete proposals to strengthen energy markets that create employment, accelerate energy transition, attract high value-added industries, and benefit Mexican consumers.

The first section of the study offers a general view of the changes in the energy matrix of different countries as a consequence of climate change and energy transition efforts, showing how fossil fuels have gradually become less important, opening up to renewable energy. It will discuss what has happened in Mexico and the major risks faced by the country on this issue.

The following sections will analyze the sector's different industries such as power, oil and gas to analyze differences between Mexican energy policy and global energy policy or the international consensus on energy transition. Finally, we put forward recommendations on regulations and public policy that must be implemented to promote economic development and social well-being in Mexico.

2. Where is the world heading to?

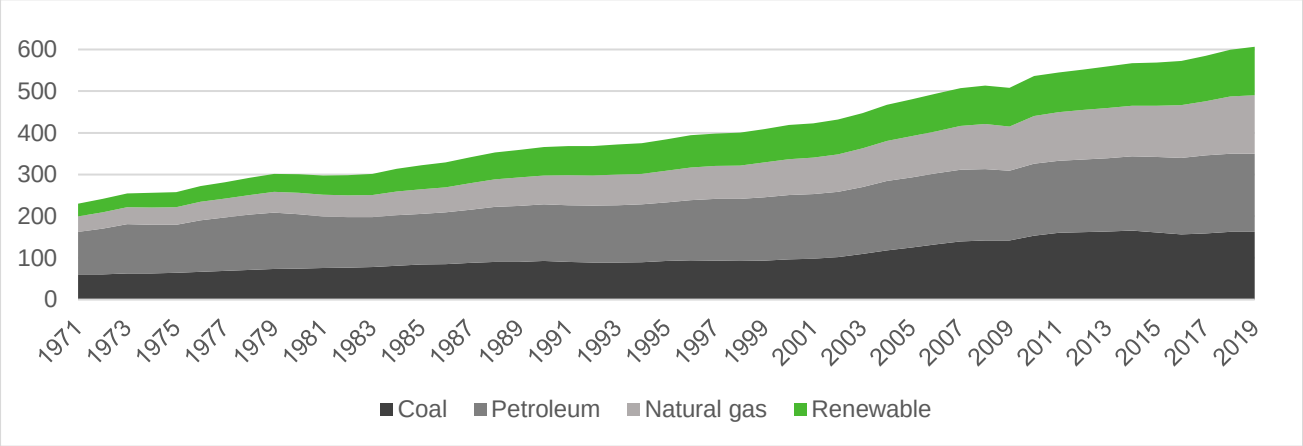
Since the mid-20th century, carbon dioxide emissions from fossil fuels have increased significantly. According to Global Carbon Update 2021[1], from an average 3 billion tons of carbon dioxide in 1960, the world burned 9.5 billion tons of carbon in 2010. Carbon dioxide, which absorbs and irradiates heat, is the greenhouse gas (GHG) used as a reference.

In 2021, carbon dioxide caused almost two thirds of all thermal influence of GHGs produced by humans.[2] Carbon dioxide is also the cause of the acidification of oceans, because when it reacts with water molecules it produces carbonic acid that makes for a lower pH. The impact of GHGs on the climate, oceans, and ability of humans to adapt to physical, social, and economic changes make it imperative to accelerate the decarbonization of global economies.

Mitigation of climate change poses the most complex and pressing collective action problem ever faced by humankind. Progress in technology makes it possible to move towards the decarbonization of economies, giving more relative weight to renewables. (Graph 1)

[1] Earth System Data Science, *Global Carbon Budget 2021*.
https://essd.copernicus.org/articles/14/1917/2022/essd-14-1917-2022.pdf
[2] National Oceanic and Atmospheric Administration, The *NOAA Annual Greenhouse Global Index* (2021).
https://gml.noaa.gov/aggi/aggi.html

Graph 1. Evolution of world energy consumption 1971-2019. Exajoules (EJ).

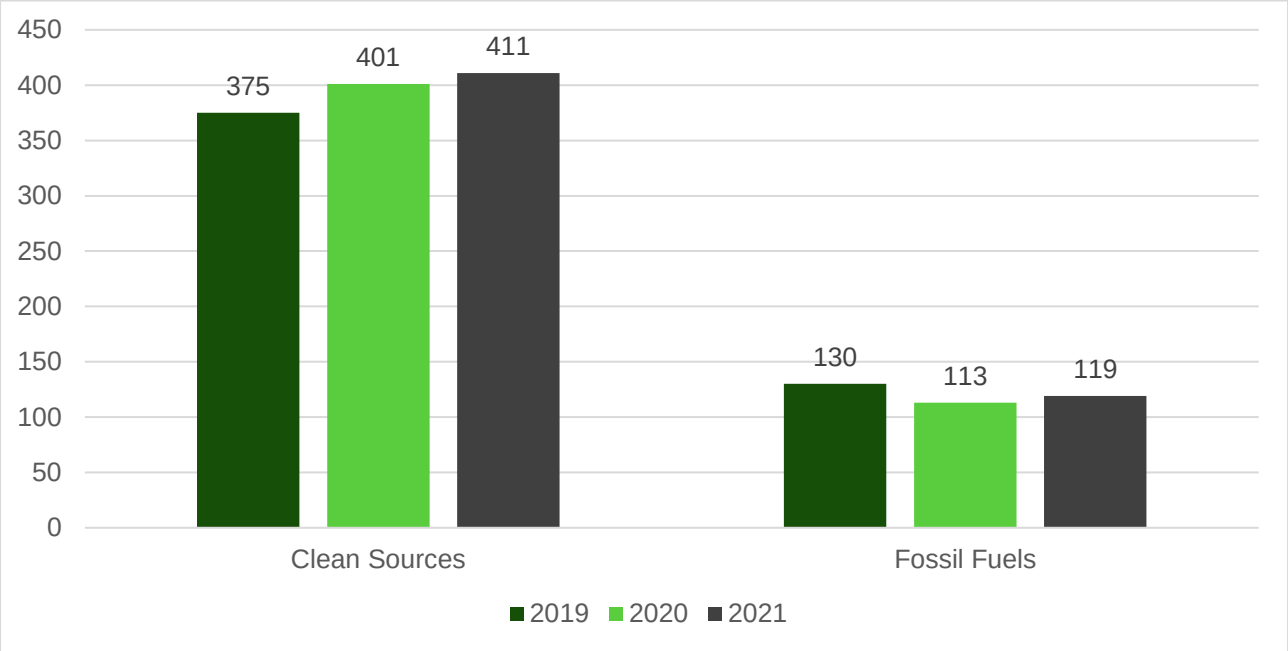


Source: Elaborated by IMCO with data from IEA. Key World Energy Statistics 2021.

One way to infer the importance of energy transition at a world level is by looking at the amount of resources devoted to climate change mitigation. Technological change has significantly improved the efficiency of renewable generation, power storage, electric mobility, and carbon capture and storage. The IEA estimates that, out of the 530 billion USD dollars invested globally in 2021 for the power generation, 411 billion USD dollars, close to 80%, were invested in low carbon footprint technologies.[3]

[3] International Energy Agency. *World Energy Investment 2021,* (Paris: IEA, 2021.), https://www.iea.org/topics/energy-security

Graph 2. Global investment by type of energy 2019-2021. Billion USD 2019.



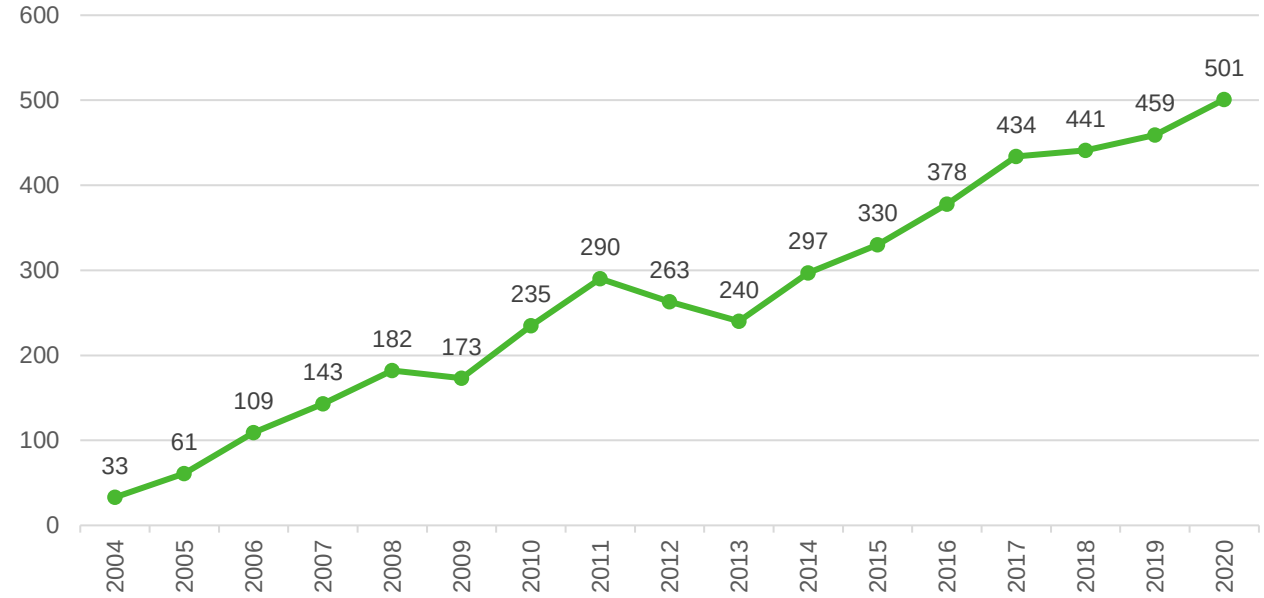
Source: Elaborated by IMCO with data from EIA. World Energy Investment 2021.

In a decade, global investment for energy transition grew over 100%.[4] It should be noted that, in 2020, in spite of the impact of COVID-19 pandemic, global investment in energy transition went beyond 500 billion dollars.[5]

[4] Bloomberg NEF, *2021 Executive Factbook. Power, transport, buildings and industry, commodities, food and agriculture, capital* (New York: Bloomberg, 2021), *https://about.bnef.com/blog/bloombergnef-2021-executive-factbook/*

[5] Bloomberg NEF, *2021 Executive Factbook. Power, transport, buildings and industry, commodities, food and agriculture, capital.*

Graph 3. Global investment in energy transition 2004-2020. Bd.



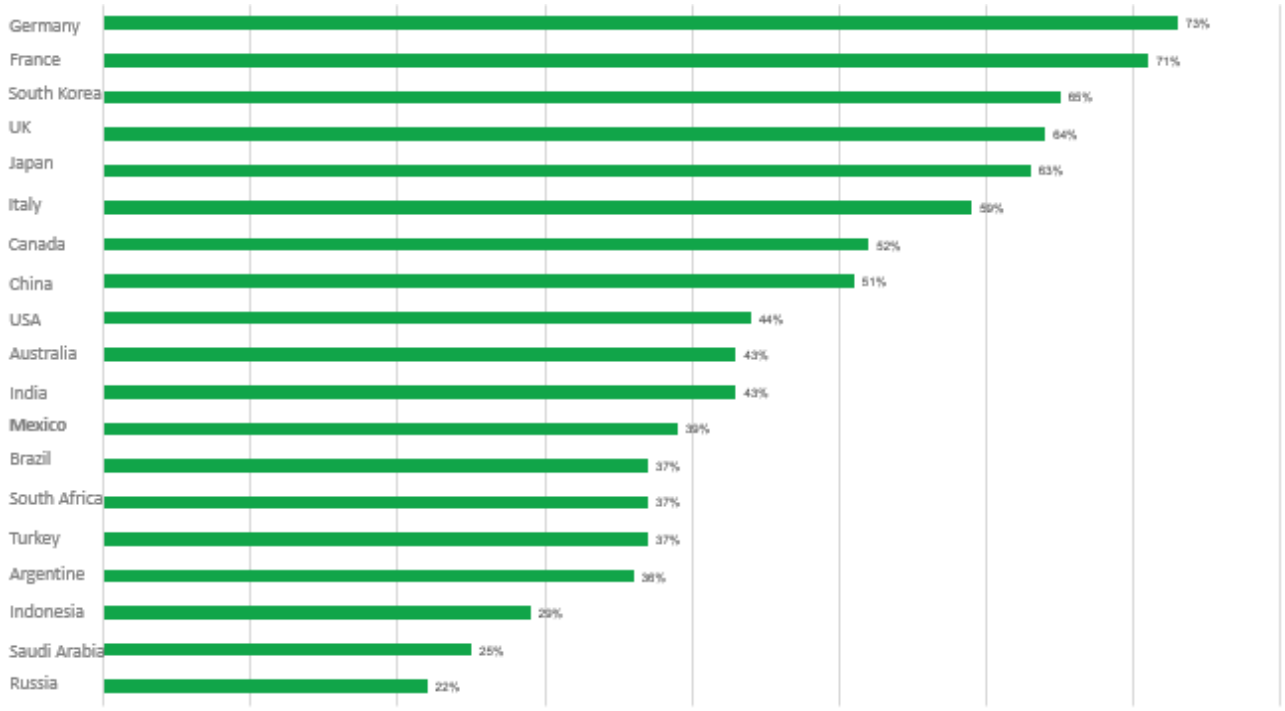
Source: Elaborated by IMCO with data from BNEF. Executive Factbook.

The 2015 Paris Agreement meant a breakthrough in the commitment of countries to reduce emissions and to limit the increase in temperature to under 2 degrees Celsius —ideally 1.5 C— when compared to preindustrial levels. In this context, Bloomberg NEF developed a tool to track public policies of G20 countries directed towards meeting the goals signed in Paris, including some indicators such as decarbonization, renewable electric power generation, and reduction of emissions. The tool assigns marks to policies depending on their alignment to Paris objectives.

Targets are different for each country and are not mandatory however, results show the commitment of countries towards energy transition. **While Germany and France received marks above 70%, Mexico stands in 12th place with 39%, below countries like China or India.**[6]

[6] Bloomberg NEF, *2021 Executive Factbook. Power, transport, buildings and industry, commodities, food and agriculture, capital.*

Graph 4. Marks given to G20 policies for energy transition in 2021. General results (percentage).

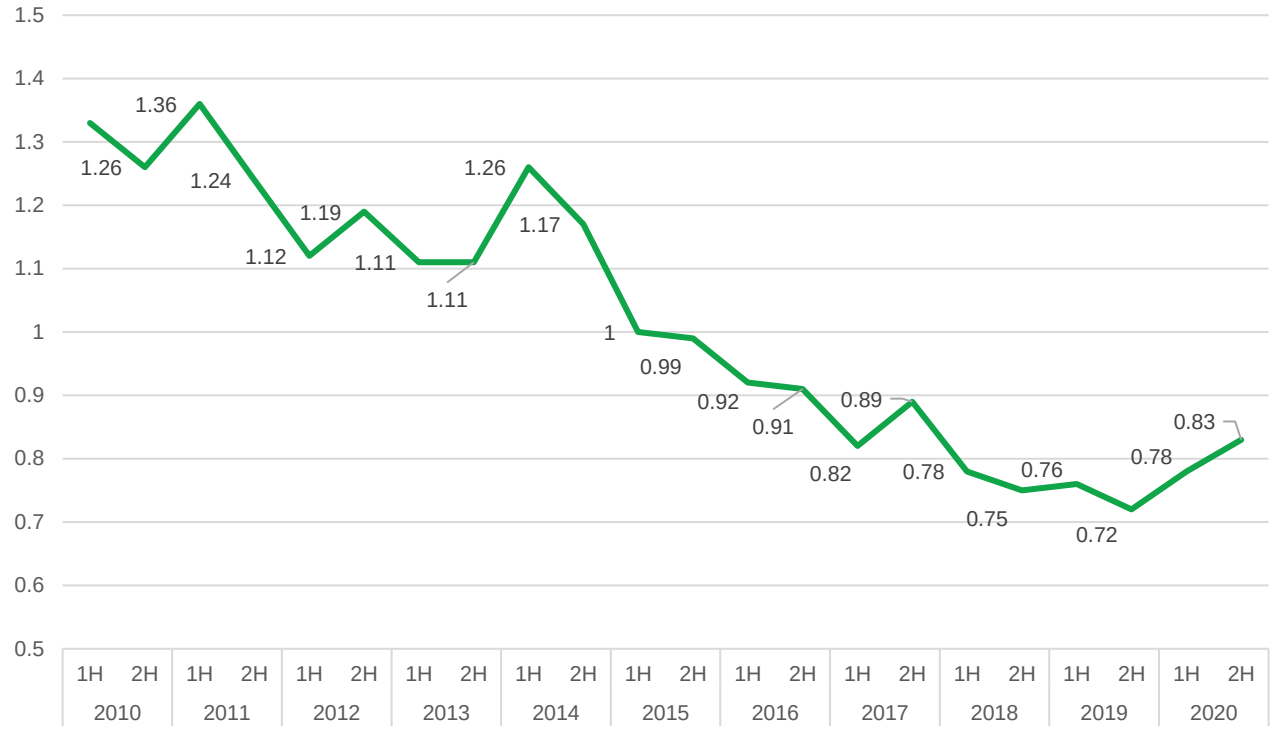


Source: Elaborated by IMCO with data from BNEF. Executive Factbook.

As countries commit towards energy transition, **energy markets must gradually adapt to the new reality**. The most telling examples may well be the use of renewable sources such as solar and wind that have become both economically and technically viable for power generation and provide a climate friendly solution for electric mobility technologies. Renewables and electric mobility mean a paradigm change for two major sources of emissions worldwide: electric power generation and transport.

As underlined by Graph 5, the need to mitigate climate change, together with technological progress, has cleared the way to reduce by 37.6% the cost of turbines for wind-powered generation between 2010 and 2020.

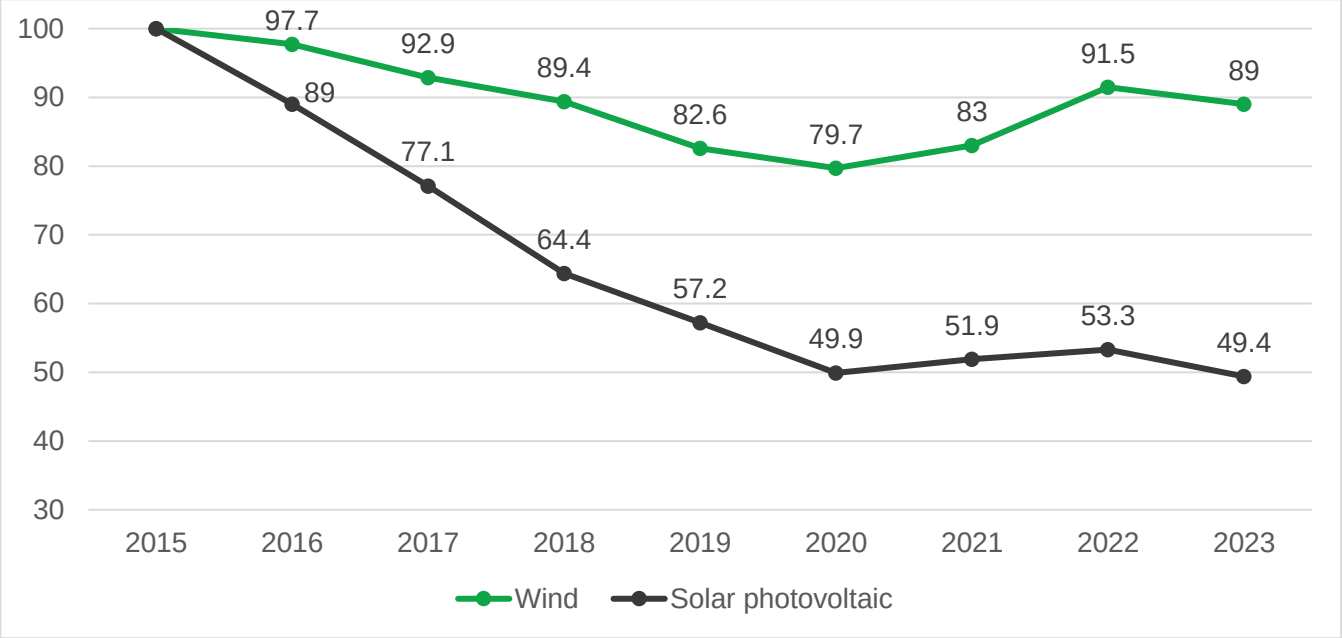
Graph 5. Cost of wind turbines 2010-2020. Million dollars (Md) per megawatt (USD/MW).



Source: Elaborated by IMCO with data from BNEF. Executive Factbook.

A similar behavior can be observed in the costs and adoption rates of photovoltaic technologies, as shown in Graph 6. The trend suggests the cost of wind and solar will keep dropping worldwide, albeit more slowly than in previous years.

Graph 6. Investment costs[7] for wind and solar energy on land, 2015-2023. Dollars per kilowatt-hour (USD/KWh).

