

Gas pipelines in Mexico's Energy Reform: 2013-2014. An extractivist business model

Jordy Micheli Thirion^a

^a Universidad Autónoma Metropolitana, Unidad Azcapotzalco (UAM-A). Mexico.

Email address: jomicheli@azc.uam.mx

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Abstract

In the period 2006-2018, just over 6 000 km of gas pipelines were installed in Mexico to form a gas-electricity chain, using private investment attracted by a business model based on the extraction of public resources. Successive neoliberal governments hastily promoted, without planning criteria or risk minimization, a large market for private companies that provided natural gas transportation services for electricity generation, resulting in an overcapacity whose budgetary dimensions and costly flaws have been evidenced by the State's public documentation. This article provides an interpretation of the extractivist-based privatization process in the Mexican natural gas sector and details the mechanisms of the business model of the well-known Energy Reform.

Keywords: corruption; innovation; economic growth; principal components; structural equations.

1. INTRODUCTION

The culmination of the historical cycle of privatization of the Mexican energy sector occurred with a series of laws between 2013 and 2014, during Enrique Peña Nieto's presidency. This new body of law, which transformed the Constitution and secondary laws, was a continuation of the changes in the energy legislation of the 1990s, which paved the way for the creation of private markets in the natural gas transportation and distribution sector as the mainstay of energy restructuring. Two expectations guided the privatization of gas: one was to create business models based on the existing gas pipeline infrastructure, known as the National Gas Pipeline System (SNG), and the other, more ambitious, was to build the private market for a new gas-electricity chain based on the creation of a system of gas pipelines that would feed a large number of electricity generation plants; all of this for the purpose of establishing the sale of electricity to the Federal Electricity Commission (CFE) or for intra-company commerce.

Investments for the new set of gas pipelines and power plants of the gas-electricity chain were mainly made between 2006 and 2018, using the service tender formula; in other words, private companies build and operate the pipelines for 25 years, while the State begins to pay for them as soon as they are installed. This new infrastructure resulted in a significant change in the electricity production grid, in which natural gas accounted for approximately 60% of electricity generation in recent years, compared to approximately 30% at the beginning of this century.

The economic policy process through which the new gas-electricity chain was built was based on creating private profits using a business model of extracting public resources. This model was applied extensively since the State promoted a vast market for private companies to build and provide natural gas transportation services without planning and risk minimization conditions by using the public budget to contract the private services.

The privatization process of the Mexican energy sector has been analyzed mainly from the oil perspective, particularly focusing on political economy and integration with the United States (Alvarez, 2014; Vargas, 2015a and 2015b; Alvarez, 2019). This current of interpretation highlights the subordinate role of the Mexican state to the interests of large energy and financial companies as a distinguishing feature of the neoliberal phase of the Mexican economy. In particular, Vargas (2015b) pointed out that Peña Nieto's Energy Reform was clearly the implementation of a business model.

In reference to the gas sector, Lajous (2012 and 2013) describes and analyzes the operational situation of the hydrocarbon transportation system, emphasizing the weaknesses of the SNG due to the absence of investments for its modernization and expansion during the period in which the reform at the end of the century promoted by the then President Ernesto Zedillo was expected to take effect. An analysis of its recent evolution in production, trade and uses was performed by Estrada *et al.* (2022) within the framework of the energy policy changes of the current six-year administration, indicating as one of the conclusions that the natural gas industry, still only just emerging in Mexico, has a long way to go and is a fundamental option for electricity production, as well as an input for petrochemicals. One of the conclusions points out that "the excessive gas transportation capacity contracted by the CFE during the past administration requires urgent attention" (Estrada *et al.*, 2022, p. 108). Finally, in an effort to analyze the regional and industrial pattern of natural gas consumption, Micheli *et al.* (2013) prepared an annotated mapping tool that shows the strategic role that the SNG has played in Mexico's industrial geography.

The foregoing, barring any inadvertent omissions, illustrates the fact that the natural gas industry in Mexico is a field of research that has barely been addressed despite its economic relevance, its role in the country's international integration, its relationship with national development strategies and, at present, its participation in the energy transition. This text addresses the business model that underpinned the construction of one of the pillars of the current Mexican energy system during the period 2007-2018, consisting of a total of 7 301 km of natural gas transportation pipelines from the border with the United States, and the purpose of which is to provide the fuel to generate electricity.

This interpretation of the study of energy privatization in Mexico is the analysis of the concrete mechanisms through which the extraction of public resources destined for private companies investing in natural gas transportation is carried out. These mechanisms, defined as deliberate overcapacity and asymmetric risk management in favor of the private company, constitute the business model that sustains privatization in practice. It is also argued that for the extensive application of this business model, the State needed to promote the market, substituting energy planning for the goal of hastily increasing the supply of natural gas in the country.

