A Brief Look at Mexico's Energy Sector

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Introduction

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Mexico's energy sector boasts abundant, diversified resources, something quite favorable for an economy that is among the world's 15 largest and most complex. Therefore, it should be expected that national energy production be efficient and diversified; however, it is actually inefficient and concentrated. It is inefficient because the sector operates with growing medium and marginal costs, as can be seen in the earnings reports of its two main entities, Petróleos Mexicanos (Mexican Petroleum, or Pemex) and the Comisión Federal de Electricidad (Federal Electricity Commission, or CFE). It is highly concentrated because both of these are government monopolies in their respective areas, hydrocarbons and electricity.

The hydrocarbon industry has undoubtedly been the country's main source of wealth since its consolidation in 1911. This can be seen in the size of its domestic and foreign sales; the surpluses it has generated; its central role in the development of other industries and economic activities; the investments made in it; the hard currency, taxes, and duties it has turned over to the state; and the jobs it has created.[1] It has been so bountiful that it has been able to survive recurring practices eradicated in other countries with similar levels of development to Mexico's: siphoning off of its products from pipelines, contraband in maritime routes, and excessive contributions to the oil workers' union and the political party that fostered the creation of both the union and Pemex itself 75 years ago, the National Revolutionary Party, today the Institutional Revolutionary Party (PRI).

Talking about Mexico's energy sector means talking about two enviably rich, but very badly managed industries. This has given rise to a choice that has polarized society, fostered by the government itself in the 1990s: they should either be managed properly or privatized. This is quite a dilemma if we take into account the fact that oil, expropriated from the foreign oil companies in 1938 by President Lázaro Cárdenas, with the support of the recently created Mexican Oil Workers' Union and individual contributions from the people of Mexico, has joined the agrarian reform, free secular education, and labor legislation protecting workers as the representation of the materialization of the Mexican Revolution.

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Legal Framework

Article 27 of Mexico's 1917 Constitution and the regulatory laws for the oil, electricity, and nuclear sectors specify that the nation is the exclusive owner of all solid, liquid, or gaseous fuels, and holds exclusive rights to exploit and regulate the use of nuclear fuels used in generating nuclear and electrical energy.[2] Article 25 considers the oil, basic petro-chemicals, radioactive mineral, and nuclear and electric energy generation industries as "strategic activities," thus excluding them from the prohibition of monopolies established in Article 28.

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Because of all this, Pemex, a vertical company since its nationalization, together with its subsidiaries created in the 1990s, is the only body in the public administration with the faculty of exploring, producing, transforming, exporting, importing, and distributing crude oil, oil-derived secondary refined forms of energy (gasoline, diesel, fuel oil, liquid gas, jet fuel, and others), and primary petrochemicals through its pipelines. It is also the only body that can call for bidding by third parties to establish contracts for the exploration and production of oil and gas, and their importation, liquefaction, and distribution, and grant licenses to private entities to transport them in tanker-trucks, or to sell gasoline and diesel at service stations.

Since the nationalization of the electricity industry in September 1960, the CFE, born in January 1934, is the only entity with the faculty to generate, manage, transform, distribute, and supply electricity as a public service. According to current legislation, it is responsible for planning the national electricity system; generating, managing, transforming, distributing, and selling electricity, and carrying out all works, creating all facilities, and doing any and all work required for the planning, execution, operation, and maintenance of the national electricity system. It is not considered a public service to generate electricity for self-supply, its co-generation, or to generate it on a small scale. Also not considered a public service are the generation of electricity by independent producers for sale to the CFE; for export as a result of co-generation, independent production, and small-scale production; the importation of electricity by individuals or legal entities exclusively for their own use; or the generation of electricity for emergencies due to the interruption of the public service provision of electricity.