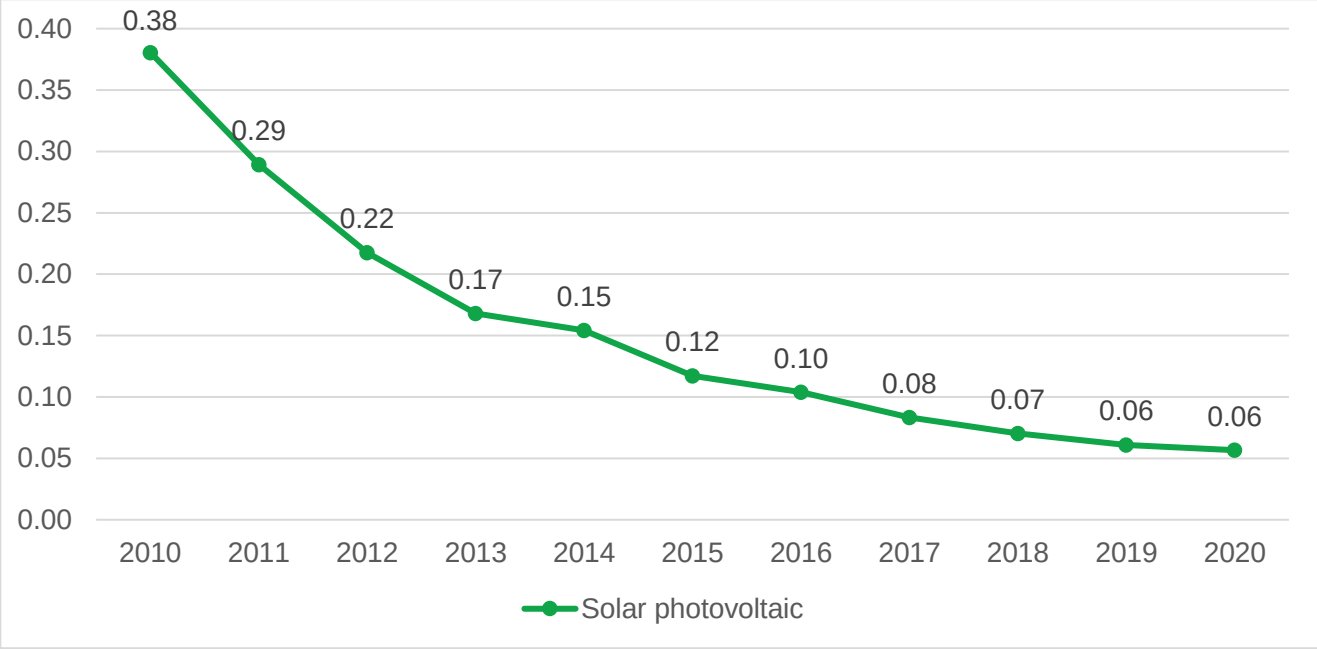


Source: Elaborated by IMCO with data from IEA. Renewable Power Generation Costs in 2020.

Similarly, between 2010 and 2020 the leveled cost of photovoltaic energy decreased from 0.38 to 0.06 per kilowatt-hour. This indicator represents a constant cost obtained by calculating the costs of building and operating an electricity generation plant, divided by all energy produced during its operating life.

[7] Investment costs are costs incurred by the acquisition and construction of the assets that a project needs before starting operations.

Graph 7. Leveled cost of photovoltaic sun-powered energy 2010-2020 USD/KWh.



Source: Elaborated by IMCO with data from IRENA.

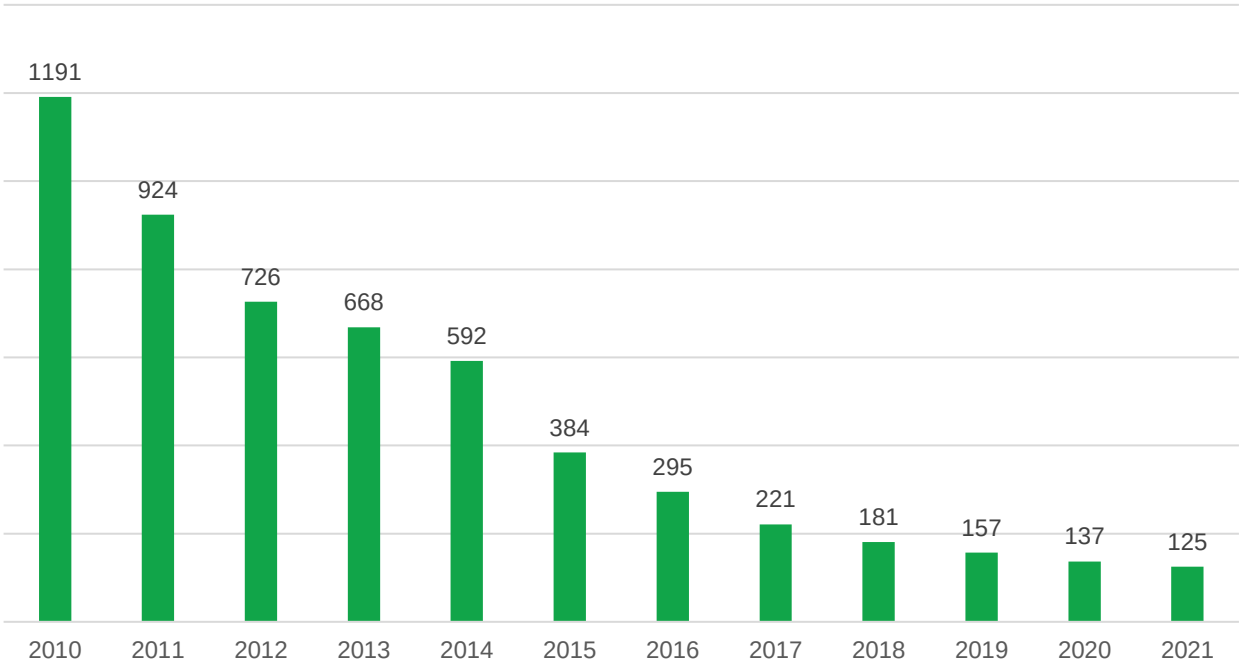
The variability of renewable generation caused by lack of sunlight or wind has driven the large-scale development of electricity storage technologies that are economically viable. This alone represents a change of paradigm: moving from instantaneous demand and supply to batteries that allow differing consumption over time.

To this day, from cell-phone batteries to electric mobility, lithium-ion batteries are the mainstream technology for storage. **The market, though still incipient, has shown a significant evolution reflected in an worldwide 89% drop in the cost of lithium-ion batteries between 2010 and 2020.**[8]

[8] Bloomberg NEF, *2021 Executive Factbook. Power, transport, buildings and industry, commodities, food and agriculture, capital.*

Alternatives to lithium ion technologies, such as sodium, sulfur, aluminum, or potassium, are likely to grow in the next few years.

Graph 8. Price of lithium-ion batteries 2010-2021. Constant 2020 dollars per KWh (USD/KWh).



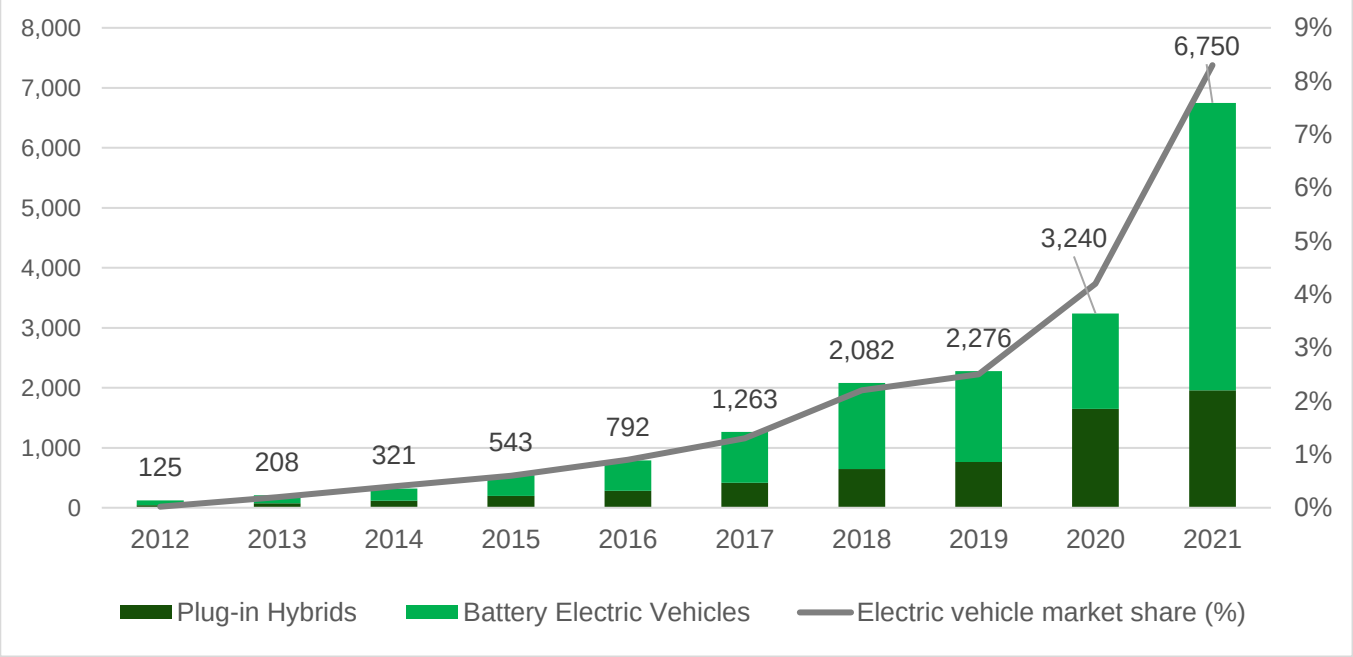
Source: Elaborated by IMCO with data from BNEF. Executive Factbook.

Moreover, battery efficiency, together with the drop in cost and other factors, has allowed for exponential growth of electric vehicles.[9] In Germany, France, Italy and the UK, sales grew 207% between 2012 and 2021, whereas sales of internal combustion cars and trucks fell up to 35%, as shown in Graph 9. Similarly, emissions limits countries and companies have committed themselves to impact on the development of electric vehicles. One example of this is the commitment to eliminate

[9] It is still to be seen whether hybrid vehicles will have a larger participation than electric ones in the mid and long-terms.

sales of internal combustion vehicles by 2035, adopted by more than 30 countries during the COP26 summit.

Graph 9. Global annual sales of electric battery vehicles 2012-2021. Thousands.



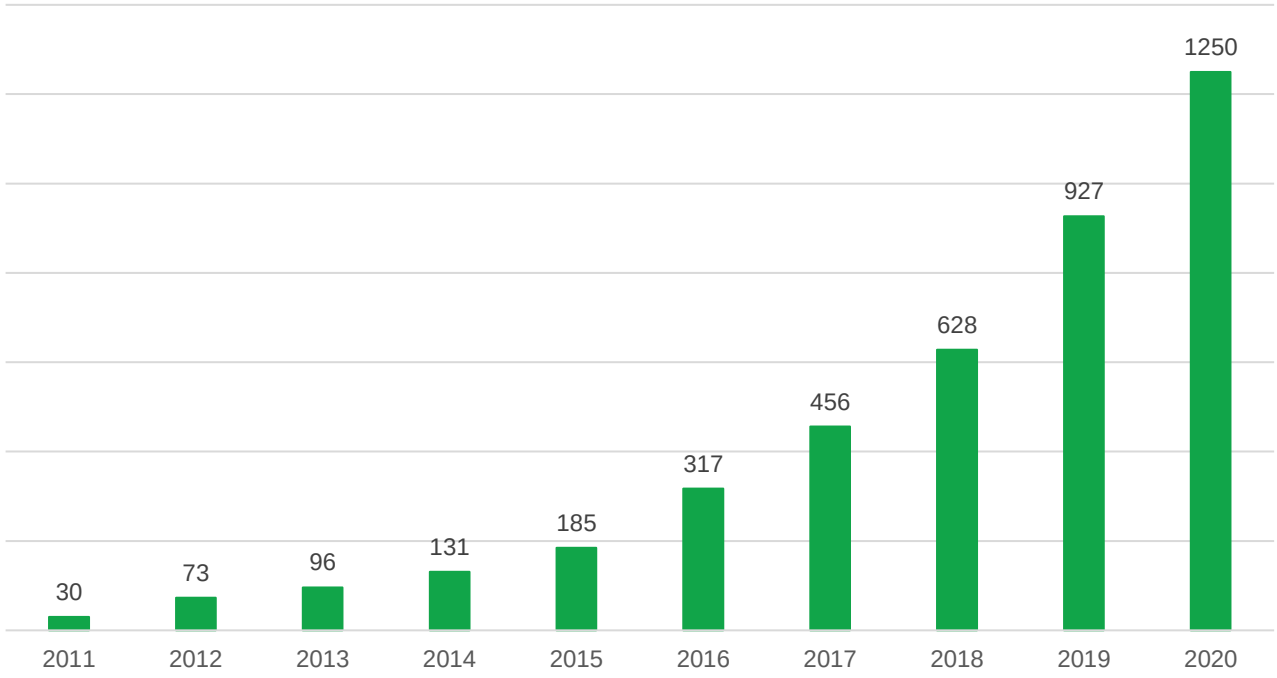
Source: Elaborated by IMCO with data from The Electric Vehicles database.

Between 2014 and 2020, worldwide sales of electric vehicles increased by 20, reaching 6.75 million.[10] The increase in electric mobility does not come unchallenged. First of all, the positive trend necessarily implies a higher demand for electricity, which means it is crucial to reinforce the transmission and the distribution grids, especially the latter. It means renewable's participation in the electric power generation matrix must increase fast, if life cycle emissions of electric mobility are ever to become significantly low or zero.

[10] EV Volumes, *"The Electric Vehicle World Sales Database",* (Sweden: EV Volumes, 2022), *https://www.ev-volumes.com/* (Seen 06/22/2022)

Secondly, reducing the cost of electric vehicles relative to internal combustion vehicles is a challenge that needs public policies that help research and development as well as production.

Graph 10. Total installed charge connectors for public electric vehicles 2011-2020. Thousands.



Source: Elaborated by IMCO with data from BNEF. Executive Factbook.

Though not always linear, **the world is clearly moving in one direction**. As stated before, this is reflected by investments, technological progress, and, above all, by the preferences of consumers. Energy transition is a gradual process, and the rate of changes depends on each country's development level and consequently on the availability of investment resources.

To date, there is no economic dilemma between renewable generation and fossil fired generation. Clean energy is cost competitive and has taken off worldwide; however, it needs to grow significantly. The trend will not change, and new lower-cost technologies will appear, thus accelerating the energy transition worldwide.

3. What about Mexico?

As member of the Paris agreement, Mexico -stands 17th on the rank of GHG emissions-[11] **committed itself to reduce GHGs emissions by 22%, black carbon emissions by 51%[12] relative to 2010 levels, and to consume 35% and 43% of power generated with clean technologies[13] by 2024 and 2030, respectively.**

Regardless of this, Mexico has waged since 2018 an energy policy that focuses on restating the old State monopolies –Petróleos Mexicanos (Pemex) and Comisión Federal de Electricidad (CFE)– with several policies targeted to eliminate competition in all energy markets. From regulatory and public policy actions to the initiative to reform the Constitution, from the changes made to the LIE to the reforms made to the Hydrocarbons Act in 2021, the Federal Government's efforts have been directed to eliminate competitors.

Consequences are already evident. The Program for the Development of the National Electricity System (Prodesen), the document that regulates the planning of electric power in the country, is the most recent example of the State's lack of commitment with energy transition. **Projections by Sener estimate the objective of generating 35% of Mexico's energy using clean technologies by 2024 will not be reached before 2031, and the objective of generating 40% by 2032 will not be met until 2035 though it is not clear how.[14]**

When public and private investment resources are scarce or not allowed, not only does it hinder the country's ability to mitigate climate change, but it has a direct impact on the system's generation costs and, consequently, on the country's consumers and economy. The artificial fostering of State

[11] Our World in Data. *CO2 and Greenhouse Gas Emissions Country Profiles,* (Oxford: Our World in Data, 2020), https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions#co2-and-greenhouse-gas-emissions-country-profiles (Seen on 06/19/2022)
[12] Black carbon is pure carbon formed by the incomplete combustion of fossil fuels. After carbon dioxide, it is the pollutant that most contributes to global warming, also causing severe damages to health.
[13] Renewable energies are those that come from natural sources that can be replenished quicker than they ares consumed, while clean energies are those with lower emissions of GHGs relative to other sources. In the Prodesen, the Sener considers as clean energy any energy that creates less than 100kg/MWh of pollution.
[14] Sener, *Programa de Desarrollo del Sistema Eléctrico Nacional 2022-2036* (Mexico City: Sener, 2022), https://www.gob.mx/cenace/documentos/programa-para-el-desarrollo-del-sistema-electrico-nacional-2022-2036

companies and giving them the responsibility to supply the entire country runs contrary to energy transition and economic rationale for three main reasons.

First, CFE does not have enough installed capacity nor is it competitive in solar and wind energy. Besides, its investment portfolio does not have enough projects to satisfy demand (as itemized in Section 6). Second, the acceleration of energy transition requires the diversification of sources for investment in electric generation, not limiting them to one single agent. Finally, a symbiosis between Pemex and CFE implies an incentive to make the first the major buyer of the fuel oil (one of the major secondary products of refineries) the oil company produces, given that international markets for that fuel have shrunk because of **regulations banning fuels with high sulfur contents**.

To be the sole generator and supplier of electricity should not be, by itself, an objective of public policy. Policy objectives that benefit consumers and citizens should push on how to make sure electricity demand is met at all times, at competitive prices and with as small a carbon footprint as possible. That is, it should prioritize energy security, instead of self-sufficiency.

The International Energy Agency (IEA) defines energy security precisely as "the uninterrupted availability of energy sources at an affordable price".[15] Public policy that **blocks private investment in energy infrastructure and purposefully eliminates competition to reinstate State monopolies is a risk for the country's energy security, not to mention the opportunity cost of spending public resources that might have a higher social utility when spent in other areas**.

Mexico needs a diversified energy matrix, access to different markets to mitigate supply and demand risks that jeopardize energy security. Thus, it is essential to have generation, transmission, transport, storage and distribution infrastructure to guarantee uninterrupted supply, even under emergency scenarios in all energy markets.

[15] International Energy Agency. *Energy Security. Reliable, affordable access to all fuels and energy sources,* (Paris: IEA, n.d.), https://www.iea.org/topics/energy-security (Seen on 06/19/2022)

The country must prove its commitment with the rule of law and with legal and regulatory certainty, if it is to foster a favorable environment for public and private investment that closes the gap in physical infrastructure, specially regarding transport and storage of fuels, as well as power generation and transmission. The following sections will tackle each subsector and provide a series of measures to face those challenges.

4. Subsector analysis: Oil

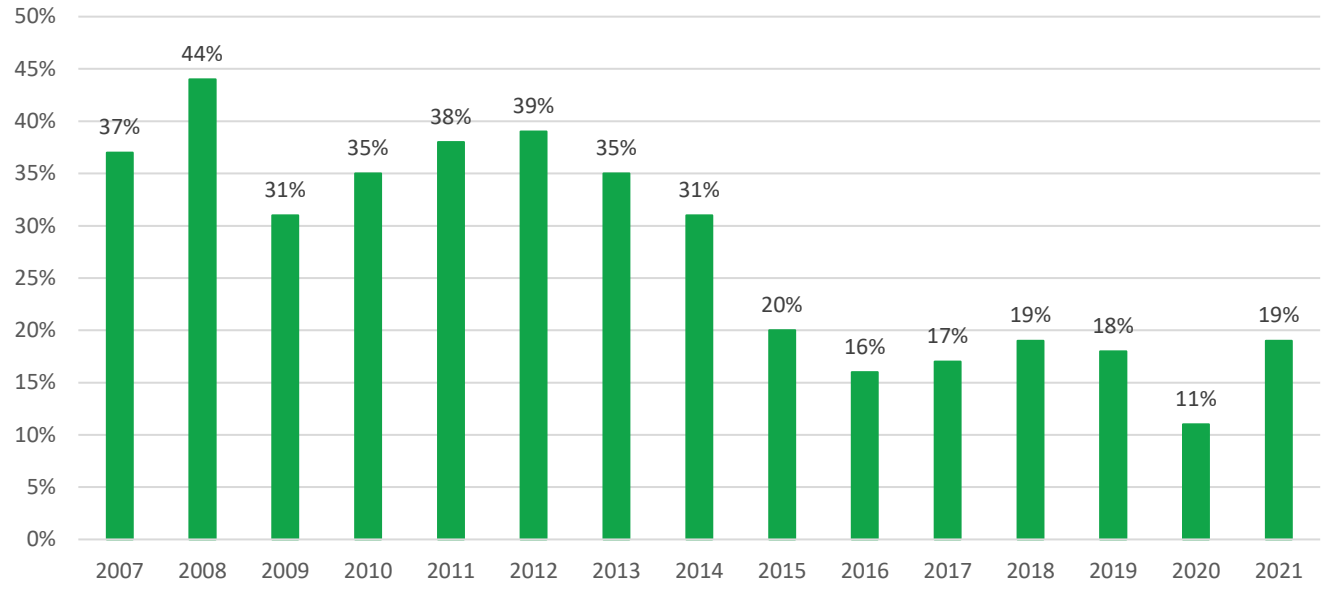
4.1 Oil exploration and production

4.1.1 Where are we today?

Mexico is no longer an oil economy. The participation of oil in GDP systematically diminished in the 90s. This does not mean that oil no longer plays a relevant role in the Mexican economy —and clearly in politics—, because the government's income has not totally freed itself from oil revenues. 19.40% of revenue still comes from oil.[16]

[16] SHCP. *Estadísticas Oportunas de Finanzas Públicas.* Ingresos Petroleros. http://presto.hacienda.gob.mx/EstoporLayout/ (Seen on 22/06/2022)

Graph 11. Oil revenues as percentage of total revenues 2007-2021 Percentage.