The *business model* concept has several meanings that allude to the competitive peculiarity of each industry or business. In this text, it refers to the condition of natural gas transportation companies, which base their profits on the power conferred by the legal and political framework of the Energy Reform. In other words, the State itself is the guarantor of this private power, which basically occurs in two ways: asymmetric regulation and the contracts signed between public energy companies and private companies. In both ways, private profits come from public resources and not from an abstract "market" and, therefore, not from the

competitiveness that would benefit consumers. The business model as a legal condition embodied in contracts leads to the privatization of the gas-electricity chain based on the dispossession of public goods and resources. This accumulation pattern requires a systematic subordination of the State to private interests.

It should be added that the business model is not strictly a concept in economic theory, but it is in applied business economics and contains two basic descriptive elements: how and to whom it is sold. In the case study, the public sector is the market in which these two characteristics are defined, and the competitive advantage for operating in this field is the contractual protection by the State that the company obtains in a business climate marked by urgency and lack of planning on the part of the purchased State. Suppose we transfer this characterization to concepts of economic theory. In that case, the notion of a sellers' market can be suggested in which the State generates the conditions to eliminate the risk of the former through various incentives, which, in the end, are the mechanisms for the extraction of public resources. This article is a description and analysis guided by this approach to the business model.

The sections that comprise the analysis begin by identifying natural gas as a factor in energy battles and explaining the economic importance and business management of natural gas transportation using pipelines (section 3). This is followed by a review of the significant steps of the neoliberal energy reform in Mexico, which began in the mid-1990s and ended in 2018, pointing out, in particular, the process of privatization of natural gas transportation to create the gas-electricity chain (section 4). Next, an analysis is carried out of the official guidelines, which, in the absence of planning, justify the policy of construction of overcapacity in gas pipelines in the gas-electricity chain (section 5). The paper then continues with the review and analysis of the evaluations of the Public Account prepared by the Federal Superior Audit Office (ASF) regarding the investments and performance of the Federal Electricity Commission (CFE) in the construction of the gas-electricity chain in the period under consideration (section 6). The conclusions indicate that, in reality, the public authority's overcapacity and asymmetric risk management constitute the institutional contribution to the extractivist business model on which the expansion of the gas-electricity chain in Mexico was based.

2. METHODOLOGY

This research is qualitative and based on a review and interpretation, under the analytical framework of privatization, of public information that quantifies in various dimensions the expansion of natural gas pipelines for electricity production during the period under study.

The documentary evidence of the exercising of the described business model was obtained from public sources, in which there is evidence of the promotion of investments under consignment and without planning requirements. There is also a description of the various operations for extracting public resources in the specific cases of tendered pipelines. This article is based on an analysis and systematization of public documentary evidence to explain the business model that supported the construction of the gas-electricity chain between 2006 and 2018, which was a significant stage in the privatization of the energy sector in Mexico. The analysis framework is the model of extraction of public assets and resources, which characterized the neoliberal phase of the economy.

3. NATURAL GAS IN THE ECONOMIC BATTLE FOR ENERGY

Natural gas has been the fundamental fuel of a global energy transition that has developed since the second half of the 20th century to the present (Smil, 2017). The historical rise of natural gas as a primary energy source is associated with its pipeline and sea transportation and new unconventional production that has made the United States a new gas energy power. The world's consumption of natural gas has been growing steadily since the last century and today represents 25% of primary energy sources, behind coal at 27% and oil at 31% (Ritchie, 2021). The energy transition led by natural gas is expressed in the construction of a new energy market that has materialized in the gas-electricity chain and its physical, financial, and legal components. The State and global companies intervene directly and compete or reach a consensus on the costs and benefits of the energy market, and the relationship between the two major players determines the stages in the construction of this market, the balance of which is the current energy transition.

For Chevalier (2013), the control of energy resources, their technologies and the means of production and distribution have been the scene of "colossal battles" in the economic, political and financial spheres and, of course, at its most destructive, in the military sphere. Chains of production, mobilization and consumption of energy constitute the matrix of society's production system. They are an inescapable condition for the development of production forces and the continued existence of societies and are a source of accumulation for those who own or control them. For this reason, the key to the battles for energy has consisted in gaining control of strategic sections of this chain of production, transportation and consumption in order to appropriate the revenues that are the source of the profits of companies along the chain.