The law states that both Pemex and the CFE are decentralized public bodies, each with its own legal status and patrimony, which operate in what the Constitution defines as strategic areas. Therefore, they cannot be understood as the equivalent of private companies, whose purpose is to make a profit. From the point of view of the budget, they are dealt with as entities under direct budgetary control. There are two more of these in Mexico: the Mexican Social Security Institute (IMSS) and the Government Workers Social Security and Services Institute (ISSSTE). From the perspective of national accounting and the public administration, both Pemex and the CFE are subsectors of the energy sector for hydrocarbons and electricity, respectively.

Bodies Derived from Pemex and the CFE

Pemex has a technological wing, the Mexican Oil Institute (IMP), created in 1965. Its mission is to transform knowledge into technology and services of use to the oil industry, focusing on research and technological development, engineering, and technical and training services. Since the federal government and Pemex itself have limited the development of these functions since the 1990s, the institute has reoriented

to giving academic degrees, commercializing its research projects, forging strategic and technological alliances with leading bodies in Mexico and abroad, and technically preparing the bidding processes in areas like refining.

In 1989, PMI Comercio Internacional (PMI International Trade) was founded, a body built like a company, but 98 percent of whose stock belongs to Pemex.[3] Its main functions are trade; export and import of all kinds of products or merchandise, whether raw materials, natural, or industrialized products; trade of crude oil and products derived from its refining and industrialization; as well as trade of petrochemical products and other liquid, solid, or gas products. They do not include their commercialization domestically for areas reserved for Pemex. PMI Comercio Internacional can also offer advisory, commission, management, agency, distribution, mediation, storage, or representation services of a technical, administrative, financial, legal, or economic nature.

In 1992, Congress passed the Law for Petróleos Mexicanos and Its Subsidiaries. This law maintained Pemex's Strategic Planning Unit, but reorganized and decentralized its main activities into four subsidiaries, each with its own patrimony, legal status, and management autonomy. These are Pemex Exploración y Producción (Pemex Exploration and Production, or PEP), whose function is to explore and exploit oil and natural gas deposits; Pemex Refinación (Pemex Refining, or PR), which is in charge of the usual industry refining processes; Pemex Gas y Petroquímica Básica (Pemex Gas and Basic Petrochemicals, or PGPB), which is responsible for processing natural gas, gas liquids, and the industry's basic raw materials; and Pemex Petroquímica Secundaria (Pemex Secondary Petrochemicals, or PPS), which takes care of petrochemical processes Pemex is involved in besides basic petrochemicals.

Based on a change in Article 27 of the Constitution discussed by Congress in 1991 and voted into law in 1993, national and international private capital has been participating directly since then in pumping and distributing natural gas. The most important company doing this is Spain's Repsol, which controls a series of subsidiaries and service providers, many of which are regional in scope.[4] In addition, it liquefies gas from Camisea, Peru, and imports it to the liquid gas plant in the Mexican port of Manzanillo. Once liquefied, Repsol distributes it to the electricity generating plants in the central and eastern parts of the country. It owns some of these generating plants, too: in 2009 it partnered up with Gas Natural and Unión Fenosa, also Spanish companies. Gas Natural had only in 2007 acquired from Électricité de France and Mitsubishi five combined gas cycle plants that sold electricity to the CFE. With that, Repsol has become a monopoly in supplying and distributing natural gas, and is a CFE duopsony together with another Spanish firm, Iberdrola, in independent energy production.[5]

Talking about Mexico's energy sector means talking about two enviably rich, but very badly managed industries. This has posed a choice that has polarized society: proper management or privatization.

Since 1975, the technological arm of the electricity industry has been the Institute for Electricity Research (IIE). Its mission is to promote and support innovation through applied research and developing technology with high value added to raise the competitiveness of the electricity industry and others with related needs. Both the budgetary limitations of the 1980s and the 1993 amendment to the Electrical Energy Public Service Law created the conditions for the participation of private capital in the industry. This led the federal government to gradually reduce the flow of public monies into the IIE, which not only led it to resort to the market to finance its existence, but also limited its participation in the CFE's technological duties. The CFE, in turn, began to depend increasingly on private investors for the purchase of electricity and technological advisory services. Thus, much of the human capital trained by the IIE has scattered or been lost to other sectors, with unfavorable results for the country's intellectual productivity.