Source: Elaborated by IMCO with data from SHCP. Oil and total revenues.

In this context, Mexico must answer two central questions on oil revenues. **How to maximize the value of the oil rent? And where to save or how to use those resources?** Public policy for oil and gas exploration and production needs should be built on the answers to those questions.

It is important to reflect on how the oil and gas sector in general and Pemex in particular, can become profitable, adapt to technology change and to energy transition, i.e. to open Mexico's path towards an economy that can grow and develop to benefit its citizens doing so with a smaller carbon footprint in the years and decades to come.

Mexico faces a double challenge. The country has not been able to increase its oil production platform to revert the trend observed in the last decades. It is also running against the clock in terms of energy transition taking place at the global level. This creates pressure to increase oil production in the short term. **The strategy should be to explore and develop fields in an efficient way, considering international markets and sources of financing.**

The second challenge is the destiny of oil and gas revenues, that is, oil rent. Historically, the country has been a poor manager of revenues' proceeds from crude oil and gas sales. The oil boom of the second half of the 20th century did not translate in productive investment to detonate development, it was mostly as current expenditure. When the sector opened to competition in 2013/2014, the idea was to fix this strategic flaw; however, oil rent could not be destined to productive investments in a significant amount due to factors such as an adverse global environment, the weight of oil revenues in the federal budget (Spanish acronym PEF), control of the federal government on Pemex strategic decisions, the design of the Mexican Oil Fund for Stabilization and Development (Spanish acronym FMP), and the regulatory limitations of CNH.

However, to finance the infrastructure required for energy transition, productive investment is more necessary than ever. Even though the funds in the FMP cannot be applied at the discretion of the Federal Government —because the Fund itself determines how the resources should be applied—, the major beneficiary of these rules is the PEF, it can receive resources from the FMP up to 4.7% of GDP.

It is essential to **analyze the challenges oil production faces and the destiny of oil rents, if Mexico will ever be able to make better use of its resources in a context of energy transition**. Public policies should be oriented towards this goal.

Table 1. Hydrocarbon production platform

Mexico's production platform by the end of 2021 was 1.664 millions of barrels per day (MMbd) of crude oil (not including condensates). That figure is practically the same as the one registered in 2020 —an atypical year because of the COVID-19 pandemics and the shutdown of the world economy—, when 1.663 MMbd were produced.[17]

Graph 12. Oil production platform. Jan. 2000-July 2022 Thousand barrels per day (Mbd).

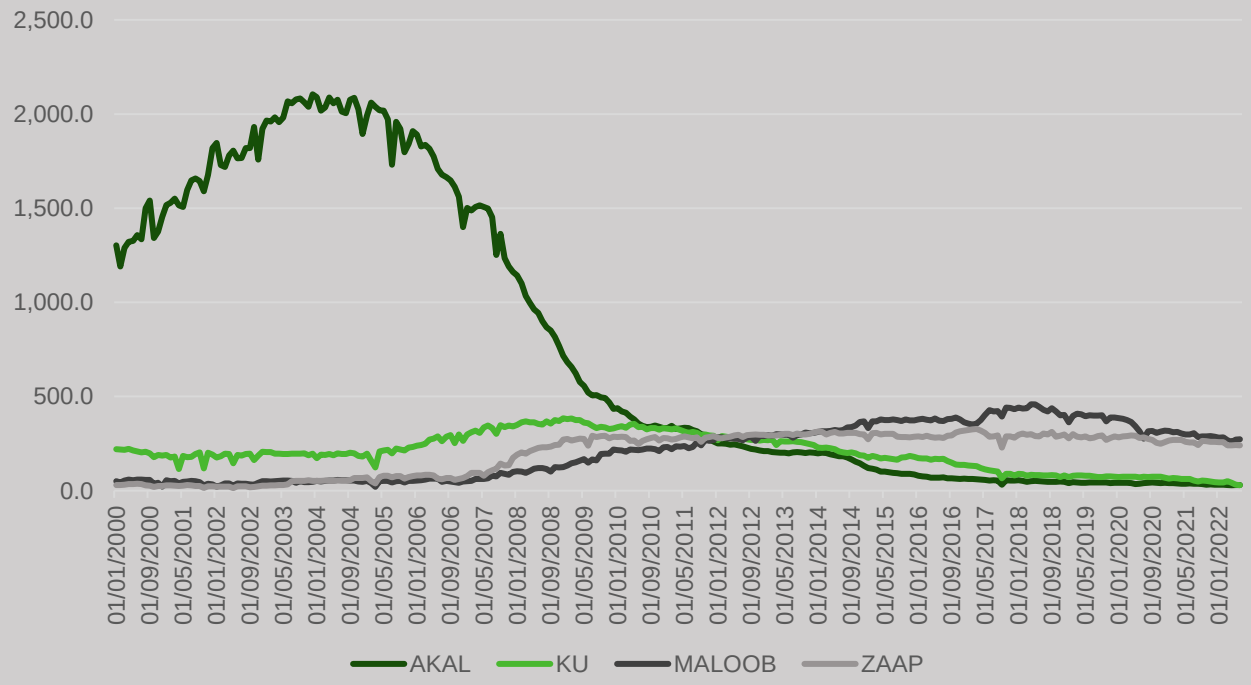
Source: Elaborated by IMCO with data from CNIH. Production by location and field.

The fall in Akal field —the biggest of the Cantarell assets in the Gulf of Mexico— is an inflection point from which Pemex has not been able to recover. The downturn experienced by Akal was partially

[17] Centro Nacional de Información de Hidrocarburos (CNIH), "Producción por cuenca y ubicación", (Mexico City: CNIH, 2022), https://sih.hidrocarburos.gob.mx/ (Seen on 06/22/2022)

compensated by Ku-Maloob-Zaap, which represents approximately 40% of Mexico's production platform to date.

Graph 13. Production in Akal, Ku, Maloob and Zaap fields. Jan. 2000-July 2022 Mbd.



Source: Elaborated by IMCO with data from CNIH.

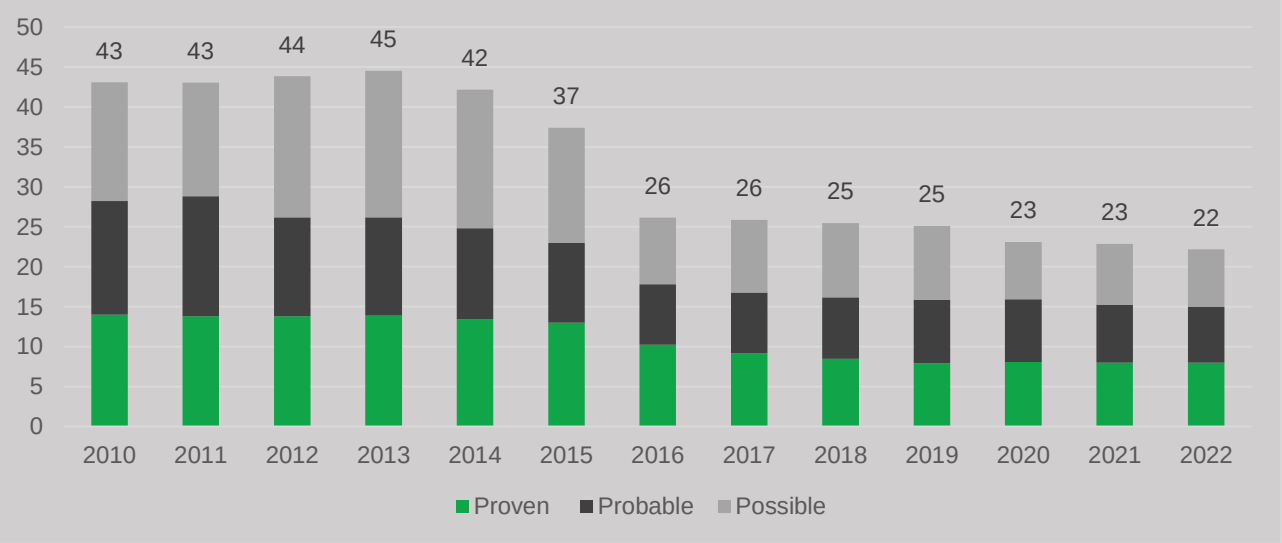
As seen in Graph 13, for the first time since the 1970's, Mexico's oil production potential is not linked to Cantarell or Ku-Maloob-Zaap. The country's possibilities to increase its production platform depends on its ability to increase the development of new fields. Pemex's comparative advantage lies in shallow waters. This requires Pemex to partner with other operators as well as increasing the overall number of operators to maximize the production platform.

Table 2. Oil reserves

According to the most recent data from the Centro Nacional de Información de Hidrocarburos (CNIH Spanish acronym), Mexico has over 8,014 MMb of crude oil equivalent in proven reserves, 7,009 in probable reserves, and 7,137 in possible reserves. To this day, the country has 6,058 MMb of proven reserves of crude oil.[18]

Even though the number of proven reserves increased slightly, this has not been enough to match the levels prior to 2016 (above 10 MMb).[19]

Graph 14. Proven, probable and possible reserves. 2010-2022. Billions of barrels per day (MMMbd).



Source: Elaborated by IMCO with data from CNIH. Oil reserves.

[18] Proven reserves are those with a reasonable chance of being recovered commercially; probable reserves are reserves that, while not proven, tend more to being recovered commercially than otherwise; finally, possible reserves have fewer probabilities of being recovered than probable reserves.

[19] Comisión Nacional de Hidrocarburos (CNH), "Reservas de hidrocarburos", (Mexico City: CNH, 2022), https://reservas.hidrocarburos.gob.mx/ (Seen on 06/22/2022)

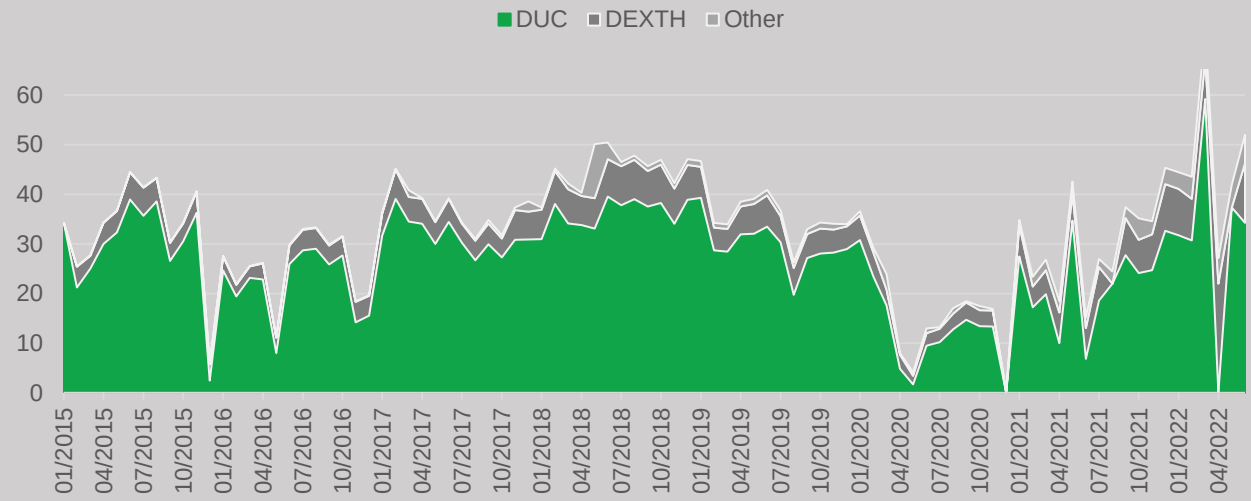
Table 3. Oil rent and the Fondo Mexicano del Petróleo para la Estabilización y el Desarrollo (FMP)

Opening exploration and extraction activities in the hydrocarbon sector to private investment came together with an instrument developed to manage the oil rent. The FMP started operations in January 2015: **the country's first sovereign fund charged with managing, investing, and distributing oil revenues.** The FMP is an instrument to manage revenues received by the Mexican state from the exploration and extraction of crude oil and other hydrocarbons. These revenues come from taxes paid by Pemex and royalties, compensations and other taxes paid by private agents (operators [20] and the State's commercializer[21]). The creation of the FMP was triggered by the need to manage oil rent with a long-term perspective without the short term pressures of the Federal government budget and expenditure.

Since 2015 up to June 2022, **2.97 trillion pesos have entered the FMP** (an average of 32 thousand million 985 per month). 96.2% of this amount came from Pemex through two major tax concepts: the rights on shared profits —Spanish acronym DUC— and the rights on hydrocarbon extraction —Spanish acronym DEXTH—. Other taxes paid by Pemex (the rights on hydrocarbon exploration —DEXPH Spanish acronym—), from new private operators, and from the State's commercializer represented a mere 3.8% of all resources accrued by the fund in those years mostly because new operators won bids of assets under exploration, these numbers will increase as those assets start production.

[20]Holders of 109 standing hydrocarbon exploration and extraction contracts that were granted to several companies on the three bidding rounds held between 2014 and 2018.
[21]The company that sells the hydrocarbons with which the Mexican state is paid in kind in contracts under this modality.

Graph 15. Origin of FMP resources by source. January 2015 - June 2022 Billions of current pesos (Bp).



Source: Elaborated by IMCO with data from Banxico. Origin and destination of the State's oil rents managed by the FMP.

While the objectives of any sovereign fund, not only the FMP, are to guarantee the rents from a non-renewable natural resource —hydrocarbons in this case— are saved and invested in productive assets that benefit the future generations according to the Hartwick rule.[22] **The FMP's design is not completely consistent with this objective.** According to the act that created the Fondo Mexicano del Petróleo para la Estabilización y el Desarrollo (Spanish acronym LFMP) and the Ley Federal de Presupuesto y Responsabilidad Hacendaria (Spanish acronym LFPRH), **resources in FMP each year under 4.7% of GDP (approximately 1.36 trillion pesos in 2022), must be transferred to the Mexican State, to be used to finance several funds and items in its budget,** according to a set

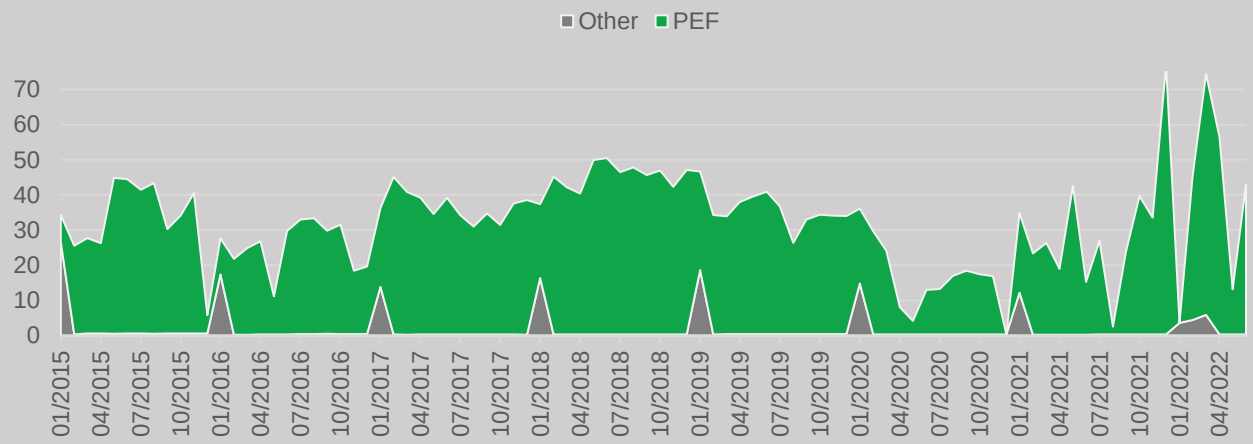
[22] The Hartwick Rule honors John M. Hartwick. It establishes that all earnings and revenues from the exploitation of non-renewable resources must be invested in reproducible capital, that is, capital that increases the production capability of an economy. In this way, a stock of finite resources transforms into a capital stock that subsists after the resource has been exhausted, thus preserving equality between generations. John M. Hartwick, "Intergenerational equity and the investing of rents from exhaustible resources", *The American Economic Review* 67, no. 5(1977): 972–74. http://www.jstor.org/stable/1828079

of criteria such as: 1) Stabilization funds (2.84%), 2) Sector funds (1.52%), 3) Other transfers (0.06%), and 4) the Federal expense budget (PEF) of the corresponding fiscal year (95.58%).[23][24]

Revenues in the FMP above 4.7% of GDP, are transferred to a long-term savings reserve, a purse meant to accumulate and invest the country's oil rents. It is also possible to reserve those oil revenues in excess of the estimations of the Ley de Ingresos de la Federación (LIF), once some compensations established by the LFPRH are made.

Practically speaking, it makes the Federal government the major beneficiary of the country's oil revenues, applying them to pay for its budget expenses (Graph 16).

Graph 16. Destination of FMP resources by type of transfer. January 2015 - June 2022 Current Bp



Note: "Others" means stabilization funds, sector funds, and other items.

Source: Elaborated by IMCO with data from Banxico. Origin and destination of the State's oil rents managed by the FMP.

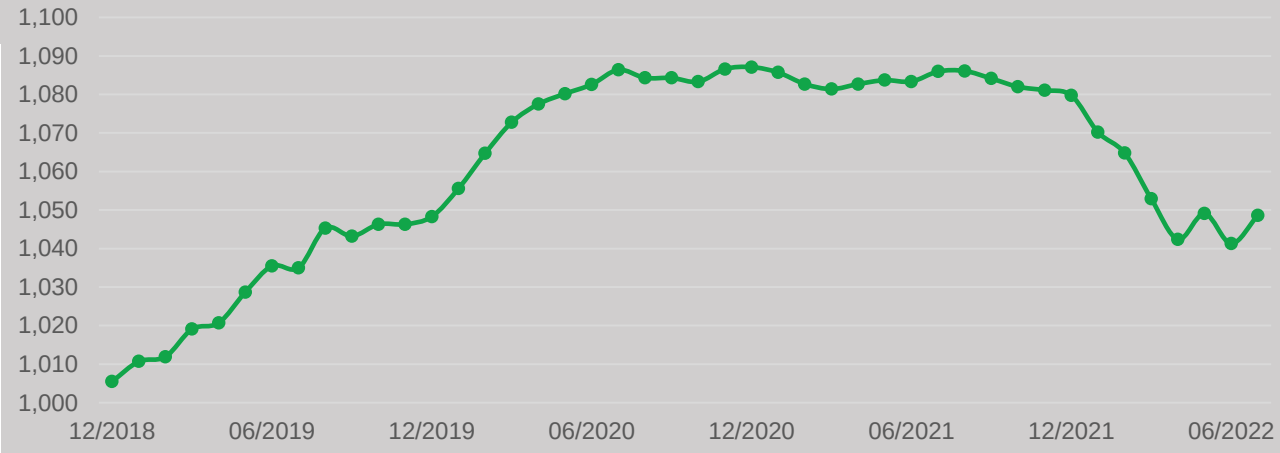
[23] Cámara de Diputados, "Ley del Fondo Mexicano del Petróleo para la Estabilización y el Desarrollo", Última reforma publicada en el Diario Oficial de la Federación el 6 de noviembre de 2020 (Mexico City. Cámara de Diputados, 2020), https://www.diputados.gob.mx/leyesbiblio/pdf/lfmped_061120.pdf

[24] Cámara de Diputados, "Ley Federal de Presupuesto y Responsabilidad Hacendaria", Última reforma publicada en el Diario Oficial de la Federación el 27 de febrero de 2022 (Mexico City: Cámara de Diputados, 2022), https://www.diputados.gob.mx/leyesbiblio/pdf/lfprh.pdf

This is one of the major design problems of the FMP. No significant resources have accumulated as practically all of the oil revenue goes to financing expenses —mostly current expenses— of the Federal government. This prevents FMP from acting as a sovereign fund that invests with a long term perspective.

Since the FMP started operations, its long-term savings reserve has only received a transfer of 987.5 million dollars (Md) —plus accrued interest— from oil revenues in excess in early 2018. By July 31 2022, the balance of the FMP's long-term reserve is one thousand 49 Md[25], or 21 thousand 369 million pesos. **The balance is equivalent to 0.7% of all the resources that entered the fund and to 0.07% of the GDP estimation for 2022.[26]**

Graph 17. Balance of the long-term savings reserve of the FMB by the end of each month. December- July 2022. Current Bp



Source: Elaborated by IMCO with data from FMP. Historic value of reserves.

[25] FMP, "Valor histórico de la reserva", Administración de la reserva de largo plazo, https://www.fmped.org.mx/administracion-reserva.html (Seen on 16/08/2022)

[26] Estimated GDP for 2022 according to the SHCP is 28.9 trillion pesos. SHCP, *Documento relativo al cumplimiento de las disposiciones contenidas en el artículo 42, fracción I, de la Ley Federal de Presupuesto y Responsabilidad Hacendaria* (Mexico City: SHCP, 2022), https://www.finanzaspublicas.hacienda.gob.mx/work/models/finanzas_publicas/docs/paquete_economico/precgpe/precgpe_2023.pdf

4.1.2 What does the country need?

Mexico must maximize the value of oil revenues and use them to finance the energy transition. This implies increasing the possibility of both private and public investment in field exploration. To grant fields and allow the participation of different operators in the exploration and production of oil, the international practice is to organize bidding rounds for hydrocarbons.