Since the 1970s, under the political current of neoliberalism, the energy systems of various nations were dismantled to create different markets, giving rise to an accelerated process of privatization of the world energy industry through the establishment of a legal and fiscal framework attractive to private investors (Chevalier, 2013). The argument was that competition would lead to lower prices for the consumer; however, the actual process was the appropriation of infrastructures and markets by large monopolies (Hansen and Percebois, 2010). Thus, the scenario of a new deployment of private markets in a dismantled electricity system was built, following the model of the US system (Hess, 2011) with the emergence of "independent producers". The resulting energy transitions resulted in conflicts over the appropriation of revenues as a means of profit for the financial stakeholders and their power dynamics (Chevalier *et al.*, 2012). The gas-electricity chain has been a paradigmatic space of this dismantling and has driven the energy transition and new markets.

This has made the political economy of this hydrocarbon more complex, while at the same time, the global geography of the natural gas industry is linked to the investment decisions made by oligopolistic companies in terms of transportation and processing of the hydrocarbon. The market for pipeline constructors has been growing steadily in historical terms and various sources report significant expectations for the years to come.¹ The terms of profitability for investors call for the following:

particular attention to the sunk costs of the capital invested in these fixed infrastructures, which require long and predictable periods of operation to recover the original investment and provide acceptable returns (also) long duration contracts play a central role in these projects (Victor *et al.*, 2006, pp. 28 and 29).

Bargaining power covers issues such as the "enforceability of contracts, the stability of the business context or regulatory constraints on the full use of private property" (Victor *et al.*, 2006, p. 29). At the beginning of this century, the World Bank encouraged the restructuring of the natural gas market in developing countries under the condition of having regulatory frameworks and local climates of trust that would allow foreign investment subject to the States showing the political will to do so (World Bank, 2004).

4. THE MEXICAN ROUTE

As Álvarez (2019) pointed out, one of the key elements of Mexico's subjection to the neoliberal economic recipe since the debt crisis of 1994-1995 would be the energy sector. A legal and institutional framework was created to allow foreign investment to enter energy chains to obtain revenue, starting with natural gas. Between 1994 and 1996, the Regulatory Law of Article 27 of the Constitution was amended, the Energy Regulatory Commission (CRE) was created and regulatory instruments were adopted for the economic regulation of the natural gas chain. Operationally, the integrated state-owned hydrocarbons company *Petróleos Mexicanos* (PEMEX) was separated into different units in charge of different businesses and markets to allow the private sector to participate in the transportation and distribution of natural gas, as well as to set up private companies to produce electricity from natural gas.

The pipeline infrastructure on which the first phase of the reform was applied was the SNG, the previously existing public network geared towards the multiple supply of hydrocarbons: from domestic consumption to its use as an energy input for various industries and its conversion to electricity. Extending more than 8 000 km and with the Gulf Coast trunk pipeline as its axis, this network sustains the economy of 254 municipalities with 64% of national industrial production and 44% of the population, located in the central, eastern and northeastern regions of Mexico (Micheli *et al.*, 2013). Figure 1 shows the territorial configuration of the Integrated National Natural Gas Transportation and Storage System (SISTRANGAS), which comprises seven interconnected and integrated natural gas transportation systems, among which the SNG serves as the central system.

The effects of the reform were not what had been envisaged in this network: with the expectation of a significant expansion through new pipelines, which would be built by private companies, the system was not covered with public resources for its improvement and modernization, and in 2005 it entered a phase of over-utilization that caused costly interruptions for safety reasons. This stagnation of the Mexican gas system occurred at the same time as the decrease in the price of natural gas in the United States, which generated growing imports of natural gas and consolidated Mexico's dependence on that country for natural gas (imports represented 14% of consumption in 2005, 36% in 2015, and 69.8% in 2022).

The price of natural gas is the most important variable for the behavior of natural gas consumption. The reference price used in Mexico is the *Henry Hub* from South Texas, to which the domestic market price is indexed. The most relevant characteristic of the cost of Texas gas in recent decades has been its upward trend at the beginning of the 1990s, reaching its high point between 2004 and 2007 before falling since then. Since 2008, from a peak of US\$18.39 per British Thermal Unit (BTU), the price trend has been downward to a range of US\$6.58 and 2.08 per BTU. Likewise, since the same year, *Henry Hub* gas and gas from Alberta, Canada, have been the cheapest in the world compared to gas from other geographical locations. In 2010, the continuous rise of natural gas exports from the United States to Mexico began: that year's 23.4 million cubic feet became 193.7 million in 2022.

Figure 1. SISTRANGAS configuration



Source: prepared by the author with information from the National Natural Gas Control Center (CENAGAS, 2023).

This represented a historic geopolitical shift that changed the conditions under which the dominant country established its influence over the Mexican gas system. As a result, by 2022, Mexico represented 26% of the United States' natural gas export market, with no other country having the same share as the Aztec nation. For example, Canada, in second place, represents 16%; and Great Britain, in third place, with 12%. Mexico is currently the most important market for the United States, but under a new model in which its gas is a commodity sold globally, basically by maritime transport in a very dynamic process of expansion that began in 2016 and that will lead in 2022, to world leadership in sales of liquefied natural gas (LNG), together with Qatar.