For its part, the National Institute for Nuclear Research (ININ), created in 1979 to do research in nuclear science and technology, like the IMP and the IIE, has reoriented toward the market. It states that its mission is to "offer specialized services and products to industry in general, and the medical field in particular."[6]

The Ministry of Energy (Sener) heads up the energy sector, and has a regulating body, the Energy Regulation Commission (CRE), created in 1993, whose jurisdiction increased after the 2008 energy reform. Since its creation, it has moved from first-hand sales of natural gas to those of fuel oil, products derived from oil refining, and basic petrochemicals. It has also taken on the responsibility of activities carried out

through pipelines, storage systems directly linked to transport or distribution through pipelines, and those that are an integral part of the import or distribution terminals for those products.

Parallel to all this, the energy reform also gave rise to the creation of a series of sectoral bodies:

a) The National Energy Council, whose function is medium- and long-term energy planning and the design of energy policy criteria and elements;
b) The National Hydrocarbons Commission and its Consultative Forum, whose functions are to evaluate and delimit the country's oil resources, regulate and supervise the exploration, drilling, and pumping of hydrocarbons, and maximize the useful life of the deposits;
c) The National Commission for Efficient Energy Use (previously the National Commission for Energy Savings) and its Consultative Council, whose aim is to promote energy efficiency and establish itself as a technical body in matters of the sustainable use of energy;
d) The Consultative Council for Fostering Renewable Energy, made up of representatives from industry, commerce, academia, the government, and the development banking system, which serves as a consulting body in the identifying projects and designing and developing programs related to using renewable forms of energy; and
e) The Consultative Council for Sustainable Energy Use, whose main functions are to review the National Commission for Efficient Energy Use program and work plan; present a report on compliance with the goals and objectives presented in both documents; propose mechanisms to plan, develop, and execute energy efficiency programs; and promote the participation of the private sector in sustainable energy use.[7]

Based on a change in Article 27 of the Constitution in 1993, national and international private capital has been participating directly since then in pumping and distributing natural gas.

The Structure of Supply

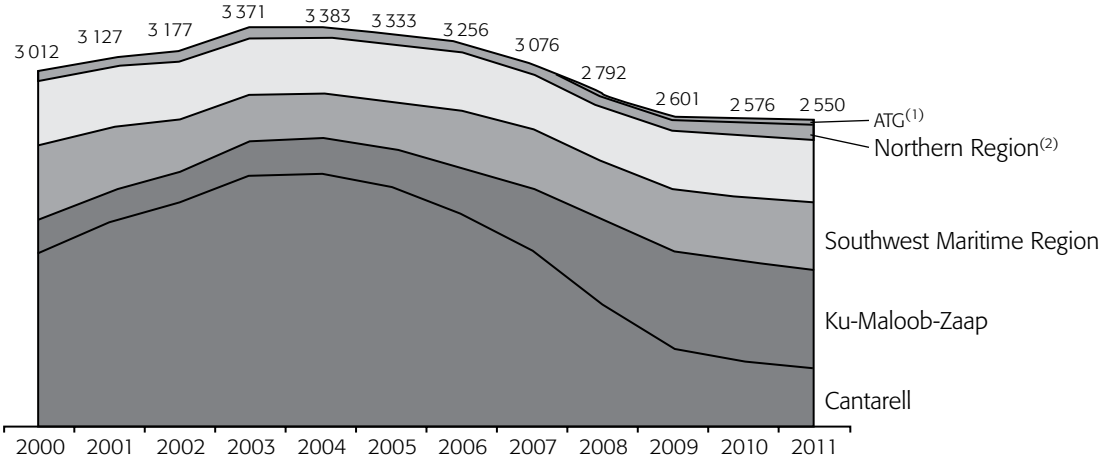
In 2010, Mexico's primary energy production came to 9 251 petajoules,[8] 92.4 percent of which came from fossil fuels: oil, 64.9 percent; natural gas, 24.3 percent; condensed fuels, 1.0 percent; and coal, 2.2 percent. The other 7.6 percent comes from nuclear energy (0.7 percent) and renewable fossil fuels: hydro-energy (1.4 percent), geo-energy (1.6 percent), solar energy (0.05 percent), and biomass, mainly firewood (3.8 percent).[9] The surprising fall in the participation of nuclear-generated electricity should be underlined here: between 2003, when it was 1.8 percent of the total, and 2010, it dropped to less than half that. This seems to confirm problems at one of the two reactors at the Laguna Verde plant, even a year after Fukushima, Japan's six reactors were taken off-line because of the March 11, 2011 earthquake and resulting tsunami, and the beginning of the dismantling of this industry in countries like Germany.