In the bidding scheme, the operators bear the financial and operative risks of field exploration. If hydrocarbons are discovered and exploited, they pay compensations and royalties to the State; if no discoveries are made, they assume their losses.

In Mexico there are currently 109 contracts for the exploration and production of hydrocarbons. These contracts, different to the assignments that are exclusive to Pemex, are entered into by the State company and private operators.[27]

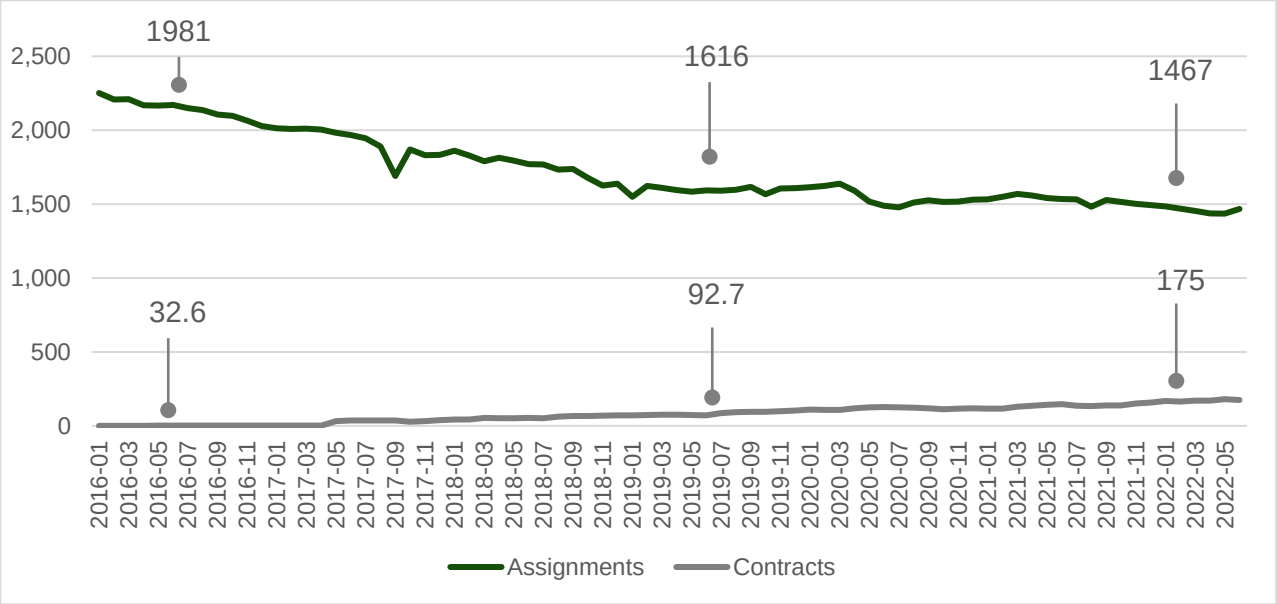
Hydrocarbon rounds have been good business for the Mexican State. As registered by the Comisión Nacional de Hidrocarburos (CNH), the investments made through the contracts for the exploration of hydrocarbons amount to 10 billion and 643 million dollars.[28] Almost 82% of that sum, that is, **8 billion and 698 million dollars, corresponds to operators other than Pemex**. These are resources that the Mexican State did not spend on, generate income for the State. By the end of June 2022, the fields granted during the bids produced 178.4 thousand barrels per day (Mbd), when counting both Pemex and private operators. **If only fields operated by private agents are considered, then production rose to 98 Mbd.[29]**

The trend observed between production in fields assigned to Pemex before the bids (assignments) and the contracts granted during the rounds (with participation of Pemex and private operators)

[27] Rondas México, "Cifras relevantes", (Mexico City: Sener, 2022), https://rondasmexico.gob.mx/esp/cifras-relevantes/ (Seen on 21/06/2022)
[28] Comisión Nacional de Hidrocarburos (CNH), "Inversiones registradas en contratos para exploración de hidrocarburos" (Mexico City: CNH, 2022) https://hidrocarburos.gob.mx/media/5065/inversiones-reportadas-en-contratos-de-exploracion-y-extraccion-de-hidrocarburos_202205.pdf (Seen on 21/06/2022)
[29] Asociación Mexicana de Empresas de Hidrocarburos (Amexhi), "Información general", (Mexico City: Amexhi, 2022), https://www.amexhi.org/ (Seen on 30/06/2022)

shows that the bidding rounds have been successful. While assignments follow a downward trend, contracts have proved they are useful vehicles to increase Mexico's production platform (they represent over 10% of the country's oil production). In spite of the bidding rounds having been suspended since 2018, it is expected the production from contracts will increase, given the maturity process of hydrocarbon exploration and production projects.

Graph 18. Oil production by assignments and contracts. January 2016-July 2022 Mbd.



Source: Elaborated by IMCO with data from CNIH. Oil and gas production chart.

The fact that Pemex accounts for almost half of oil production from contracts proves that, **under the existing framework, both the State company and private operators can succeed.** Adding to this, the concept of farm-outs, or associations between several operators that exploit a field, opens a way for Pemex to benefit from the technical experience and access to technology of other operators, to develop its own capabilities in areas it has never explored or been profitable, such as deep waters and unconventional fields.

The success of contracts depends on an environment that fosters investment and a technical regulator or independent administrator with a long-term view, CNH in this case.

In 2016, the IEA estimated that, if hydrocarbon exploration and production were fully open to private operators, the country might reach a production platform of 3.0 MMbd by 2030 and of 3.5 MMbd by 2040. **Deep waters should contribute with 1 of these 3.5 MMbd and unconventional reservoirs would render approximately 500 Mbd.**

Though the global context for oil has changed since, there is no reason to assume the potential has disappeared. On the contrary, **high oil prices should make Mexico more attractive** for the exploration and production of crude oil.

Being a non-renewable resource, oil must be considered an asset. Considering the design faults of the FMP that, as mentioned before, does not modify the destiny of oil rents, but gives them to the Tesorería de la Federación, this premise only highlights that the question at hand is **how to maximize the value of this asset from an intergenerational perspective**. In other words, how can oil revenues benefit generations living once the resource has been exhausted.

From a climate change perspective, **the FMP could become a key financing mechanism to accelerate energy transition**.

Mexico faces an additional challenge: to make up for lost years in developing new fields. To accelerate the increase of the country's production platform bidding rounds must be restarted and increase their frequency. **It is in Mexico's best interest to take advantage of a context of high oil prices to maximize the value of its oil rent. Oil and Gas** current and potential uses are itemized in the following section.

4.2 Industrial processes: Crude oil refining and energy transition

4.2.1 Where are we today?

For the first time in 30 years, refining installed capacity fell in 2021. In other words, closure or reconversion of facilities, for example, petrochemical complexes, were higher than new refineries worldwide.[30] Since COVID-19, the equivalent of 3 MMbd of capacity has been shut down, and by 2025 another 1.5 MMbd will be out of operation.[31]

Beyond the distortions brought about by the pandemic, this is a symptom of a larger trend: the impact of energy transition on oil and petrochemical markets. **What is refining's role in a world that aspires to zero net carbon emissions?**

Refining companies must adapt to this new context. **IHS Markit estimates that global refiners will invest 150 Bd in decarbonization measures during the next three decades.**[32] The company also calculates that, by 2050 world demand for refined products will decrease to about 75 MMbd, whereas current installed capacity amounts to 105.6 MMbd.[33]

In response, investment in refineries in Europe and the United State focuses on biofuels and decarbonization projects, while most of the investment in traditional refining will take place in Asia, specifically in China.[34] **Since the market will not disappear, successful players will be those who adapt to the new circumstances.**

[30] International Energy Agency, *Oil Market Report-January 2022*, (Paris: IEA, 2022) https://www.iea.org/reports/oil-market-report-january-2022 (Seen on 06/22/2022)
[31] IHS Markit, *The Refinery of the Future,* (London: IHS Markit, 2021), https://ihsmarkit.com/research-analysis/the-refinery-of-the-future.html (Seen on 06/22/2022)
[32] IHS Markit*, The Refinery of the Future*
[33] Global Data, *Refineries Capacity and Capital Expenditure Outlook, 2022-2026*, (London: Global Data, 2022), https://store.globaldata.com/report/refineries-capacity-and-capital-expenditure-market-analysis/ (Seen on 06/22/2022)
[34] IHS Markit, *The Refinery of the Future*

Globally, 70% of additions in refining capacity are estimated to happen in countries that are now net exporters of fuel.[35] That is not the case for Mexico, a net importer of fuels. Data on operations point out this trend will remain unchanged, as seen in Graphs 19 and 20. Even if the Dos Bocas refinery operates at full capacity, it would still not be able to compensate for oil products' imports.

Of the 340 Mbd that Dos Bocas will presumably refine once operating at full capacity, 170 Mbd will be gasoline. However, average demand for gasoline during the first 22 weeks of 2022 rose to 749 Mbd, while imports amounted to 498 Mbd. In other words, the import percentage was 67% and Dos Bocas will not be enough to substitute all imports.[36] From a sustainability standpoint, it is not rational to invest in additional capacity to reverse this trend in the mid-term and long-term.

Mexico is at a crossroads and must decide what to do about its installed refining capacity in the mid and long terms. By the end of the first half of 2022, the average efficiency of the National Refining System (Spanish acronym SNR) was 49%,[37] investing in modernizing the existing infrastructure would make more sense economically, socially and in energy security terms than investing in new refineries. Evidently, this does not get Mexico any closer to an energy transition path or the mitigation of the risks posed by climate change.

Expanding installed refining capacity is questionable from an economic, social and sustainability perspective. Building and operating a seventh refinery —Olmeca at Dos Bocas, Tabasco— is clearly inconsistent with the global tendency to build smaller refineries and reconvert existing facilities into petrochemical plants.

[35] International Energy Agency, Oil 2020. *Analysis and Forecast to 2025*, (Paris: IEA, 2020), https://iea.blob.core.windows.net/assets/4884bbba-d393-48b8-a9e9-6c2e002efc55/Oil_2020.pdf (Seen on 06/22/2022)
[36] Secretaría de Energía, *Estadísticas de petrolíferos*, (Mexico City: Secretaría de Energía 2022), https://estadisticashidrocarburos.energia.gob.mx/inicio.aspx (Seen on 07/01/2022)
[37] Pemex, *Reporte de resultados no dictaminados 2022*, 2 trimestre. (Mexico; 2022) https://www.pemex.com/ri/finanzas/Reporte%20de%20Resultados%20no%20Dictaminados/Reporte%202T22.pdf

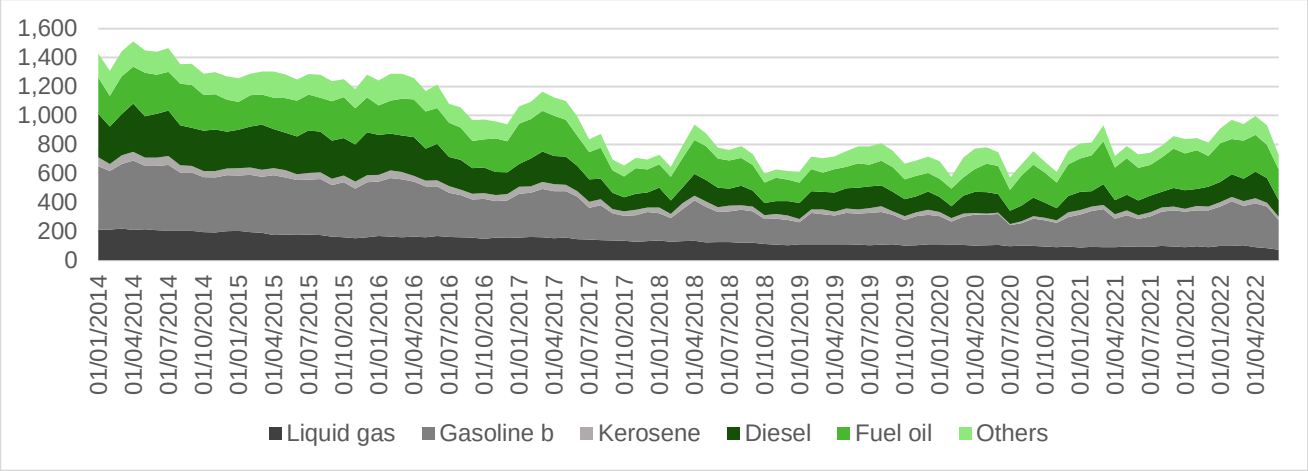
Besides the objective of increasing production in the short term, it is relevant to think about Pemex refineries' future. **The challenge is supply reliability and the company's profitability, not who or where hydrocarbons are processed.** Fuels consumed in Mexico and Pemex's refining production are not, and do not need to be, the same.

In Mexico, the Pemex production of refined products has increased to levels not seen since 2017. However, **Pemex Transformación Industrial (Spanish acronym PTRI) profits decreased from -55.8 in 2017 to -219.8 by 2021**. **In 2021, SNR's six refineries produced 714 Mbd of oil products, whereas in 2020 they produced 591 Mbd.** In spite of a 20.8% growth between 2020 and 2021, manufacture of oil products is 43.5% below the production reported for 2013 (1.26 MMbd).

Higher production volumes per se are not good news, as they do not necessarily imply larger profits or efficiency. For instance, by the end of 2021 Pemex produced for the first time ever more fuel oil (244 Mbd) than gasoline (226 Mbd), and production of the former grew by 38.6%. Thus, fuel oil production in the SNR was 8% larger than the manufacture of gasoline.

Fuel oil is a by-product of the refining process. The more efficient the refining process is, the more gasoline and less fuel oil it produces. Fuel oil has a much lower price than gasoline, it has fewer applications, and has more GHG and sulfur emissions. Production and efficiency trends have remained unchanged since the first months of 2022. According to the most recent available data, more than half of Pemex refining capacity is idle due to operation issues.

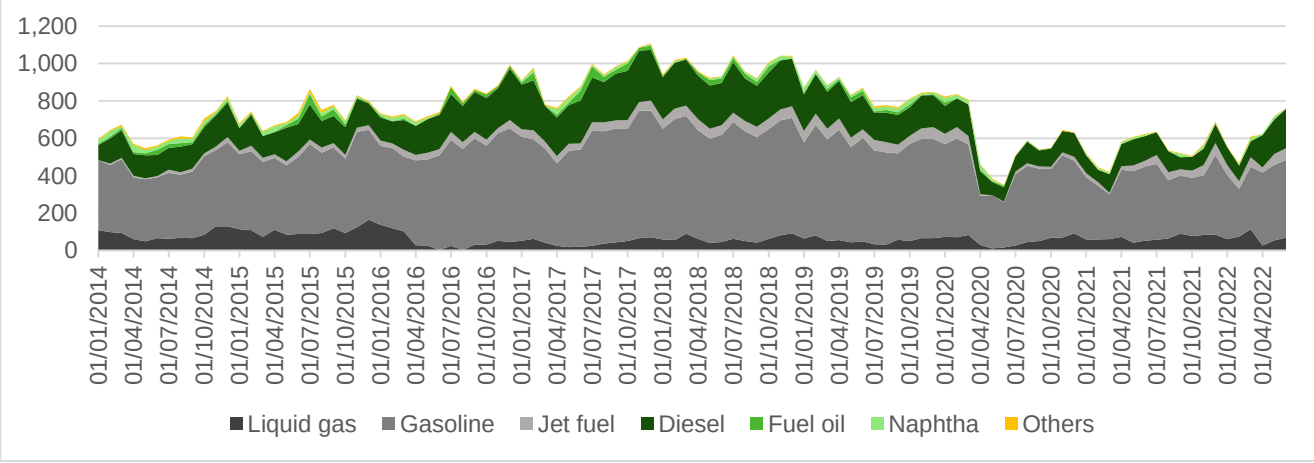
Graph 19. Manufacture of oil products by product. January 2014-July 2022. Mbd.



Source: Elaborated by IMCO with data from Sener. Sistema de Información Energética.

As evidenced by data and Pemex operation capabilities, to meet fuel demand the country needs both Pemex domestic production and imports.

Graph 20. Imports of oil products by product. January 2014-July 2022. Mbd.



Source: Elaborated by IMCO with data from Sener. Sistema de Información Energética.

Current regulation complicates fuel imports by private operators, specifically a 2020 executive resolution that establishes imports and exports of fuels are subject to Secretaría de Energía's decision on a case-by-case basis.[38]

This regulation creates uncertainty for imports and limits long-term planning by reducing permit duration from 20 years, that may be twice extended, to a period of 5 years that may be extended another 5. The prices for gasoline contracts with shorter durations are higher than with long term contracts. This implies higher fuel costs which have a negative impact on consumers.

At the same time, companies are required to justify the volumes they intend to import, thus creating a scope of discretion when Sener authorizes or denies a permit and/or modifies authorized volumes. This issue also has the effect of placing larger responsibilities on Sener, when it comes to absorbing the risk of supply security. When companies are willing to take the risk of purchasing quantities of fuel larger than the amount in demand it benefits consumers, because the cost is minimized when purchases are negotiated at long-term prices.

The bureaucratic red tape is an unnecessary burden on fuel imports by private companies, making fuel markets less competitive and increasing the supply risk for the country. Under a supply, price and sustainability standpoint, making the import process more difficult only harms consumers and citizens.

4.2.2 What does the country need?

Mexico must prepare for structural changes in the oil products markets and industrial transformation processes of crude oil. This planning implies more storage and transport infrastructure. Moreover, the country should profit from international trade to minimize costs to consumers.

[38] Secretaría de Energía, *Acuerdo que establece las mercancías cuya importación y exportación está sujeta a regulación por parte de la Secretaría de Energía,* (Mexico City: Secretaría de Energía: 2020), https://www.dof.gob.mx/nota_detalle.php?codigo=5608832&fecha=26/12/2020 (Seen on 06/22/2022)

Pemex must build a strategy for energy transition in the refining subsector, together with feasible alternatives to maximize the value of the company's installed capacity —soon seven refineries— in the country and the Deer Park facility at Houston, Texas.

Energy security must focus on meeting the country's demand at all times at affordable prices without a burdensome load of subsidies on public finances.

This goal implies an environment that favors public and private investment within a predictable legal and regulatory framework, in which competitive infrastructure for import, transport and storage of fuels may be developed.

Refineries are not an end, they are useful in as much as they meet three conditions: produce high added value goods, reduce their impact on the population's health, minimize their carbon footprint and, finally, that they be profitable.

Considering the greater weight electric mobility will have globally, refineries must bet on producing petrochemicals for pharmaceuticals, fertilizers, detergents, soap, pesticides, and other such markets. In the years to come, the success of refineries will depend on their productivity, strategy, capital discipline, management of supply chains, digital transformation, and talent administration.[39] In other words, refineries will succeed based on their ability to adapt to a global context of falling demand for fossil fuels. **To this day, Pemex shows no signs of having any such strategy.**

[39] Dickson, Duane, Hardin, Kate y Shatuck, Thomas*, Building resilience in refiningNavigating disruption and preparing for new opportunities* (New York: Deloitte, 2020), https://www2.deloitte.com/us/en/insights/industry/oil-and-gas/building-resilience-future-of-oil-refining.html (Seen on 06/ 22/2022)

5. Subsector analysis Gas markets

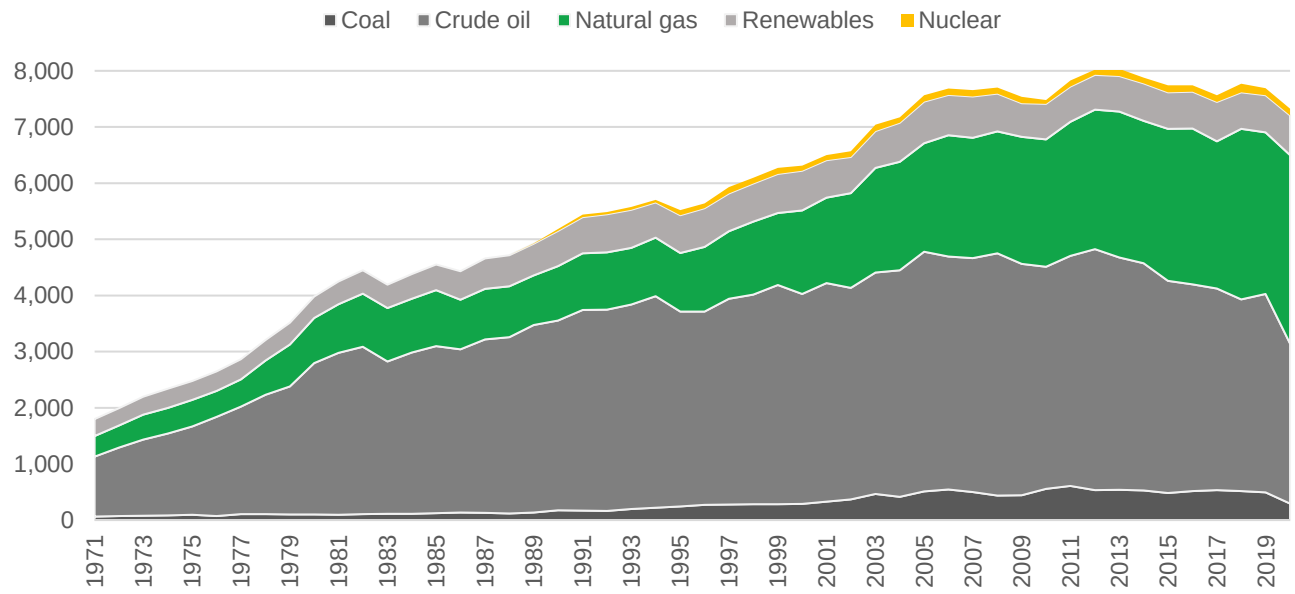
5.1 Natural gas

5.1.1 Where are we today?

Natural gas has been considered a "transition fuel" from a fossil fueled economy to an economy based on clean or renewable sources of energy. Some years ago the price of gas was more competitive than renewables or other clean energy technologies. This has changed and is currently as competitive as renewables at least for power generation. In terms of emissions, natural gas has lower GHG emissions than coal, fuel oil, gasoline or diesel. However, it does emit GHGs when burned and fugitive methane emissions from transport and storage infrastructure have recently raised many red flags globally. However, it definitely is **an efficient fuel and is affordable compared to the rest of fossil fuels**, thus remains essential to energy transition efforts and overall economic growth worldwide.