Despite the privatization of some SNG pipelines, their management and bargaining power remained in the hands of PEMEX through its specialized gas transportation company. An industry analyst describes the reasons for the unexpected weakness in investment:

the complexity of the private sector's interaction with and among state monopolies in the energy sector has discouraged private investment and encouraged the inclusion of PEMEX as a partner (...). On many other occasions, the construction of pipelines failed to bring in potential investors, whose expected discount rates were incompatible with those of a regulated utility (Lajous, 2013, p. 27).

In December 2013, the Mexican Congress approved three changes to Articles 25, 27 and 28 of the Mexican Constitution. During the following year, a legal framework of new laws and the modification of others, as well as new regulations, was created, culminating in the widely known controversial Energy Reform, which, in theory, opened the way to an economic-political regime of openness to international companies in the Mexican energy sector. Thus, for the exploration and extraction of hydrocarbons, private companies, together with the public sector, must participate pursuant to various forms of contracts; however, in the subsequent activities comprising refining, transportation, storage, processing, distribution and commercialization, the opening to private companies is total.

5. DESCRIPTION OF THE PIPELINE SYSTEM FOR THE GAS-ELECTRICITY CHAIN

The set of pipelines put out to tender specifically to transport natural gas for electricity production purposes totals 7 301 km and consists of 19 pipelines. The first was tendered during Ernesto Zedillo's term of office (1994-2000), the Mayakán pipeline, which supplies hydrocarbons to the Yucatán Peninsula and measures 695 km in length. During the six-year term of Vicente Fox (2001-2006), only one 127 km pipeline was built.

The take-off of the system responsible for the gas-electricity chain took place in the following two presidential administrations (2007-2018): Felipe Calderón's, in which 2 907 km were put out to tender, and Enrique Peña Nieto's, with 3 572 km. Overall, 89% of the system was tendered between 2007 and 2018, corresponding to 17 pipelines out of 19. Table 1 lists all the pipelines in the gas-electricity chain.

Table 1. Gas pipelines for electricity production in Mexico per six-year presidential terms

<i>Period</i>	<i>Gas pipeline</i>	<i>Operating company</i>	<i>Length (km)</i>
1994-2000	Mayakán gas pipeline	Engie	695
2001-2006	Naranjos-Tamazunchale (Tamazunchale I-III)	TC Energía	127
2007-2012	Chihuahua Corridor	Fermaca	381
	Manzanillo-Guadalajara (Guadalajara- CT Manzanillo)	TC Energía	321
	Morelos	Macquarie Group Limited	160
	El Encino-Topolobampo	TC Energía	560
	Guaymas-El Oro (Sonora gas pipeline)	IENova	330
	El Oro-Mazatlán	TC Energía	431
	Sásabe-Guaymas (Sonora gas pipeline)	IENova	495
	Tamazunchale-El Sauz	TC Energía	229
2013-2018	Ojinaga-El Encino	IENova	221
	El Encino-La Laguna	Fermaca	423
	Tuxpan-Tula	TC Energía	273
	Samalayuca-Sásabe	Carso Energy	614
	San Isidro-Samalayuca	IENova	23
	La Laguna-Aguascalientes	Fermaca	452
	Villa de Reyes-Aguascalientes-Guadalajara	Fermaca	374
	Tula-Villa de Reyes	TC Energía	420
	Sur de Texas-Tuxpan	TC Energía, IENova	772

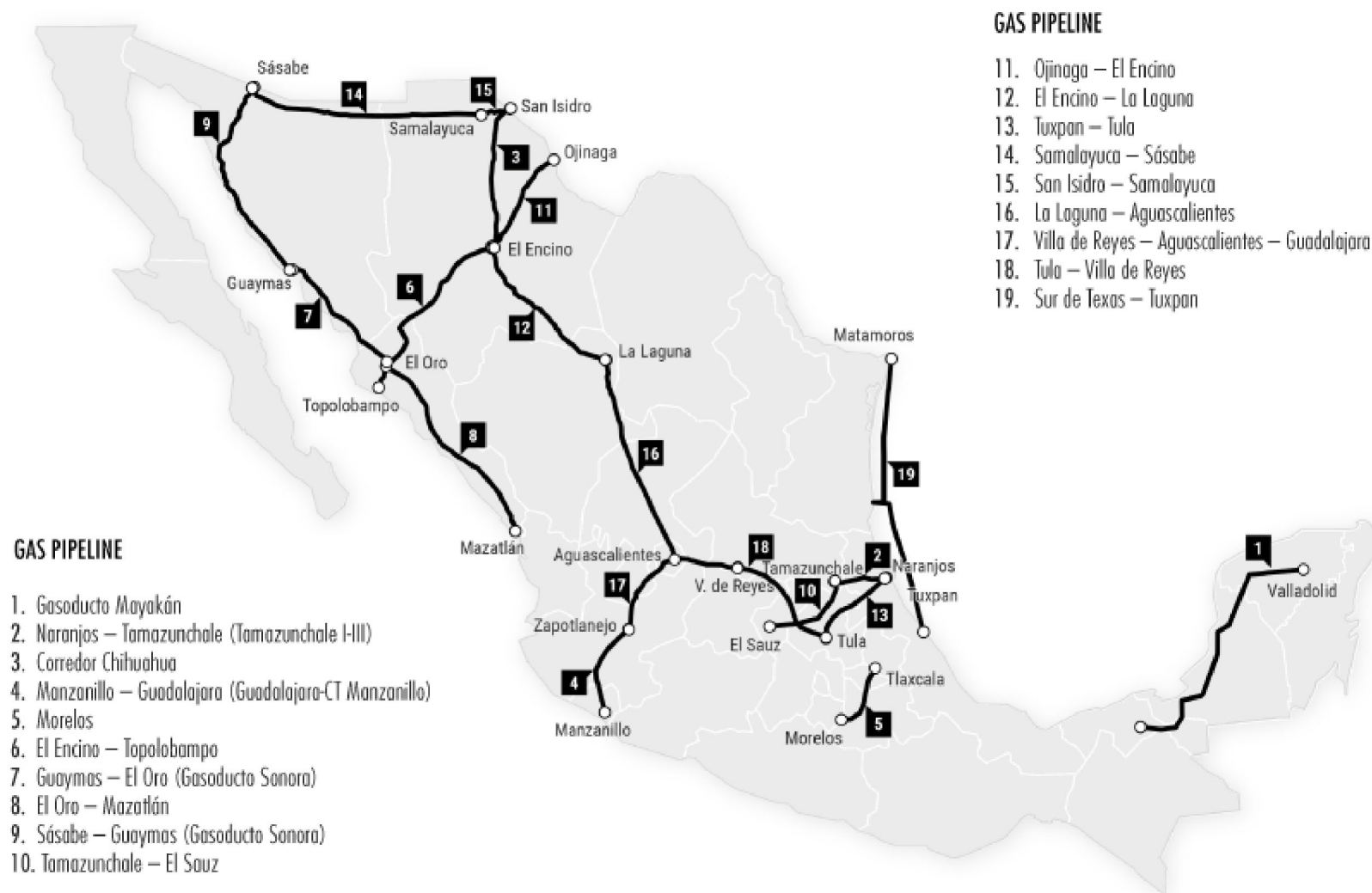
Source: prepared by the author with information from the Federal Superior Audit Office (ASF, 2018) and the Federal Electricity Commission (CFE, s.f.).

The eight gas pipelines put out to tender during the 2007-2012 six-year presidential term include those that make up the Northwest Project, comprised of the following pipelines: El Encino-Topolobampo, the Sásabe-El Oro System and El Oro-Mazatlán: El Encino-Topolobampo, the Sásabe-El Oro System and El Oro-Mazatlán. In the 2013-2018 six-year term, the gas pipelines corresponding to the Wahalajara Network, comprising the Ojinaga-El Encino, El Encino-La Laguna, La Laguna-Aguascalientes, Villa de Reyes-Aguascalientes-Guadalajara gas pipelines, were put out to tender.

It is important to mention that during Peña Nieto's six-year term, five branches that allow the interconnection between gas pipelines with other gas pipelines or with power generation plants were also put out to tender. Of the five branches, one was tendered in 2014 (Tula Branch), one in 2015 (Villa de Reyes Branch), two in 2016 (Empalme Branch and Hermosillo Branch) and one in 2017 (Topolobampo Branch).

Figure 2 below shows the system configuration for the gas-electricity chain described.

Figure 2. Gas-electricity chain pipeline configuration



Source: prepared by the author with information from the Ministry of Energy (SENER, 2020).

6. THE GAS-ELECTRICITY CHAIN EXPANSION SCHEME AND ABSENT PLANNING

To determine the technical bases regarding energy foresight and planning that supported this expansion, a chronological list of the evidence contained in the set of documents prepared by the authorities with decision-making capacity in the energy sector is presented. Public sources were used, which are the set of sectoral documents made up of legal and regulatory instruments through which the State's commitment to the Energy Reform was implemented.