According to the IEA, **in 2020 natural gas was Mexico's major energy source for the first time in history**. That year, 45.8% (3 thousand 353 petajoules –PJ–) of the total supply of primary energy available in the country (7 thousand 327 PJ) came from natural gas. This percentage was higher than other energy sources, such as crude oil (38.9%), renewable energy (9.7%), coal (4.0%), and nuclear energy (1.6%).

Graph 21. Total energy supply in Mexico 1971-2020. Petajoules (PJ).



Note: 2020 data are preliminary.

Source: Elaborated by IMCO with data from IEA. World Energy Balances (database).

As shown in Graph 21, the amount of natural gas used by the Mexican economy increased gradually along the last 50 years: between 1971 and 2020, **natural gas as a percentage of total energy sources grew from 20.4 to 45.8%.**[40]

The rate, which increased by the early 2000's, can be attributed to two factors: its widespread use in the power industry to generate electricity (mostly in combined cycle plants) and its many applications in other industrial processes. **This is a consequence of its low relative price and of the lower GHG emissions compared to other fossil fuels.**

The relatively low price of natural gas can be explained by the shale gas revolution in North America towards the end of the first decade of the 21st century. Commercial production of unconventional

[40] IEA, *World Energy Balances* (database) (Paris: IEA, 2021), https://www.iea.org/data-and-statistics/data-product/world-energy-balances-highlights

fields with fracking **considerably increased natural gas supply in the US at competitive prices worldwide**.

Graph 22. Henry Hub average spot price of natural gas. January 1997 - June 2022 Dollars per million BTU (USD/MMBtu).

Source: Elaborated by IMCO with data from EIA. Henry Hub natural gas spot price.

In terms of GHG emissions, the Environmental Protection Agency of the US (EPA), burning natural gas emits 53.1 kilograms of carbon dioxide for every million BTUs (kg CO2/MMBtu), whereas fuel oil and coal emit 75.1 and 95.7 kg CO2/MMBtu, respectively.[41] Natural gas also emits considerably less methane (CH4) and nitrous oxide (N20) than those fuels (Table 1).

However as stated earlier in this section, recent evidence[42] has raised the issue of the potential for fugitive emissions of methane in natural gas production, transport and storage facilities. Fugitive methane is natural gas that leaks without burning. Its impact in terms of carbon emissions to the atmosphere is greater than when it burns, because methane's potential for global warming within 100

[41] EPA, "GHG Emission Factors Hub", EPA Center for Corporate Climate Leadership, https://www.epa.gov/climateleadership/ghg-emission-factors-hub (Seen on 06/07/2022)
[42] IEA, "Driving down methane leaks from the oil and gas industry", https://iea.blob.core.windows.net/assets/465cb813-5bf0-46e5-a267-3be0ccf332c4/driving_down_methane_leaks_from_the_oil_and_gas_industry.pdf (Seen on 07/01/2022)

years is 28 times larger than the potential of CO2.[43] Recent technological advances in monitoring fugitive emissions and the infrastructure to prevent them will have a considerable impact on the real costs of natural gas and on its status as transition fuel.

Table 1. GHGs emissions coefficient by type of fuel.

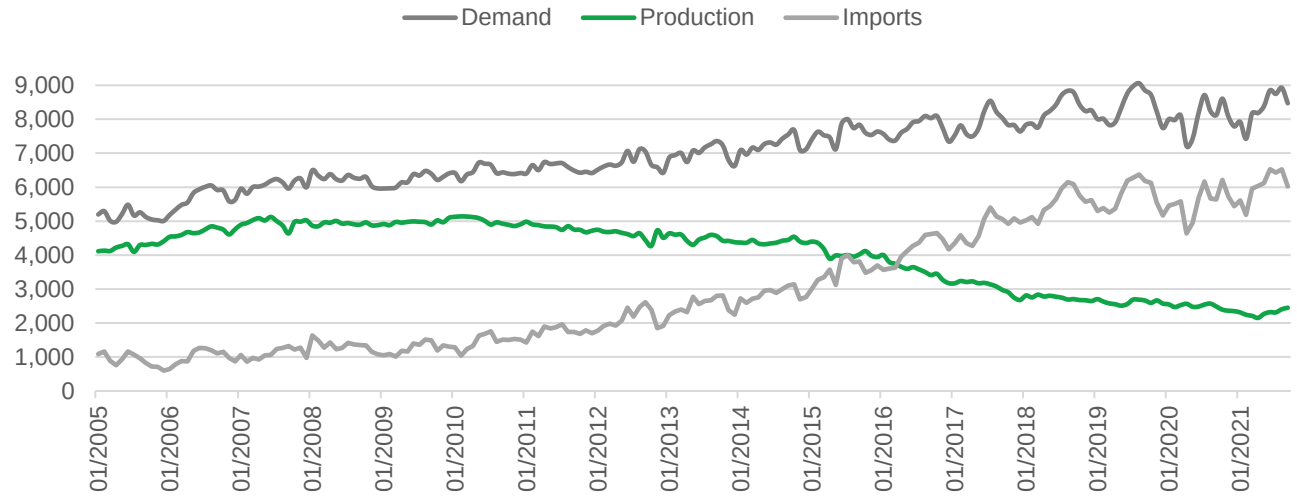
Fuel	CO2 (Kg/MMBtu)	CH4 (g/MMBtu)	N2O (g/MMBtu)
Coal	95.5	11.0	1.6
Fuel oil	75.1	3.0	0.6
Natural gas	53.1	1.0	0.1

Source: Elaborated by IMCO with data from EPA. GHG Emission Factors Hub.

Amidst competitive prices and perceptions of relatively low GHGs emissions, demand for natural gas in Mexico grew steadily. Demand was much higher than domestic production of natural gas, which has been reducing continuously since Feb., 2010. Between that month —that registered a peak of production— and Sep. 2021, production of natural gas[44] decreased -52% from 5 thousand 140 million cubic feet per day —MMscfd— to 2 thousand 450 MMscfd.[45]

[43] Unece, *Sustainable Energy: methane management*. https://unece.org/challenge (Seen on 17/08/2022)
[44] For clarity, from this section onwards by natural gas we will be referring to dry natural gas, that is, gas containing fewer quantities of heavier hydrocarbons than methane.
[45] Sener, "Balance nacional de gas natural. Prospectivas", Gobierno de México, https://datos.gob.mx/busca/organization/sener (Seen on 14/06/2022)

Graph 23. Demand, production and imports of natural gas, January 2005-September 2021. Million cubic feet per day(MMscfd).



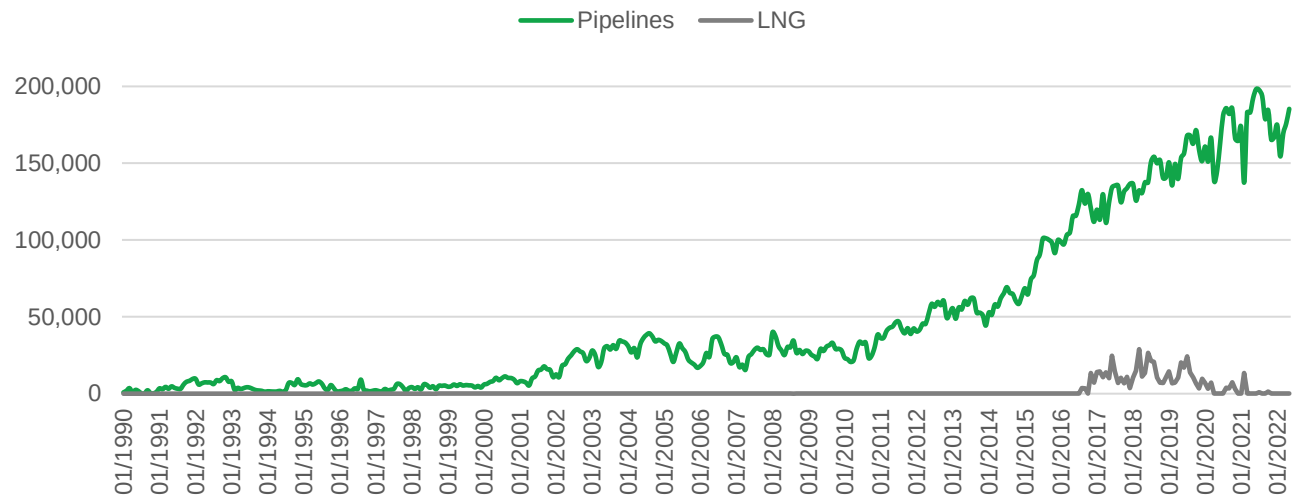
Note: Differences between supply (production and imports) and demand of natural gas correspond to exports, stock variations, and statistical differences.

Source: Elaborated by IMCO with data from Sener. Balance nacional de gas natural. Prospectivas.

The gap between domestic production and demand has been bridged with increasing imports from the US by pipeline. A small proportion of these imports is LNG (liquefied natural gas) and get to Mexico by ship or truck at a higher price. Between 2000 and 2021, natural gas imports from the US grew at an average annual rate of 15.5%, and went from 105 thousand MMcf in 2000 two 2.17 billion cubic feet in 2021.[46]

[46] EIA, "U.S. natural gas exports and re-exports by country", Natural gas, https://www.eia.gov/dnav/ng/ng_move_expc_s1_m.html (Seen on 08/02/2022)

Graph 24. Monthly imports of natural gas from the US by means of importation. January 1990- May 2022. Million cubic feet per day (MMscfd).



Source: Elaborated by IMCO with data from EIA. U.S. natural gas exports and re-exports by country.

Mexico is a country particularly vulnerable to sudden changes in supply and demand due to its dependence on natural gas imports from the USA —73.1% of national demand between Jan. and Sep, 2021—. One such example is the crisis from the low temperature event in Texas in February 2021 that disrupted imports of natural gas from that Texas to Mexico. As a result, four million users in the North of Mexico suffered blackouts and restrictions to commercial users of natural gas, mandated by the Centro Nacional de Control de Gás Natural (CENAGAS).[47]

Mexico's natural gas storage infrastructure is insufficient and limits the country's ability to respond to supply shocks. Several storage technologies exist, some examples are underground storage (in gas form), depleted oil reservoirs, confined aquifers, and salt caves. However, **Mexico's**

[47] IEA, *Gas market report Q4-2021* (Paris: IEA Publications, 2021), https://www.iea.org/reports/gas-market-report-q4-2021

only storage is LNG tanks at three terminals with limited capacity for both storage and regasification (Altamira, Ensenada, and Manzanillo).

Currently, these terminals' capacity is 32.5 MMscf of LNG,[48] equivalent to 19 thousand 975 MMcf of natural gas,[49] or **2.4 days of the average daily consumption in Mexico for the first nine months of 2021 (8 thousand 265 MMcf)**.

According to a diagnosis made by Sener in 2018, the storage capacity in these terminals **was insufficient to face different scenarios of interruptions to natural gas supply**. This compromises Mexico's energy security and is a major risk for electric power generation, industry, and other productive sectors.[50] Mexico contrasts with other countries that have storage capacity above 34 days of average consumption (Table 2).

[48] CNH, *El sector del gas natural: algunas propuestas para el desarrollo de la industria nacional* (Mexico City: CNH, 2018), https://www.gob.mx/cnh/documentos/el-sector-del-gas-natural-algunas-propuestas-para-el-desarrollo-de-la-industria-nacional

[49] To convert cubic feet to cubic meters (m^3) we used a conversion factor of 0.0283168466 m^3 per cubic feet. Afterwards, LNG in m^3 were converted to cubic feet of natural gas applying a factor of 21,718.52 cubic feet of natural gas per cubic meter of LNG. See CANIE, "Factores de conversión y unidades comunes", Datos, https://www.nacei.org/#!/data (Seen on 08/03/2022)

[50] Sener, *Política pública en materia de almacenamiento de gas natural* (Mexico City: Sener, 2018), https://www.gob.mx/cms/uploads/attachment/file/312167/documento_pol_tica_p_blica_de_almacenamiento.pdf

Table 2. Natural gas storage capacity in selected countries by Dec. 31, 2020.

Country	Storage capacity (TWh)	Daily average consumption (TWh)	Storage days
Austria	95.5	0.3	318.3
France	128.5	1.3	98.8
Italy	196.9	2.1	93.8
Germany	240.3	2.7	89.0
Spain	34.2	1.0	34.2
Mexico	6.1	2.5	2.4

Notes:

1/ The number of storage days was calculated using the average daily consumption registered during 2020.

2/ Data from Mexico correspond to the first nine months of 2021.

Source: Elaborated by IMCO with data from CNH. El sector del gas natural: algunas propuestas para el desarrollo de la industria nacional; GIE. Aggregated Gas Storage Inventory.

Early in 2018 Mexico approved public policy for natural gas storage to reduce risks associated to supply interruptions,[51] this policy has not been implemented nor given proper follow-up. Some of its objectives were to have a strategic stock of at least 5 days of consumption by 2026. This figure starkly contrasts with the storage capacity of other countries. This policy includes measures such as public bidding for construction of an underground gas storage facility. None of these objectives has materialized.

Together with the challenges posed by storage, **the country needs more duct infrastructure to move gas across the country**. In 2011 CFE started an expansion program for gas ducts that sought to take advantage of the natural gas boom in Texas and the competitive prices it meant for imports into Mexico. That program extended access to regions that previously did not receive any gas, for instance, Jalisco.

[51] Sener, Política pública en materia de almacenamiento de gas natural.

Figure 1. Mexican gas pipeline network.

Note: Jáltipan Salina Cruz and Prosperidad gas ducts are in the planning stage.
Private gas ducts whose construction has not yet started (Leona Vicario, Francisco I. Madero, Dulces Nombres, Extensión Sureste Dulce Marino, and Estación de Compresión Chinameca are not included.
Source: Elaborated by IMCO with data from Sener.

In May 2019, CFE initiated international arbitration against four companies for breaching construction contracts for six gas ducts. The capacity contracts were renegotiated and the conflict was resolved. However, construction stopped because of social conflict and several issues with permits at the three levels of government **show how complicated it is to build a redundant network of gas pipelines in the country.**[52] The Tuxtla-Tula gas pipeline should have started operations in 2018 but has been on hold for over four years, this a clear example of how burdensome it is to develop gas infrastructure in Mexico.

[52] Redundant refers to a system with pipelines that can substitute each other during maintenance periods.

5.1.2 What does the country need?

The country needs to take advantage of natural gas as a transition fuel and to develop the infrastructure to transport it to all the country's regions.

Natural gas will continue to be essential for the industrial sector and key to efficient and clean electricity generation. Reliable supply is essential for Mexico's economic growth and can only be achieved with investment in pipelines and the implementation of a storage policy that gradually moves the country towards international standards.

The South and Southeastern regions of the country lag behind the rest of the country in natural gas infrastructure. The extension of the maritime pipeline to Coatzacoalcos and the Salina Cruz-Tapachula pipeline would be helpful to this end.

Mexico has also the potential to increase domestic production of natural gas without any public resources or investment if the bidding rounds for contracts are restarted not to substitute imports in the short term, but to gradually increase the national production platform to face climatic events and foster economic growth without jeopardizing the country's energy security.

5.2 Liquefied petroleum gas

5.2.1 Where are we today?

LPG is an essential commodity for Mexican households. According to the national survey of home's energy consumption (Spanish acronym Encevi) made by the INEGI, in 2018 it was the fuel most used for cooking and heating water.[53] Moreover, it is fifth out of 299 of Mexican household expenses. Only housing, gasoline, diners and restaurants rank higher.[54]

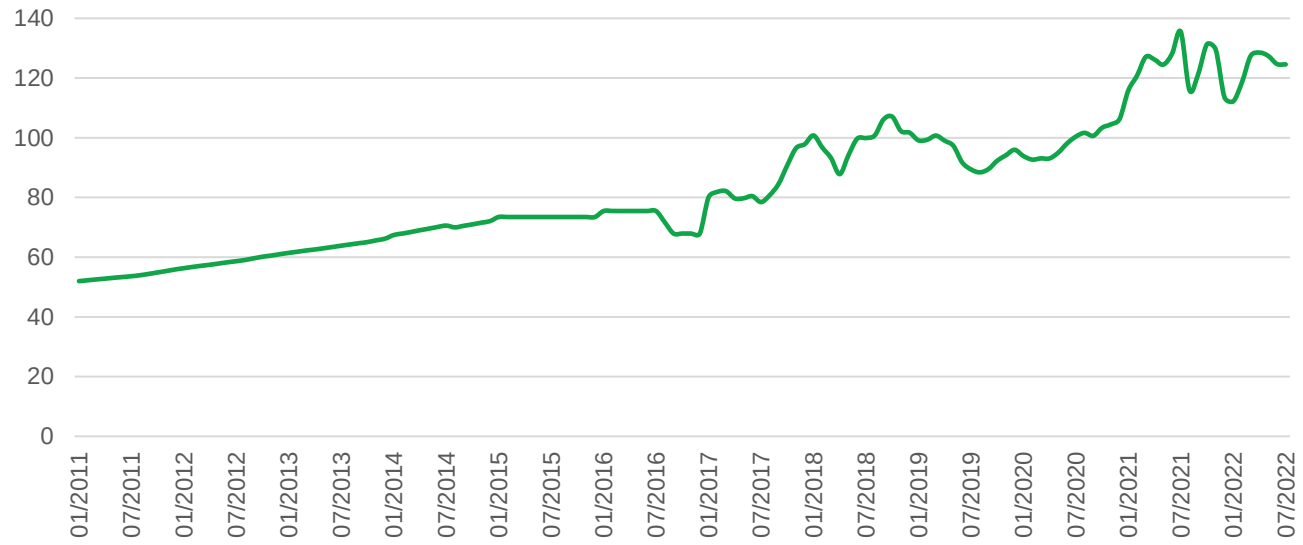
LPG is a **highly concentrated market as a consequence of high entry barriers all along the value chain** from imports and distribution to permitting at the local level and most importantly an

[53] Inegi, "Encuesta Nacional sobre Consumo de Energéticos en Viviendas Particulares (Encevi) 2018", https://www.inegi.org.mx/programas/encevi/2018/ (Seen on 06/21/2022)
[54] Inegi, "Ponderadores del INPC", https://www.inegi.org.mx/programas/inpc/2018/ (Seen on 06/21/2022)

absence of natural gas distribution infrastructure that could compete as a substitute to LPG. This translates to high prices and low quality and safety of service.

CRE set cap prices for retail sales of LPG in Aug., 2021, in an effort to contain price increases in the months prior (Graph 25), this policy decision did not take into account the price responds to supply and demand conditions in international markets. Besides, prices are influenced by other factors such as limited access of households to substitute fuels like natural gas, especially, the limited number of players that participate in this market.

Graph 25. Monthly price of LPG for domestic use. January 2011-July 2022. Index (second half of July, 2018=100).



Source: Elaborated by IMCO with data from INEGI. Índices de precios.

If structural factors are not resolved, **cap prices will be of little effect and raise the possibility of illegal markets** that can limit consumer's access to LPG at competitive prices.

5.2.2 What does the country need?

Mexico needs competitive LPG markets to provide better services to Mexican households at competitive prices to avoid using public resources for subsidies.

Price controls do not solve long-term problems in LPG markets. Economic competition must be promoted, reducing entry barriers in all segments of the value chain.

To this end, the Comisión Federal de Competencia Económica (Cofece) must finish its study on conditions for effective competition in the Mexican LPG markets opened in May 2021, if these conditions are found non existent, Cofece will determine measures to improve market conditions. Sener and CRE as well as local authorities should make permitting easier and more efficient to eliminate entry barriers and more participants can enter the market, especially at the municipal level.

6. Subsector analysis Electricity

All countries need a reliable supply of electric power —no blackouts— at competitive prices. It is now essential that electricity increasingly comes from renewable sources to reduce and eliminate GHGs emissions to mitigate climate change and minimize the negative effects on health caused by fossil fueled generation plants. To achieve this goal, investments in generation capacity and the transmission and distribution infrastructure need to grow at the same rate as demand.

To understand the electricity sector, it is important to differentiate activities open to competition (generation and commercialization of electric power) from those the Constitution reserves to the Mexican State such as the grid, that is, transmission and distribution of electricity, where CFE is the legal monopoly.