More than a systematic statement regarding the need to expand the gas pipeline network to increase the supply of gas to new markets, generating greater efficiency and benefiting consumers, no technical support is provided to determine the new volume of gas to be transported and its relationship with the amount of electricity produced.

According to the CFE's White Paper "Gas Pipeline Package" (2012), in November 2011, in the final stage of Calderón's six-year term, a gas pipeline development strategy was announced that would imply a 38% increase in the transportation network. For this reason, "the CFE planned the development of transportation, reception, storage, supply and regasification of natural gas in the states of Morelos, Puebla, Tlaxcala and in the areas of Manzanillo, Colima and Guadalajara, Jalisco, as well as in the northwest of the country" (CFE, 2012, p. 34).

With the arrival of the new Peña Nieto administration, the 2013-2018 National Development Plan was issued, in which axis VI.4 "Prosperous Mexico", objective 4.6 "To supply energy to the country at competitive prices, with quality and efficiency throughout the production chain" was established in its line of action "To strengthen the natural gas market by increasing production and strengthening the importing, transportation and distribution infrastructure, to ensure the supply of energy in optimal conditions of safety, quality and price" (Government of the Republic of Mexico, 2013, p. 81). Thus, using axis VI.4, CFE's contracting of the natural gas transportation service through pipelines for the supply of natural gas to electricity generation plants was aligned with the National Development Plan.

The continuity between the six-year terms of Calderón and Peña Nieto was manifested through the Energy Reform, which was to be the culmination of the construction of the private market in hydrocarbons and electricity. According to SENER:

In 2013, the fourth paragraph of Article 28 of the Political Constitution of the United Mexican States was amended, allowing competition in electricity generation and maintaining the strategic nature of the planning and control of the National Electric System (SEN), as well as making the activities related to the transmission and distribution of electricity a public service (SENER, 2014, p. 21).

In 2014, the 2014-2018 National Infrastructure Program was announced, which sought to "optimize the coordination of efforts for the generation of energy infrastructure, thus ensuring its suitable development for the purposes of having sufficient quality energy at competitive prices" (Government of the Republic of Mexico, 2014, p. 2). Furthermore, it was stated:

Currently, under the framework of the public-private investment possibilities opened up by the Energy Reform, the Federal Electricity Commission has identified numerous gas pipeline development projects to supply electricity generation plants in different parts of the country. This will expand both the supply of electricity flow and the availability of natural gas transportation capacity for users, generating favorable conditions for increasing the economic growth of these regions. With the gradual entry into commercial operation of these pipelines between 2013 and 2016, the CFE will incorporate more than 2 728 km into the country's comprehensive network. In this context, the CFE will evolve from an electricity company to an energy company, providing electricity and natural gas services (Government of the Republic of Mexico, 2014, p. 35).

That same year, the 2015-2019 SISTRANGAS Five-Year Expansion Plan was released (SENER, 2015), which is essentially the basic instrument for planning and decision-making regarding the gas pipelines to be built. It is defined as an indicative planning tool to assess the availability and demand for natural gas in the medium term based on the highest-ranking document, the National Infrastructure Program (Programa Nacional de Infraestructura): "More than 5 150 kilometers of gas

pipelines resulting from projects contemplated in the PNI are included in the Five-Year Plan" (SENER, 2015, p. 10). The document explicitly states the line of decisions: "This first Plan is based on the projects contained in the 2014-2018 National Infrastructure Program (PNI)" (SENER, 2015, p. 6).

The expansion plan for the gas-electricity chain considered the CFE to be the operating axis as the state entity responsible for managing contracts for private natural gas transportation and electricity production companies. Meanwhile, the decision to build the infrastructure responded to an expansion criterion without explicit planning bases dictated by the SENER. This was noted and pointed out during the auditing of public spending through the so-called Performance Audit of the ASF, indicating that "(...) the SENER did not provide evidence of having an integral planning document for the electricity power plants to meet the country's needs related to the gas pipeline network, contrary to what is established in its Internal Regulations" (ASF, 2018, p. 8). Likewise, "(...) the CFE also failed to demonstrate that it had a strategic planning and programming document for the expansion of the gas pipeline network and power plants" (ASF, 2018, p. 9), and summarizes that:

From the review of the medium- and long-term planning documents, it was identified that, in general, neither the SENER nor the CFE were able to prove that they had carried out comprehensive planning based on a diagnosis of the expansion of gas pipelines in which the objectives, goals, strategies, priorities, responsible parties and coordination of actions were defined. Nor were they able to prove that they had assessed the results or the link between the 24 gas pipelines and the 51 power plants to which they would supply fuel, contrary to the terms of Article 3 of the Planning Law (ASF, 2018, p. 9).

The business model: deliberate overcapacity and asymmetric risk management

The consequences of the unplanned expansion scheme were noticed early on during the audits carried out by the ASF between 2016 and 2020. The auditing body reviewed the investments, costs and operations of the CFE from 2016 to 2020 (for the analysis in this article, those of 2016 and 2017 were used) (ASF, 2016 and 2017) (ASF, 2016 and 2017).² This documentation contains several observations and conclusions from the concrete analysis of various pipelines and their associated electricity production plants. As will be shown, the first set of observations reveals a systematic process of extracting public resources in favor of the private companies contracted to build the pipelines and provide the gas transportation service to the CFE. The legal basis of this extractive process can be found in the contracts between the public and private companies, technically known as *take or pay*, which states that the service contractor pays for the pipeline's capacity, whether or not the service is used. This is a principle that should work in two directions: on the one hand, it provides an incentive for investment since it provides protection if the service is not required once the pipeline is completed and on the other, it is an incentive for the contractor to avoid incurring costs due to lack of efficiency and planning. The notion of sunk cost is behind this principle since, once the investment has been made, the used capital can only be evaluated through the installed infrastructure.

The evidence gathered by the ASF indicates that in several cases, precisely due to the absence of planning, the private company completed pipelines that were not used by the CFE or were only partially used. Given the pressure exerted on CFE to contract pipelines, it is possible to qualify the creation of this overcapacity as deliberate. Given the pressure to contract pipelines exerted on CFE due to the aforementioned context of privatization, it is possible to qualify this overcapacity as deliberate.

This deliberate overcapacity is demonstrated by: 1) the underutilization of the pipeline by CFE while having to pay for the total capacity of the pipeline; 2) the electricity generation plants that were planned to consume the supply of gas transported by the new private pipelines do not exist or are currently under construction.

However, this is only one part of the business model. Another essential part is the asymmetric risk management in favor of the private company: 1) construction of the pipeline is delayed due to unforeseen circumstances that are assumed to be CFE's responsibility, for which the public company covers the cost; 2) the public company does not charge the private companies for certain contractual breaches that they incur and which are grounds for penalties.

Table 2 shows the cases for both business model components: deliberate overcapacity and asymmetric risk management.

Table 2. Cases that illustrate the business model in the expansion of the gas-electricity chain

<i>Case</i>	<i>Gas pipeline</i>	<i>Amount (MXN\$ thousands) and/or information on the state of the infrastructure</i>
Underutilization: CFE pays for capacity according to contract, even if it is underutilized.	Sásabe-Guaymas (90.7% is not used)	\$970 376.7
	Tamazunchale-El Sauz	\$1 729 602.4
	Chihuahua Corridor Gas Pipeline (92.9% is not used)	\$1 042 368.9
	Sásabe-Guaymas (90.7% is not used)	\$970 376.7
Contracting gas pipelines without existing plants: this is a special case of underutilization because the plants that will use the gas do not exist.	Sistema Sásabe-El Oro	1 plant under construction
	Corredor Chihuahua	3 plants no tender
	El Encino-Topolobampo	2 under construction, 2 no tender
	Sistema Sásabe-El Oro	2 in gas testing
	Tamazunchale-El Sauz	6 no tender
	Morelos	1 under construction
	El Encino-La Laguna	1 under construction, 4 no tender
	Ojinaga-El Encino	1 under construction
	Waha-Presidio	1 under construction
	San Isidro-Samalayuca	1 under construction
	Waha-San Elizario	1 under construction
	Ramal-Empalme	2 in gas testing
Unforeseen circumstances: CFE accepts the unforeseen circumstances submitted by the company and pays for them.	Encino-Topolobampo	\$1 070 143.7
	Guaymas-El Oro	The transportation company requested 106 days, and CFE granted 183 days. They did not prove that the conventional penalties were charged.
	Tamazunchale-El Sauz	\$33 152.7
Underutilization and unforeseen circumstances: the two cases simultaneously.	Morelos	\$397 817.2
Contracting pipelines without the existence of power plants: this is a special case of underutilization because the plants that will use the gas do not exist.	Ramal-Hermosillo	CFE did not provide evidence of the collection of a conventional penalty of: \$32 967 000
Waiver of conventional penalties for non-integration: the CFE does not provide evidence of having charged the company for non-compliance.	Ramal-Hermosillo	CFE did not provide evidence of the collection of a conventional penalty of: \$16 193 263.39
	Ojinaga-El Encino	CFE did not provide evidence of the collection of a conventional penalty of: \$92 745 119.97

Note: the amount refers to what the CFE paid to the corresponding contractors or what it waived for the benefit of said contractors.

Source: Compiled by the author using information from the ASF (2016 and 2017).