Mexico's electricity sector faces challenges in all its segments. Renewable integration and capacity additions are among these challenges. However, transmission and distribution grids are the system's most pressing challenges to **Mexico's energy security risk.** Both grids, legal monopolies owned by CFE, have historically suffered from underinvestment. This infrastructure is mainly high-tension towers and cables that transports electricity from power plants to the **distribution grids**, the infrastructure through which energy flows from the delivery points of the transmission grid to

consumers. The reliability and extension or robustness of the grid is essential to renewable integration, due to its variable nature (there is not always wind or sun). Consequently, **energy transition is impossible to achieve without investing heavily in the expansion and reinforcement of Mexico's transmission and distribution grids**.

6.1 Where is the country today?

During the last decade, Mexico transitioned from an electric power system almost totally controlled by CFE, either directly or through independent power producers (Spanish acronym PIE, meaning private centrals that sell all of their production to CFE that, legally, economically, and from an accounting perspective belong to the State company[55]), **to a competitive market**. As a result of this change, new investments were made in generation plants. Given the technological changes and the evolution of costs, this meant more renewable centrals were incorporated into the system, decarbonizing the country's generation matrix. However, in 2018 this stopped because of changes in policy and regulation that de facto prevent private participation.

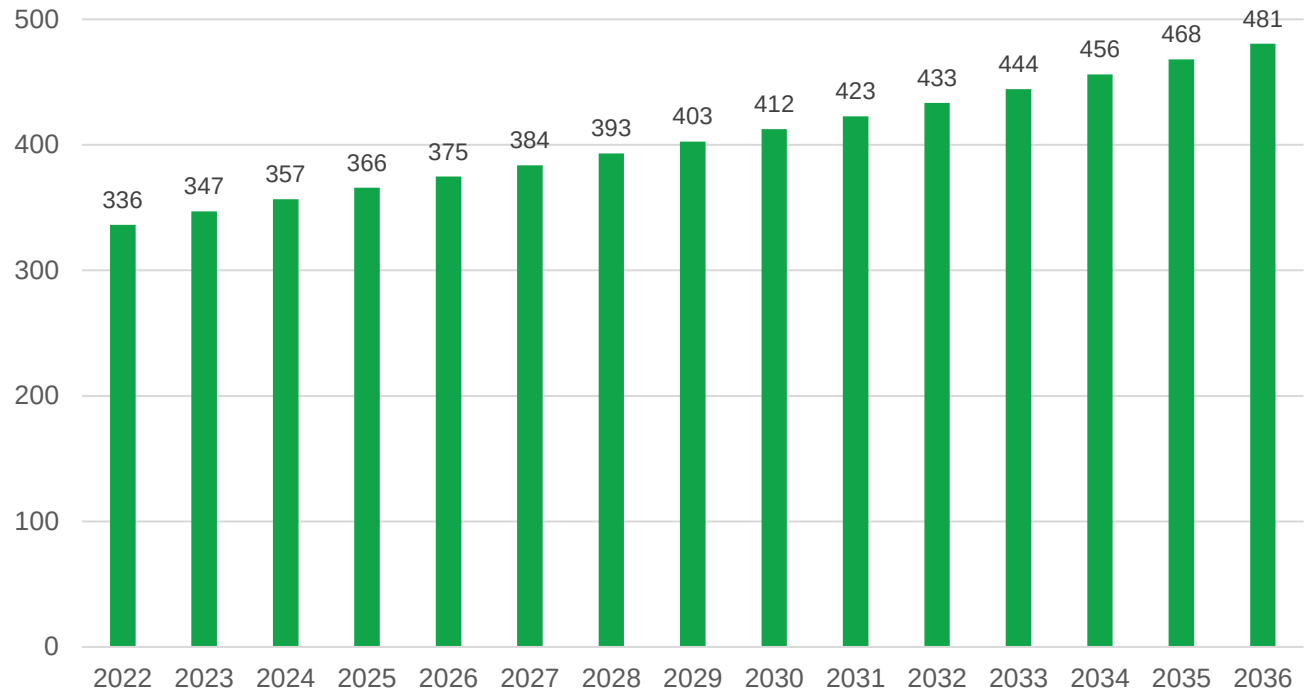
Allowing and fostering private investment in electricity is beneficial beyond additional installed capacity, it increases energy security by way of a diversified energy matrix in line with energy transition goals (CFE has practically no installed capacity for solar or wind power). This would strengthen CFE's finances, which could then purchase energy at more competitive prices, under its role as supplier to residential consumers. As a result, Mexican consumers would be better off being able to consume cleaner energy at competitive prices without interruptions in the service.

The challenge lies not only in balancing current demand and generation, but also in expanding installed capacity for generation to match Mexico's electricity demand growth. As previously stated, **this would imply major investments in generation, transmission, and distribution.** Currently, Prodesen's base estimates for growth in demand (GWh/year) and peak demand (GW or GJ/s) for electric power between 2022 and 2036 are 3.2%, peak demand refers to the highest demand at a given moment. Prodesen's scenarios might prove conservative when the economy's electrification

[55] PIEs are considered in the assets, the liabilities, and the sheet of results of the CFE through its subsidiary Empresa Productiva Subsidiaria CFE Generación V, a company that yields profits year after year.

trends worldwide are considered. One example is the expected growth in electric mobility, whose growth could potentially represent an additional challenge for electric power generation in the country.

Graph 26. Estimated electric power demand 2022-2036. Gigawatt-hour per year (GWh/year).



Source: Elaborated by IMCO with data from Sener. Programa de Desarrollo del Sistema Eléctrico Nacional 2022-2036.

By Dec. 31 2021, the country had 86 thousand 154 megawatts (MW) of installed capacity.[56] When adjusted by plant factor, the country's real generation capacity amounts to 334 gigawatts-hour per year (GWh/year).[57]

[56] Sener, "Programa para el Desarrollo del Sistema Eléctrico Nacional 2022-2036", https://www.gob.mx/cenace/documentos/programa-para-el-desarrollo-del-sistema-electrico-nacional-2022-2036 (Seen on 06/02/2022)

[57] The adjustment is calculated multiplying the MW generated with each technology by the average plant factor (that reflects the relation between energy produced over a set amount of time and energy that could have been

Table 3. Installed capacity by type of technology adjusted by plant factors. 2021.

Technology in 2021	Installed capacity (MW)	Average plant factor (%)	Generated energy (GWh/year)
Hydroelectric	12,614	40	44,199
Geothermal	976	73	6,241
Wind	6,977	27	16,502
Solar	5,955	16	8,347
Bioenergy	378	21	695
Nuclear	1,608	77	10,846
Efficient cogeneration	2,305	55	11,105
Combined cycle	33,640	56	165,024
Conventional thermal energy	11,793	33	34,091
Gas turbines	3,744	23	7,543
Internal combustion	701	10	614
Coal	5,463	61	29,192

produced if the plant were to operate at 100% capacity 100% of the time, which does not happen due to maintenance, repairs, lack of fuel, among other reasons). That figure is then multiplied by 8,760 (the number of hours in a year) to get energy produced annually (GWh/year).

Total	**86,154**		**334,402**

Source: Elaborated by IMCO with data from Sener. Programa de Desarrollo del Sistema Eléctrico Nacional (over several years).

Since 2019, plants have not been retired as planned by the Programa Indicativo para la Instalación y Retiro de Centrales (PIIRCE), a program designed to gradually modernize generation plants in the country, retiring obsolete centrals to be replaced by more efficient and therefore cleaner technologies. According to PIIRCE 13.7% of the existing installed capacity should have been retired and replaced with new generation plants. To operate all the 115 centrals and the 11 thousand 821 MW of installed capacity that were programmed for retirement in 2018[58] represents a heavy cost, in terms of the economy, health, and environment. However, there is no updated public information on existing or new retirement plans for these centrals.

[58] Sener. "Programa para el Desarrollo del Sistema Eléctrico Nacional 2018-2032". https://www.gob.mx/cms/uploads/attachment/file/331770/PRODESEN-2018-2032-definitiva.pdf (Seen on 06/02/2022)

Table 4. Installed capacity by type of technology considering PIIRCE centrals. 2021.

Technology	Installed capacity (MW)	Retirement	Installed capacity to retire PIIRCE centrals
Hydroelectric	12,614		12,614
Geothermal	976	60	916
Wind	6,977	1	6,976
Solar	5,955		5,955
Bioenergy	378		378
Nuclear	1,608		1,608
Efficient cogeneration	2,305		2,305
Combined cycle	33,640	1,656	31,984
Conventional thermal energy	11,793	7,426	4,367
Gas turbines	3,744	1,174	2,570
Internal combustion	701	104	597
Coal	5,463	1,400	4,063
Total	**86,154**	**11,821**	**74,333**

Source: Elaborated by IMCO with data from Sener. Programa de Desarrollo del Sistema Eléctrico Nacional (over several years).

Currently, installed capacity has generated up to 334 thousand 402 GHh per year, taking into account the average plant factor for each technology.[59] While aggregate private investment in generation between 2015 and 2020 amounted to 250 billion pesos, CFE's budget for investment in generation according to the company's business plan considers 285 billion 730 million pesos in the next year. 272 billion will be invested between 2022 and 2024, and the remaining 13 thousand million will be invested from 2026 onwards.[60] However, the source for the investment is not mentioned in the document, it is assumed that it will proceed from trusts operated by CFEnergía, a subsidiary, and not from the parent company's annual budget.

If public policy keeps avoiding private investment, with the intention of making CFE responsible for all new generation projects in Mexico, generation capacity of the company must grow at the same rate and level as Mexico's electric power demand, in spite of the impact that such responsibility would have on public finance. CFE's project portfolio includes the construction of 12 combined cycle centrals, an extension of the geothermal central of Los Humeros, Puebla, and the solar project of Puerto Peñasco, Sonora. It also plans to modernize hydroelectric centrals with three investment trusts: the Fideicomiso Maestro de Inversión, the Fideicomiso de Proyectos de Generación Convencional, and the Fideicomiso for Energías Limpias.

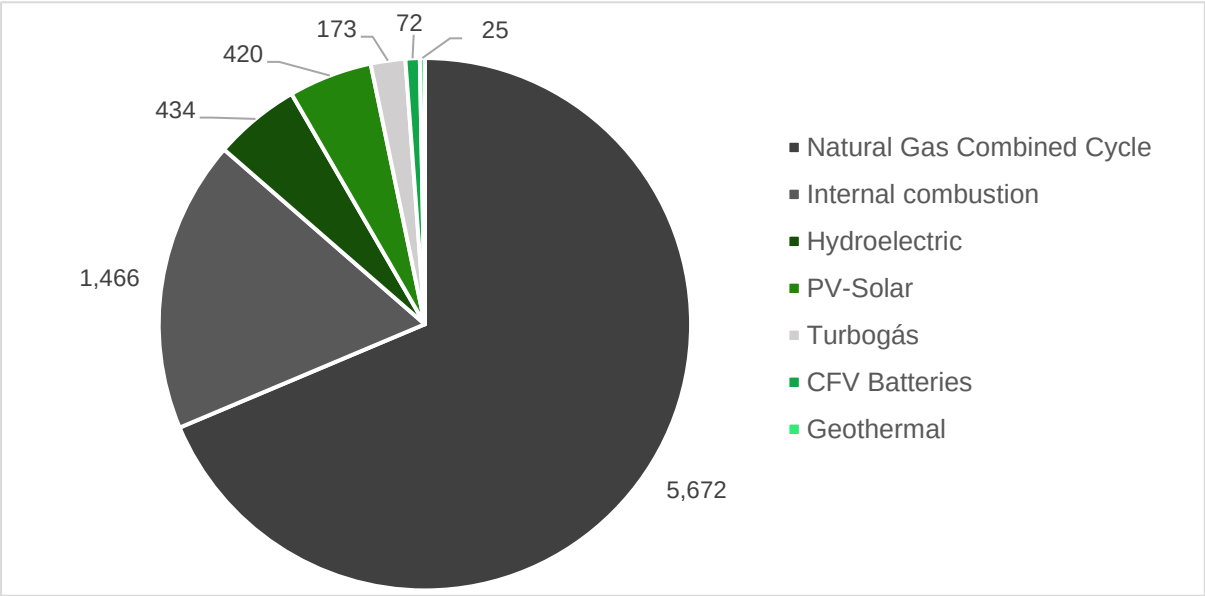
These trusts are a financial mechanism operated by CFEnergía. CFEnergía, as a subsidiary of CFE, is not obligated to report its operations or comply with transparency mechanisms designed for state owned companies that spend public finance resources, or implement its procurement and expenses strategy under competitive mechanisms or public bids. This means they can operate in complete opacity, with no safeguards for accountability of public investment resources. It must be noted that the Fideicomiso de Proyectos de Generación

[59] Average plant factor as estimated for the CFE corresponds to the average plant factor of all electric centrals (privately owned or CFE's property) that operated in 2017 (last year on which information is available), pondered by the installed capacity of the CFE by type of technology as of 2021. See Sener, Programa de Desarrollo del Sistema Eléctrico Nacional 2021-2035.
[60] CFE, "Plan de Negocios 2022-2026". https://www.cfe.mx/finanzas/Documents/Plan%20de%20Negocios%202022-2026%20V48%20PUBLICA.pdf (Seen on 06/05/2022).

Convencional, and the Fideicomiso for Energías Limpias were first included in CFE's business plan in 2022 with the purpose to finance renewable energy projects.[61] However, there is no public information about its resources or its operation rules.

Graph 27 shows Prodesen's figures on capacity additions that would be financed by both trusts between 2022 and 2025.

Graph 27. Programmed additions to installed capacity between 2022 and 2025. Megawatts (MW).



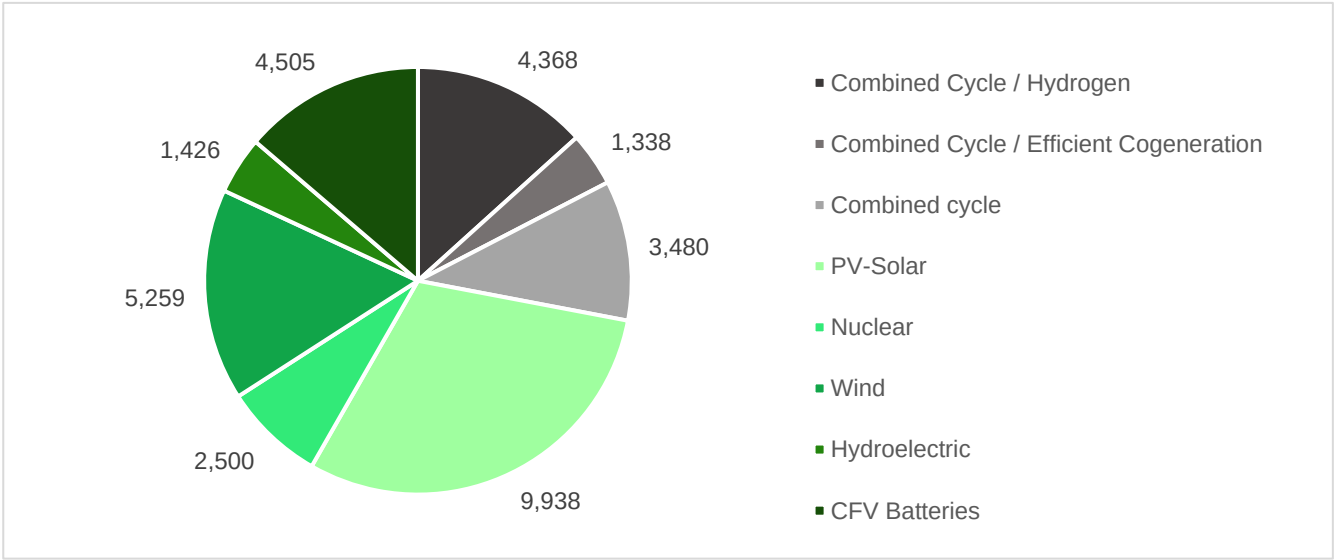
Source: Elaborated by IMCO with data from Sener. Programa de Desarrollo del Sistema Eléctrico Nacional 2022-2036.

According to Prodesen, between 2022 and 2025 CFE plans to extend its renewable energy capacity in 951 MW, that is, 12.5% of the additions made between 2015 and 2017, when the three first

[61] CFE, "Plan de Negocios 2022-2026".

—and, to this day, only— long term bids (Spanish acronym SLP).[62] [63][64]These bids raised investment resources for 8 thousand 969 million pesos, representing 7 thousand 563 MW of new renewable installed capacity. The fact that the trusts are considered as the sole investor in generation represents a high opportunity cost for distribution and transmission and government programs in other sectors .

Graph 28. Installed capacity additions between 2026 and 2035. MW.



Source: Elaborated by IMCO with data from Sener. Programa de Desarrollo del Sistema Eléctrico Nacional 2022-2036.

62 Proyectos México, "Contratos de largo plazo de cobertura eléctrica para la compraventa de energía eléctrica para la compraventa de energía eléctrica acumulable y certificados de energías limpias correspondientes a la Primera Subasta de Largo Plazo de 2015". Subasta eléctrica, https://www.proyectosmexico.gob.mx/proyecto_inversion/primer-subasta-de-largo-plazo-slp-12015/ (Seen on 05/20/2022).

63 Proyectos México, "Contratos de largo plazo de cobertura eléctrica para la compraventa de energía eléctrica para la compraventa de energía eléctrica acumulable y certificados de energías limpias correspondientes a la Primera Subasta de Largo Plazo de 2016". Subasta eléctrica, https://www.proyectosmexico.gob.mx/proyecto_inversion/primer-subasta-de-largo-plazo-slp-12015/ (Seen on 05/20/2022).

64 Proyectos México, "Contratos de largo plazo de cobertura eléctrica para la compraventa de energía eléctrica para la compraventa de energía eléctrica acumulable y certificados de energías limpias correspondientes a la Primera Subasta de Largo Plazo de 2017". Subasta eléctrica, https://www.proyectosmexico.gob.mx/proyecto_inversion/primer-subasta-de-largo-plazo-slp-12015/ (Seen on 05/20/2022).

CFE does not have enough resources to pay for this extension, and the document does not provide information on how it plans to finance these projects. **IMCO** estimated the amount of investments, based on the additional installed capacity figures in the Prodesen 2022-2036. Our estimation considers cost per unit by type of technology contemplated by the Prodesen 2018-2032 —last data available—, adjusted to 2022 prices. **The investment needed to pay for additions to installed capacity between 2026 and 2036 amounts to 53 billion dollars.**

As trusts that were created to finance the construction of centrals have already assigned all of their resources to several other projects in the business plan, it is not clear where the financing will come from. **However, it is probable that financing will come from fiscal resources or debt taken by the CFE.** Budget restrictions and fiscal goals are restrictions to hierarchize government spending, diversification of the sources of investment for the expansion of electric power generation capacity is absolutely necessary. Using public resources to satisfy a growing demand for energy, when private investment is available and willing, represents too high an opportunity cost for social spending priorities such as health, security, and education.

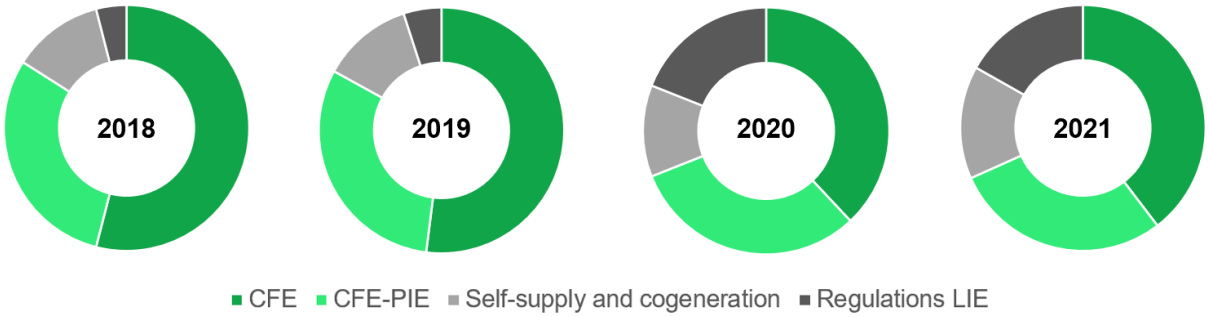
Private investment in electric power generation in Mexico represents approximately 44 billion dollars, according to the Consejo Coordinador Empresarial (Spanish acronym CCE).[65] These investments do not necessarily replace CFE's participation, but rather a complement, by offering a generation matrix with more installed capacity, more diversified in terms of technology, more efficient, thus, with a greater share of renewable energies and consequently less carbon footprint.

The impact of private generation that came online after 2013/2014 is clear: between 2017 and 2021 generation from renewable sources grew 8 percentage points, from 19% to 27%. However, this growth rate will not continue as a consequence of policy and regulatory changes designed to inhibit or prevent new permits for private industry participants. Blocking new generation permits at CRE reduces the country's competitiveness. It prevents accelerated renewable integration and clean energy capacity additions that would reduce not only the system's generation costs but also its emissions and distances Mexico from its energy transition goals. It also affects the country's investment conditions as companies invest in jurisdictions that guarantee access to clean and

[65] CCE, "Comunicado No.35 Reforma Eléctrica". https://cce.org.mx/wp-content/uploads/2021/10/VF-Comunicado-No.-35-Reforma-Electrica.pdf (Seen on 06/02/2022).

renewable energy with low GHGs emissions and stable and predictable legal and regulatory frameworks.