Summarizing: revenue and business models

As Chevalier *et al.* (2012) point out, the existence of revenue in energy transformation chains is a characteristic of the political economy of the energy system. Revenue is derived from the situation of power of the economic participants in the nodes of the chains, which, although they are characterized by technological coupling, are differentiated business spaces. These revenues have been manipulated by the power of the State in its neoliberal phase to generate business models based on the transfer of public resources to private parties. In terms of micro- and macro-economic analysis, this involves handling massive subsidies under various modalities in favor of the private sector participating in the chains. In terms of the history of capitalism, it is comparable to accumulation by dispossession (Harvey, 2004) since the source of value does not come from innovation and productivity but from the private exploitation of pre-existing public resources. Contrary to the view that the State facilitates access to the market in neoliberal capitalism, what happens is that the private sector benefiting from energy markets would not be able to participate without state protection that guarantees access to public resources, which is the source of profit, not the market in the abstract.

In the case of Mexico, it is helpful to bear in mind the two stages of the model applied to the type of infrastructure:

The SNG is a pre-existing public network to which private pipelines are added, whether new or due to a change in ownership. Therefore, revenue design should be based on a policy of regulating asymmetric gas transmission tariffs in favor of private companies (Micheli and Ramírez, 2023). When gas passes through public pipelines, the tariff set for the public company is relatively low due to the non-recognition of the actual costs. This translates into a subsidy received by the private company, which is thus "rewarded" for its risks in sunk investments.

On the other hand, in the new set of gas-electricity system pipelines subject to this analysis, the revenue design is based on promoting private transportation pipelines in contracts in which the State assumes all the risks and costs of deliberate overcapacity and asymmetric risk management. The first cost is evidenced by not having

the electricity plants to consume the gas transported by the new pipelines. The second is manifested in the various unplanned eventualities, the cost of which is covered by the State.

7. CONCLUSIONS

The previous analysis enables us to synthesize and evaluate the process of generating a business model using the gas pipeline infrastructure of the gas-electricity chain built between 2007 and 2018. An economic analysis must assume the explanation of the mechanism by which investments in production methods, gas transportation infrastructure in this case, generate value for the participants in the operation of such infrastructure, and the model in question is the extraction of public resources using rules accepted in the contracts and a management of incidents in favor of the private companies, within the framework of an absence of planning that is paid for with public resources.

The decision to generate the gas-electricity infrastructure was based on a "self-evident" need to create a private market and not on a technical and economic rationale based on energy planning. The different announcements of the extension of the national gas pipeline network in official texts referred to expansions of the capacity to transport gas without a concrete relationship with the new supply of electricity and its different regional and sectorial uses. The pace of the construction of the pipelines was not related to the pace of the construction of the electricity plants to which they were to supply the natural gas necessary for the conversion.

The flow of investments resulted in overcapacity, significantly impacting the public budget. This cannot be attributed to a planning failure since planning did not exist. Instead, it can be attributed to applying an explicit business model whose operation has been described throughout this paper. The private investment with which the pipelines are built begins to be recovered by the companies from the moment they are declared completed, according to the contractual date, regardless of their level of operation. The contracts are established for 25 years, during which the company will own the pipelines and receive payment for their capacity.

However, this contractual element, typical of a sector with sunk costs and which is a risk minimization mechanism for the investing party, requires, in return, a precise scenario of investment requirements and risk minimization for the contracting party, consisting of cost-optimization planning. By contrast, the Mexican contracting process was massive and involved deliberate contracting of overcapacity, accompanied by asymmetric risk management in which the contracting party automatically absorbed cases of non-compliance.

The economic rationale behind the gas-electricity chain was opening a market exploited under a business model that extracts public resources as a mechanism to increase the value of investment in pipelines. Characterizing this business model is an essential analytical step for understanding the general process of the Energy Reform within the framework of the economic battles for energy.

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¹ For example, the business portal Mordor Intelligence (2023) forecasts a minimum annual growth of 6.5% in the gas pipeline construction market for the period 2022-2027. The expansion of gas pipeline infrastructure placed Mexico in 17th place worldwide among the countries that, at the end of 2020, had pipelines in the process of pre-construction and construction. There were a total of 2 803 km in that situation, the first ones being China with 29 467 km, India with 20 440 km and the United States with 11 000 km (Browning *et al.*, 2021).

² The aim is "To audit the financial and operational management of the physical and financial progress of the construction of gas pipelines for the transportation of Natural Gas, to verify that they correspond to those envisaged in the investment projects, as well as compliance with deadlines for commercial operation; that the transportation service is supplied to the electricity generation plants as contracted, and that the legal and regulatory provisions were observed in their payment, verification and budgetary accounting records" (ASF, 2016, p. 1)