Graph 29. Electric power generation by permit 2018-2021. Percentage.



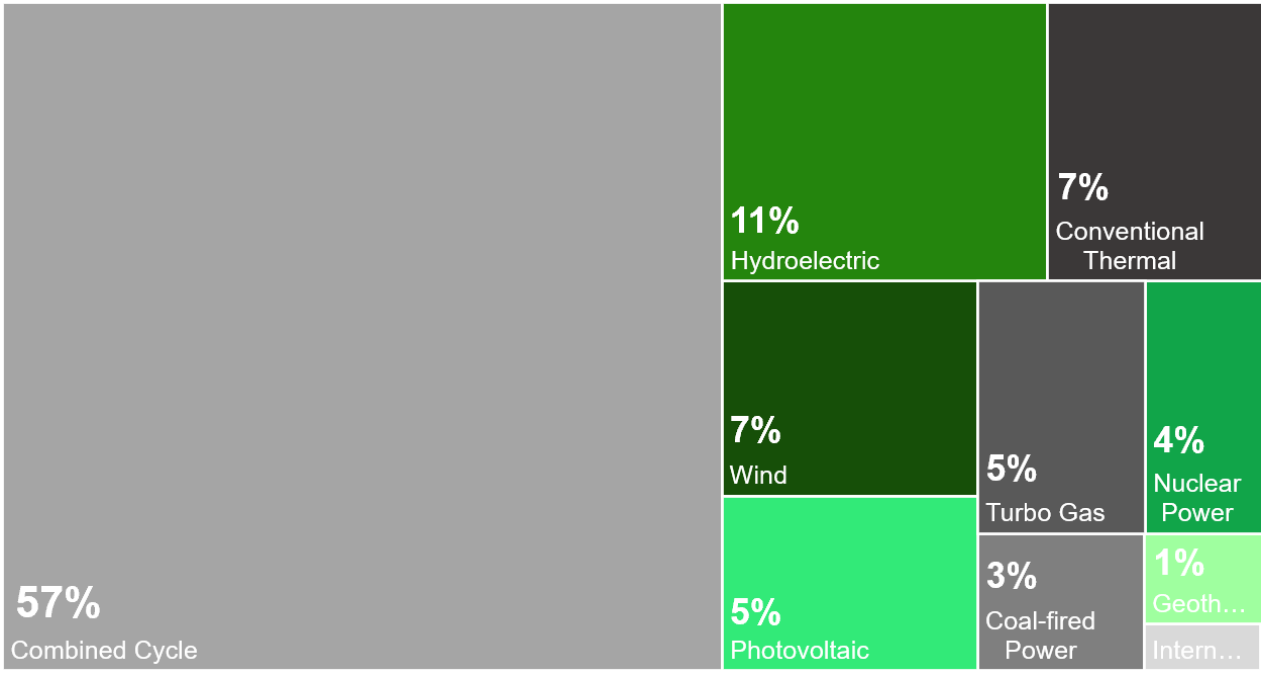
Source: Elaborated by IMCO with data from Sener. Programa de Desarrollo del Sistema Eléctrico Nacional (over several years).

In terms of energy transition and domestic and international commitments against climate change, expanding generation installed capacity is not enough. A significant share of the expansion needs to be renewable energy.

This can be achieved given the cost structure evolution of renewables. LIE's regulations establish that CFE Suministrador de Servicios Básicos (CFE SSB) must purchase a percentage of certified clean energy produced under the Certificados de Energía Limpia (Spanish acronym CEL). CEL's are an instrument designed to promote the expansion of renewable capacity in Mexico. Each certificate amounts to 1 MW of renewable energy. Under current legislation and regulation CFE is obligated to purchase 13.9% of the energy it supplies from clean sources.[66] The mechanism is conceived as a market incentive to integrate renewable and clean generation, the price of CELs should fall as the share of renewable energy in the generation matrix increases. By the end of 2021, 57% of electric power was generated with combined cycles and only 28%from clean energy sources.

[66] Cenace. "Sistema de Información de Mercado". Mercado de Certificados de Energía Limpias (MCEL) https://www.cenace.gob.mx/Paginas/SIM/MercadoCEL.aspx (Seen on 06/22/2022)

Graph 30. Electric power generation by type of technology 2021. Percentage.



Source: Elaborated by IMCO with data from Cenace. Energía generada por tipo de tecnología.

The changes to the LIE in 2021 —currently suspended by a judicial order— eliminated the start of operations date requirement for clean energy status (after Aug. 2014). **This change makes the instrument ineffective to accelerate the rate of renewable and clean energy integration, and favors CFE with no environmental benefits.**

As mentioned before, CEL's are meant to work as an incentive to attract investment, as the generation matrix becomes cleaner, demand for CEL's will fall along with the price, which would tend to be negligible whenever clean generation becomes dominant. This would eliminate the need for incentives. For example, in Australia, where renewable generation has grown exponentially because of effective investment in clean energy and low generation costs, the CEL mechanism was voluntarily canceled. According to data of the clean energy regulatory commission that

regulates in Australia,[67] 5.8 million CELs were voluntarily canceled, 43% more than in 2020. Mexico must look forward to the moment Mexico no longer needs incentives to integrate renewable energy.

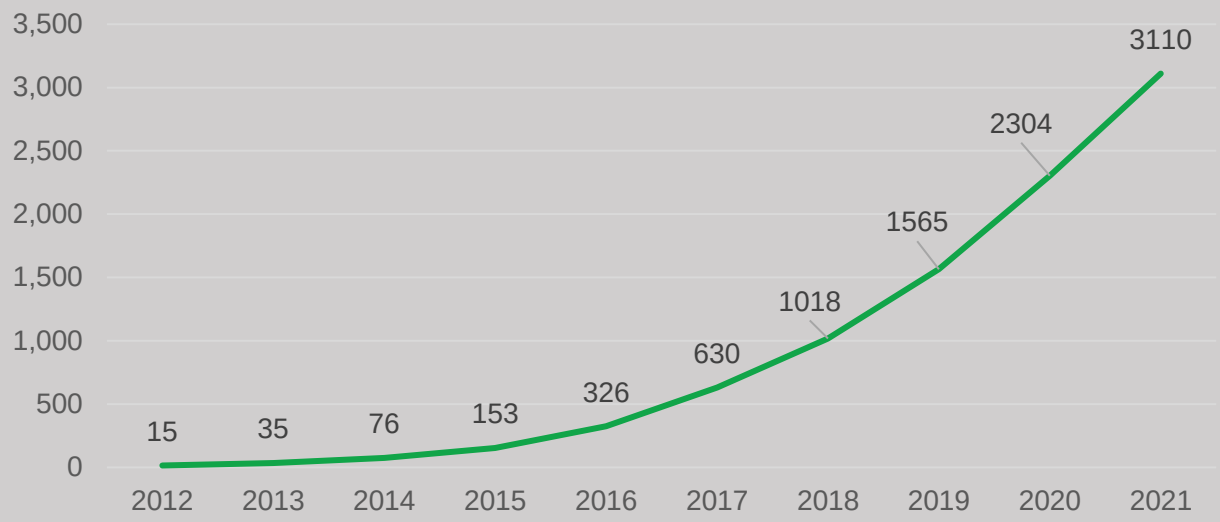
Table 4. Distributed generation

Mexico must take advantage of its solar potential by using distributed generation. According to the LIE,[68] distributed generation does not need a generation permit from CRE, it needs an interconnection agreement with CFE distribution subsidiary as well as with CFE basic services supplier that specifies the compensation mechanism for the energy injected to the grid. Installed capacity must be lower than the estimated demand on the distribution grid to which the system is connected, and must reduce or eliminate the impact on the distribution circuit. In other words, distributed generation (DG) is small-scale power generation (in Mexico this means generation under 500 KW, though other countries have different thresholds).

When the sector opened to competition, distributed generation became a viable and affordable alternative for efficiently satisfying demand and diversification of the electric power matrix. It also represented an instrument to empower consumers and develop a solar energy value chain in Mexico. **99.2% of all distributed generation capacity comes from photovoltaic solar panels**. To date more than 270,000 DG contracts have been signed and generate 3 thousand 110 GWh per year. Current capacity is approximately 2,015 MW and is expected to reach 10,996 MW, 8.6% of total installed capacity by 2035.[69]

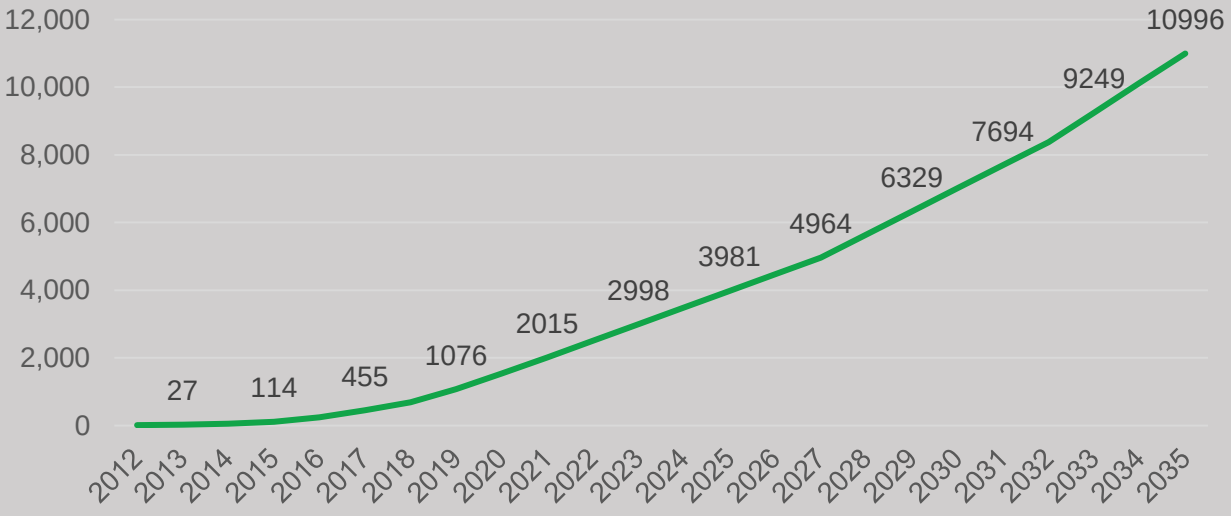
[67] Clean Energy Regulator. "Large-scale generation certificates (LGCs)" http://www.cleanenergyregulator.gov.au/Infohub/Markets/Pages/qcmr/december-quarter-2021/Large-scale-generation-certificates-(LGCs).aspx (Seen on 06/29/2022)
[68] Cámara de Diputados, "Ley de la Industria Eléctrica", Última reforma publicada en el Diario Oficial de la Federación el 11 de mayo de 2022, (Mexico City: Cámara de Diputados, 2022), https://www.gob.mx/cms/uploads/attachment/file/31722/LIElec_110814.pdf (Seen on 06/02/2022)
[69] Cámara de Diputados, "Ley de la Industria Eléctrica".

Graph 31. DG Electric power generation 2012-2021. GWh/year.



Source: Elaborated by IMCO with data from Sener. Programa de Desarrollo del Sistema Eléctrico Nacional 2022-2036.

Graph 32. Cumulative installed capacity for photovoltaic DG 2016-2035 MW.



Source: Elaborated by IMCO with data from Sener. Programa de Desarrollo del Sistema Eléctrico Nacional 2022-2036.

Distributed generation reduces energy lost from transmission and distribution, because energy is generated and consumed locally. This is particularly relevant for Mexico, because in 2021 (most recent available data) losses along the distribution grid were 11.2%, a figure significantly higher than the global standard of 8%.[70]

Distributed generation could be more efficient under a collective distributed generation mechanism. This is different to regular DG in that one system can supply several consumers, that is, several consumers connect to the same distributed central. Thus, a group of consumers **(residential, commercial, and even industrial)** can benefit from **a more efficient use of the installed distributed central (for example, solar panels on top of buildings shared by several users)**.

CRE issued in 2019 rules for collective distributed generation, or to migrate distributed generation projects to that regulatory figure, for example, each user must have a fiscal meter, the energy supplied by CFE, and the energy generated by the panel must all be under the same SSB contract. If these requirements are met, there is no limit to the number of users that can be associated.

In Aug. 2020, CRE approved to withdraw from publication in the Diario Oficial de Federación norms A/002/2019, A/005/2019, A/015/2019, A/021/2019 and A/034/2019, that regulated collective distributed generation. This canceled the possibility of having a social participation mechanism that allows the country to move along an energy transition path.[71]

[70] Cámara de Diputados, "Ley de la Industria Eléctrica".

[71] CRE, "Proyecto por el que se determina retirar la solicitud de publicación en el Diario Oficial de la Federación de los diversos A/002/2019, A/005/2019, A/015/2019, A/021/2019 y A/034/2019", (Mexico City: CRE, 2020), https://www.gob.mx/cms/uploads/attachment/file/569364/8._EXT._Orden_del_D_a_Agosto_2020.pdf (Seen on 06/30/2022)

6.2 Where does Mexico stand on electric power transmission?

One of the most pressing challenges for Mexico's electric sector is to guarantee the expansion and modernization of the grid (Spanish acronym RNT).[72] The grid is essential to transport increasing flows of electricity from power plants to distribution grids and end users under conditions of efficiency, quality, reliability, continuity, safety, and sustainability.

Table 5. Electric power transmission infrastructure by year end (2017-2021/1)

Grid element	Measure unit	2017	2021	Growth rate (2017-2021)
Transmission lines	Length (Km)	107,042	110,315	3.1%
Electric substations	Transformation capacity (MVA)	158,035	165,879	5.0%

Note: 1\ Figures by Jun., 2021.

Source: Elaborated by IMCO with data from Presidencia de la República Tercer informe de gobierno 2020-2021.

According to a reliability report on the national electricity system, in 2020 the RNT worked within the reliability parameters set by Comisión Reguladora de Energía (CRE). However, **the grid suffers from saturation and congestion issues —when the energy flow is above the transmission capacity of lines— in several transmission corridors.** This increases the

[72] The RNT consists of those facilities (lines, substations and transformation and compensation components) as are necessary to transmit electric power from the generation centrals -at tension levels of no less than 69 kV (high tension) or whose purpose is to increase the tension levels to 69 kV or more- to the distribution networks (Spanish acronym RGD). CRE, "Resolución por la que la Comisión Reguladora de Energía expide las disposiciones administrativas de carácter general en materia de acceso abierto y prestación de los servicios en la Red Nacional de Transmisión y las Redes Generales de Distribución de energía eléctrica", Resolución no. RES/948/2015, Dec. 31, 2015, https://drive.cre.gob.mx/drive/obtenerresolucion/?id=zdq1odzmm2qtytvjnc00ymy0ltk2mzutnzi5ztewnjjlzmmw

probability of failure or interruption in the electric power service available to users in some regions of the country. This makes Mexico's electric system less reliable.[73]

Moreover, saturation of the RNT reflects on higher prices because congestion is one of the components of local marginal prices (Spanish acronym PML) and of electricity prices in several SEN nodes. Congestion acts as scarcity when it comes to electric power's price determination. According to Centro de Investigación Económica y Presupuestaria (Spanish acronym CIEP), between Jan. 2017 and Apr. 2019, congestion was responsible for more than 25% of the price of electricity in Campeche, Quintana Roo and Yucatán.[74]

The Federal budget for 2022 considered **spending only 4.1% (18.3 billion pesos) of CFE's total budget (450 billion pesos) on transmission,** while 95.9% of the budget (431.7 Bp) was assigned to other activities such as generation (11.3%), commercialization (10.2%), and other items (35.4%).[75]

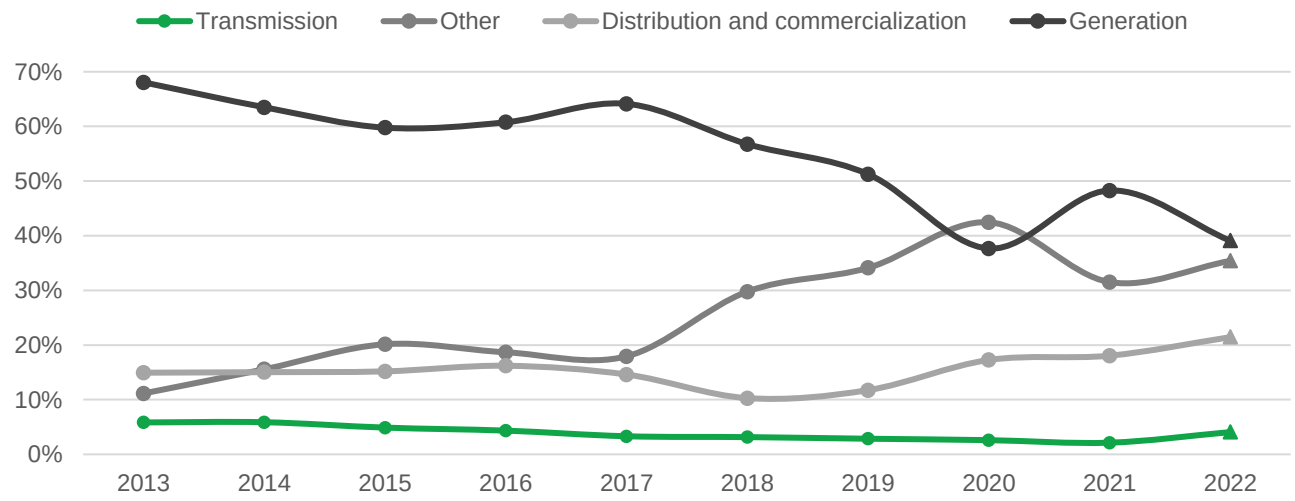
As shown in Graph 33, the share of total expenses in transmission has not changed significantly in the last 10 years, it has even decreased. Though the private sector has been able to participate in electric power generation since 2015, this participation could have led to a reduction in generation expenses at CFE, which should have freed resources to finance transmission and distribution infrastructure, an area exclusively reserved to CFE.

[73] CRE, *Reporte de confiabilidad del Sistema Eléctrico Nacional 2020* (Mexico City: CRE, 2020), https://www.gob.mx/cms/uploads/attachment/file/693799/rcsen_2020_vf.pdf

[74] Alejandro Limón, "Diagnóstico de costos de congestión en la Red Nacional de Transmisión", Centro de Investigación Económica y Presupuestaria, https://ciep.mx/atqn (Seen on 06/30/2022)

[75] SHCP, "Presupuesto de Egresos de la Federación ejercicio fiscal 2022", Paquete económico 2022, https://www.pef.hacienda.gob.mx/es/pef2022 (Consultado el 0517/2022)

Graph 33. CFE expenses by type 2013-2022.* %.

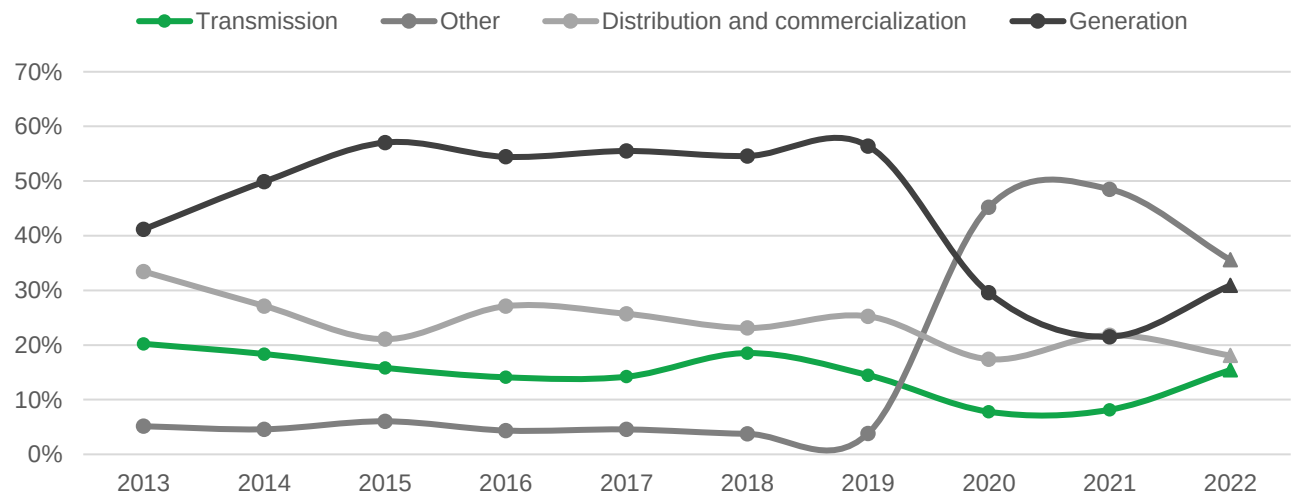


Note: Figures before 2022 correspond to amounts paid as reported to the public treasury, while figures for 2022 are resources approved by the Federal budget of that fiscal year.

Source: Elaborated by IMCO with data from SHCP. Cuenta de la Hacienda Pública (varios años); SHCP. Presupuesto de Egresos de la Federación 2022.

When analyzing CFE Transmisión's budget in 2022, two fifths (7.3 bp) are physical investments (infrastructure projects, maintenance of infrastructure, construction of administrative offices, and procurement programs), while the remainder of the budget (11 bp) is assigned to operation and maintenance of the grid. This means just 1.6% out of CFE's whole budget, or 15.4% of the company's investment budget, went to finance transmission projects.

Graph 34. CFE's expenses on physical investments by type 2013-2022.* %.



Note: Figures before 2022 correspond to amounts paid as reported to the public treasury, while figures from 2022 correspond to the amounts approved by the Federal budget of that fiscal year.
Source: Elaborated by IMCO with data from SHCP. Cuenta de la Hacienda Pública (varios años); SHCP. Presupuesto de Egresos de la Federación 2022.

It is important to point out that the amount spent on transmission is not only small in terms of CFE's total budget, **but is also below what is necessary to meet RNT's infrastructure requirements.**

As stated by Sener in Prodesen 2016-2030, the necessary investments to modernize and expand the RNT between 2016 and 2022 amounted to 141.7 bp (an average of 20.2 bp each year). [76] However, the CFE's average annual investment for that same purpose was just one fourth of it, or 5 bp, according to official government's public information.[77]

Low levels of physical investment in transmission may be partially attributed to the delay or cancellation of projects that were part of a number of editions from the Programa de Ampliación y Modernización de la Red Nacional de Transmisión y Redes Generales de Distribución del Mercado Eléctrico Mayorista (Expansion and Modernization Program for the Electricity Grid, Spanish

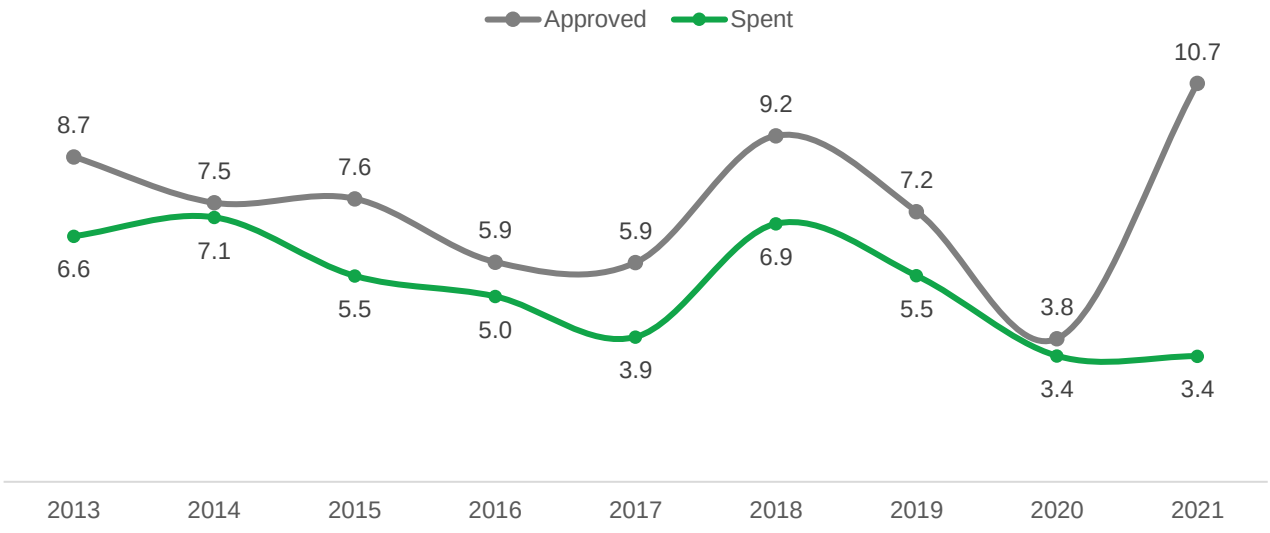
[76] Sener, Programa de Desarrollo del Sistema Eléctrico Nacional 2016-2030 (Mexico City: Sener, 2016), https://base.energia.gob.mx/prodesen/prodesen2016/prodesen-2016-2030.pdf
[77] Figures for 2022 were drawn from the Federal budget of that year.

acronym PAMRNT). In that program, Sener instructed CFE —as per the LIE— to execute infrastructure projects designed to expand and modernize the RNT (see Table 2), with special emphasis on the recurrent under-expenditure of resources for that purpose.

Between 2013 and 2021 (last year with available information) CFE Transmisión did not spend all of the resources the Federal budget originally assigned to physical investment (Graph 35). For instance, in 2021 the subsidiary only spent 31.5% of the resources that were authorized for these investments.

If all the resources assigned to **transmission investments that were not spent are added**, **the cumulative under-expenditures during the period amounted to 19.3 bp** (29.1% of the total approved budget for those years).

Graph 35. Approved resources and expenses on physical investments in transmission 2013-2021. Current Bp



Source: Elaborated by IMCO with data from SHCP. Cuenta de la Hacienda Pública (varios años).

Table 5. Canceled strategic infrastructure transmission projects

According to the LIE, SENER can instruct CFE to execute infrastructure works to reinforce, expand and modernize the grid (RNT). However, as published in the most recent edition of Prodesen, five projects have been delayed and four canceled out of 184 projects.[78]

Two international tender processes for two priority projects for the expansion of the grid (2621 Km) with $2,300 bp estimated investments were canceled in Jan. 2019. These two foregone projects were the Yautepec-Ixtepec direct current transmission line and the interconnection of the electric power system of Baja California with the Sistema Interconectado Nacional (SIN).

The Yautepec-Ixtepec direct current transmission line was supposed to connect the electric substations of Yautepec (Morelos) and Ixtepec (Oaxaca) with a 1221 Km line with transmission capacity of 3 thousand MW that would transport electricity from the Isthmus of Tehuantepec to the Mexico's central region, taking advantage of the high potential for wind generation in the region.

The tender process for the project was canceled by CFE Transmission arguing that after an analysis of the project positive conditions for the tender were non-existent.[79] The line was supposed to start operations in the summer of 2022 and represented investments for approximately $1,200 bp under a private-public association mechanism (Spanish acronym APP), Regarding the Baja California interconnection program a direct current transmission line of 1,400 Km was supposed to from Mexicali (Baja California) to Hermosillo (Sonora). The line's objective, with 1,500 MW of transmission capacity, was to increase efficiency and reliability of the Baja California system by integrating it with the SIN. It was also a way to integrate more wind and solar generation in the Mexicali-San Luis Río Colorado-Tijuana area.[80]

[78] Sener, *Programa de Desarrollo del Sistema Eléctrico Nacional 2022-2036* (Mexico City: Sener, 2022), https://www.gob.mx/sener/articulos/programa-para-el-desarrollo-del-sistema-electrico-nacional-304042

[79] Banobras, "Construcción, modernización, operación y mantenimiento de la línea de transmisión de corriente directa, Yautepec - Ixtepec, en los estados de Morelos, Oaxaca, Puebla, Veracruz, Ciudad de México y Estado de México", Proyectos México, https://www.proyectosmexico.gob.mx/proyecto_inversion/024-linea-de-transmision-de-corriente-directa-yautepec-ixtepec/ (Seen on 05/ 16/2022). 16/05/2022)

[80] Banobras, "Construcción, instalación, operación y mantenimiento de la infraestuctura de transmisión que conecta el sistema eléctrico de Baja California (BC) con el Sistema Interconectado Nacional (SIN) en el estado de Sonora", Proyectos México, https://www.proyectosmexico.gob.mx/proyecto_inversion/716-interconexion-del-sistema-electrico-de-baja-california-con-el-sistema-interconectado-nacional/ (Seen on 05/ 16/2022)..

Canceling the tender process for the project contravened one the main objectives stated in different editions of the PAMRNT.[81]

6.3 Electric distribution in Mexico?

The distribution grid (Spanish acronym RGD)[82] transports electric power from the RNT to end consumers; in Mexico that is over 46 million final users. It faces significant challenges because of old infrastructure and technology with technical and non-technical losses, not to mention the electrification of the economy and its impact on distribution grids worldwide.

Table 6. Infrastructure for electric power distribution by the end of each year 2017-2021/1.

Element	Measure unit	2017	2021	Growth rate (2017-2021)
Distribution lines	Length (Km)	829,925	873,445	5.2%
Electric substations	Transformation capacity (MVA)	74,626	78,089	4.6%

Note: 1\ Figures by Jun., 2021.

Source: Elaborated by IMCO with data from Presidencia de la República Tercer informe de gobierno 2020-2021.

Energy losses lost energy mostly happen along distribution lines. In 2021, 13.8% (33,385 GWh) of electric power available for distribution was lost on the RGD due to technical (4.8%) —heating of the transmission components— and non-technical factors (9%) — theft mostly.[83]

[81] *Cenace, Programa de Ampliación y Modernización de la Red Nacional de Transmisión y Redes Generales de Distribución del Mercado Eléctrico Mayorista 2021-2035* (Mexico City: Cenace, 2021), https://www.cenace.gob.mx/docs/10_planeacion/programasaym/programa%20de%20ampliaci%c3%b3n%20y%20modernizaci%c3%b3n%20de%20la%20rnt%20y%20rgd%202021%20-%202035.pdf

[82] The RGD consists of facilities and components that conduct and convert voltage (lines, substations, and transformation, compensation, commutation, measurement and monitoring equipment) through which electric power flows from delivery points along the RNT -at tension levels below 69 kV (mid and low tension)- to the consumption points. CRE, Resolución no. RES/948/2015.

[83] Sener, Programa de Desarrollo del Sistema Eléctrico Nacional 2022-2036.

According to Prodesen 2016-2030, the investments required for expansion and modernization of the RGD between 2016 and 2022 were estimated at 96.2 bp: an average of 19.2 bp per year.[84] However, for the same period, average annual investment by CFE Distribución was only 8.4 bp, that is, less than half of the investment needed.[85]

Table 6. Transferences between CFE's subsidiaries and implications for investment on grids

CFE has been separated into several subsidiary companies that are supposed to operate independently. Since 2015, the most profitable of these subsidiaries have been CFE Transmisión and CFE Distribución. However, these companies transfer resources to compensate the subsidiaries that operate at a loss (CFE Suministrador de Servicios Básicos — CFE SSB— and CFE Generación).

This practice decreases CFE's grid infrastructure investments, **CFE Transmisión and CFE Distribución's revenues have traditionally been used to finance the less profitable subsidiaries.**

Between 2018 and 2020, both subsidiaries transferred 150 820 Bp to CFE SSB. If CFE Distribución had not transferred 100 884 bp to CFE SSB, the company could have invested in distribution infrastructure almost four times more resources than what it did over the last three years (25.9 bp). CFE Transmisión could have made three times larger investments than the 15.8 bp invested, had it not transferred 49 936 bp to CFE SSP between 2018 and 2020.[86]

6.4 What does Mexico need?

[84] Sener, Programa de Desarrollo del Sistema Eléctrico Nacional 2016-2030 (Mexico City: Sener, 2016), https://base.energia.gob.mx/prodesen/prodesen2016/prodesen-2016-2030.pdf
[85] Figures for 2022 were drawn from the Federal budget of that year.
[86] Diego Díaz, Sonia Mancera, and Oscar Ocampo, *La CFE frente al espejo: Incentivos mal alineados en la empresa productiva del Estado* (Mexico City: IMCO, 2021), https://imco.org.mx/la-cfe-y-subsidiarias-distorsionan-los-estados-financieros/

Electricity must grow its share of energy consumption in the country. This electric power must be generated increasingly with renewables and clean energy to reach climate change mitigation goals and provide reliable and affordable energy to consumers.

Mexico must use public resources efficiently, letting others invest in activities open to competition such as power generation. It should provide predictable legal and regulatory conditions that result in higher investment throughout the value chain, especially in renewables. Generally speaking, commit to the rule of law, so that Mexico, among other things, can go back to renewable integration rates such as those observed between 2015 and 2017.

Mexicans would directly benefit from a cheaper generation matrix, less resources would be needed to keep residential fees at current levels or even lower them. Additional public resources would be available to spend in areas where government spending is not only crucial but the only source of investment or financing. The environmental benefits of lower GHGs emissions from power generation must also be accounted for. CFE's resources spent on generation and subsidies on residential tariffs (97% of residential use) are a very considerable opportunity cost, resources unavailable to spend on priority areas such as security, health, education, or in CFE's transmission and distribution subsidiaries.[87]

Transmission infrastructure must grow at a rate that is consistent with both the growth in electric power demand[88] **and the evolution of cost of generation technologies.** This means managing a much larger share of renewable generation and thus a robust, reliable and modern grid is an absolutely necessary condition for the development of the sector.

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87 Comisión Federal de Electricidad, *Informe Anual 2020,* (Mexico City: CFE 2020), https://www.cfe.mx/finanzas/reportes-financieros/Informe%20Anual%20Documentos/CFE%20Informe%20Anual%202020.pdf

88 It is estimated that the SEN's gross energy consumption by 2036 will lay between 458 231 and 522 919 MWh. That is, it will be somewhere between 39.3%-58.9% above the consumption registered in 2021 (329 033 MWh). Regarding the peak integrated demand of the SEN, it will be between 43.2% and 62.9% higher than observed in 2021 (48532 MWh/h). Cenace, Programa de Ampliación y Modernización de la Red Nacional de Transmisión y Redes Generales de Distribución del Mercado Eléctrico Mayorista 2022-2036 (Mexico City: Cenace, 2022), https://www.cenace.gob.mx/docs/10_planeacion/programasaym/programa%20de%20ampliaci%c3%b3n%20y%20modernizaci%c3%b3n%20de%20la%20rnt%20y%20rgd%202022%20-%202036.pdf

CFE is the legal monopoly for transmission and distribution in Mexico, no other company can provide these services. However, as discussed in the sections above, it has allocated limited resources to these subsidiaries as a result of cross subsidies. Underinvestment in transmission and distribution is the biggest risk in terms of energy supply to consumers both residential and industrial.

7. Conclusions: What is next for Mexico's energy sector?

This document argues that any country's energy sector's most pressing objective is to reliably **supply, at affordable prices and with the lowest possible carbon footprint, the energy demanded by consumers –citizens and businesses–.** In other words, consumers should be the center of all policy objectives or goals. Additionally, as one of the largest economies of the world, Mexico has signed treaties on trade, cooperation, and environmental protection. Besides pursuing economic, social and environmental development for the Mexican people, **the country has international commitments for decisive actions to mitigate climate change**. As the global economy heads towards decarbonization, a process that will benefit those who seriously align public policies, regulations, and public and private investment towards this goal.

Mexico is running against global actions on energy transition. Reversing course is not just urgent, but imperative, if Mexico is to increase its competitiveness, that is, its ability to create, attract and retain both talent and investment. Mexico must show its commitment to the environment and sustainability. This is as important for competitiveness as complying with international trade treaties and the commitment to the rule of law.

The aspiration for sustainable development is necessary to trigger public and private investment in all energy markets. To maximize the value of its oil rents, Mexico must resume oil and gas bidding rounds with the participation of both public (Pemex) and private sector operators and finance the energy transition of the country. **Mexico oil rent should be saved for future generations and a sustainable future. The country must also develop infrastructure to store and transport fuels in competitive markets.**

Natural gas will continue to play a major role in electric power generation, temperature comfort and industrial activities. Thus, a storage policy with infrastructure expansion standards needs to be implemented as well as the plan to expand Mexico's network of gas pipelines that transport **it to regions where it is still scarce. Mexico also needs to increase its national production of gas.**

Mexico's generation matrix must reflect the cost efficiencies of low carbon technologies. **Climate and geographic diversity offer the opportunity to increase the rate of renewable integration to the country's electric capacity and profit from its comparative advantages.** To consolidate North America as the most competitive region in energy and lowest GHG emissions, Mexico must make the most of its geography and its international trade agreements.

Development is not achieved by chance. It is chosen. This study puts forward the path to **energy markets that supply reliable energy at affordable prices with the smallest carbon footprint possible.**

8. IMCO proposes

Oil

- **Resume and increase the frequency of Oil and Gas bidding rounds for exploration and production.** The bidding rounds had good results for oil production, investment, and revenues for the Mexican government. Mexico must make up for the lost years and increase production without using public resources. In other words, it must maximize the country's oil rent.
- **Mexico must foster farm-outs between Pemex and private operators.** Farm-outs allow Pemex to diversify operative and financial risks from exploration and acquire experience and best practices from other operators. This partnership also allows the State oil company to increase production without spending scarce public resources.

- **Redesign the Fondo Mexicano del Petróleo operation rules.** It is essential to redesign how the FMP operates to accumulate a larger share of oil rents in benefit of future generations and energy transition.

- **Develop a strategy for Pemex's industrial activities towards processing high value added products and reconfigure petrochemical facilities.** Pemex must implement a long-term **profitable** strategy and business plan.

- **Unburden the process for fuel import permits.** Potentially larger production in Pemex's refineries does not mean fuel supply sources should not be diversified. Concentrating supply in Pemex, even if it were plausible from an operations perspective, creates commercial, and financial risks for the company and the country. Pemex needs to share those risks with private participants in the industry. Limiting imports jeopardizes Mexico's energy security. All available alternatives must be allowed and not prevented if not fostered to guarantee fuel supply in the country.

Gas

- **Increase domestic production of natural gas** The easiest most cost-effective strategy to increase production in Mexico and thus reduce the country's dependence on imports from the US is to resume bidding rounds canceled in 2018. Private investors could increase their share and investments in gas production and potentially develop unconventional natural gas assets Pemex has not been able to exploit.

- **Develop natural gas storage infrastructure.** Mexico's growing dependence on natural gas imports particularly from the US and the risk this poses to the country's energy security can be mitigated with natural gas storage infrastructure. This can be achieved with the implementation of public policy for storage with clear goals and responsibilities for all industry participants.

- **Develop natural gas transport infrastructure.** The 2019 conflict between CFE and private companies developing pipeline infrastructure is an example of the kind of obstacles and problems the development of energy projects face in Mexico. The most effective solution for this is the rule of law.

- **Comply with norms and regulations for LPG permits for both imports and distribution by the private sector.** Sener and CRE must eliminate policies and practices that burden and prevent private participation in the industry.

- **Design a strategy to mitigate and prevent methane fugitive emissions to the atmosphere.** Pemex has a dire history when it comes to controlling fugitive methane emissions in its natural gas infrastructure. This is also true for the venting and burning of gas in its production wells. A strategy with clear objectives, responsibilities and realistic goals and budget needs to be designed and made public for accountability purposes.

Electricity

- **Comply with norms and regulations for new generation permits for electricity.** To resume the regulatory process for generation permits to private participants in the industry would contribute to the country's energy security, it would diversify risks liberating CFE from the responsibility of being the company responsible for capacity growth. Competition reduces costs and is a driver for renewable integration that would result in environmental benefits such as lower GHG emissions.

- **Reactivate long-term bids.** Long-term bids minimize generation costs through a competitive process that benefits citizens and consumers with investments in clean and efficient generation plants. They encourage competition in the sector and minimize prices of energy. Energy costs observed in the bids that took place between 2015 and 2017 are below the average generation cost of the sector. The mechanism must be resumed for Mexico's electricity prices to drop and to guarantee an increasing share of renewable and clean energy supply.

- **Clean energy certificates.** CELs operation rules have been modified and no longer depend on the start of operations date. This changes the mechanism's original aim design and objectives. CELs need to reflect scarcity to be effective and increase the speed at which renewable energies are integrated, so that eventually the certificates are no longer needed.

- **Publish in the Federal official gazette (Spanish acronym DOF) regulations for collective distributed generation.** CRE approved in 2019 regulations on this matter but were never

published. Publication is necessary for the mechanism to work and issuing permits for new collective distributed generation projects. This is a mechanism for social participation in the generation of energy and energy transition. Collective distributed generation is more efficient in terms of infrastructure use and reduces installation costs for users.

- **Invest in transmission and distribution infrastructure.** CFE must strictly follow Prodesen plans and approve a budget to meet transmission and distribution goals. According to the LIE, SENER can instruct CFE to execute infrastructure projects to expand and modernize the RNT. CFE is significantly behind schedule on this. Some projects have been stalled and the competitive process for building others has been outright canceled. We propose CFE speeds up the execution of the projects it has been ordered to build and restarts strategic projects that it canceled, such as the interconnection of the Sistema Eléctrico de Baja California with the SIN and the Yautepec-Ixtepec direct current transmission line.

- **Provide additional resources to CFE Transmisión and CFE Distribución.** Cross subsidies from CFE Transmisión and CFE Distribución to CFE SSB and CFE Generación decreases the pool of resources these subsidiaries could apply to expand and modernize both transmission and distribution grids. This practice goes against CFE's legal mandate for strict separation of all subsidiaries of the CFE. We propose to eliminate cross subsidies and allow transmission and distribution subsidiaries to increase their investment budget.

- **Prioritize public investment in those business areas that are profitable to CFE.** Instead of building new generation plants, CFE ought to redirect its budget to business areas that are profitable and are legal monopolies.

- **Use available mechanisms for financing investments.** Even if transmission and distribution of electricity are classified as exclusive to the State, the LIE gives CFE the ability to partner with private investors, when the purpose of the partnership is to finance, install, maintain or operate transmission and distribution infrastructure. CFE must make the most of the available mechanisms (PPA and E Fibers) that allow the private sector to invest and operate infrastructure. Then, the expansion and modernization of the transmission and distribution grids would be secured.

- **Make it simpler for the private sector to contribute to the reinforcement and expansion of transmission infrastructure.** The law allows generators to collectively reinforce or build transmission lines to interconnect generation plants with the RGD either through CFE Transmisión or by themselves with CENACE's approval. We recommend current laws and regulations are followed and private participants are allowed to invest and cooperate to develop transmission projects.

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