Another significant element is that the country's primary energy production dropped from 10 543.2 petajoules in 2005 to 9 250.7 petajoules in 2010, 12.3 percent in six years. This can be explained mainly by the effects of over-exploitation of the Cantarell deposit in the Sea of Campeche under the administration of President Vicente Fox (2000-2006), which led to a production decline from 2.2 million barrels a day (MBD) in 2004 to only 0.5 MBD in 2010 (see Graph 1).[10]

In the electricity sub-sector, effective capacity in 2009 was 60 440 megawatts (MW), from the following sources: thermoelectric plants, 71 percent; hydroelectric plants, 18 percent; coal-driven plants, 5 percent; nuclear-electric plants, 2 percent; and renewable sources, 4 percent. Most of the renewable sources are geothermal-electrical, wind, biomass, and micro-hydroelectricity, with very limited advances in biogas.[11] Surprisingly, this structure has not evolved favorably *vis-à-vis* 25 years ago, when the first measures to substitute traditional energy sources with renewable ones were put in place. In 1986, thermal power stations were the source of 62.6 percent and hydro-electric plants, 30.7 percent —25 years later they had lost 13 percentage points—; coal plants, 4.2 percent; and geothermal-electric plants, 2.5 percent.[12]

Although since the 1990s Mexico has had nuclear-generated electricity, its weight in effective productive capacity has been declining (from 4 percent in 1995 to 2 percent in 2009). At the same time, thermoelectric plants increased their part of the pie by 8 percentage points between 1986 and 2009, moving away from dependence on fuel oil toward using nat-

GRAPH 1
PRODUCTION OF CRUDE OIL BY REGION AND OVERALL ASSETS
(MILLIONS OF BARRELS PER DAY)



* The ATG asset information is official as of 2008, when its associated fields were dis-incorporated from the Poza Rica-Altamira Comprehensive Asset.
(1) Official information as of 2008; its associated fields were dis-incorporated from the Poza Rica-Altamira Comprehensive Asset.
(2) Does not include ATG.
Source: Sener (Ministry of Energy), *Estrategia nacional de energía 2012-2026*, Mexico City, 2012.

ural gas, which Mexico produces less and less of, thus needing to increase its imports. In the field of renewable energy, geothermal electricity represents 1.6 percent of effective capacity (one percentage point less than in 1987); and electricity produced by wind, which in 1986 did not exist, by 2009, already represented 0.8 percent. It should be underlined that this sector not only has had the highest growth in the industry in the last decade, but that its prospects for development have increased due to the strong winds that blow across states like Baja California and Oaxaca. This has combined with the interest of several Spanish and U.S. firms in this sector. Among them are Renovalia Energy, a Spanish firm operating in Oaxaca through its subsidiary Desarrollos Eólicos Mexicanos, and U.S.-based Sempra Energy, which operates in Baja California and in addition has a subsidiary, Energía Costa Azul, which owns a natural gas regasification plant in Ensenada, Baja California, which imports gas from the United States.

Another important point is that, of the existing 60 440 mw effective capacity, two-thirds are controlled by the CFE and the rest by private companies. Of the latter, most is sold to the CFE for distribution in the national electricity system (19 percent of the total) and the other 14.4 percent is consumed by the producers (6.9 percent), is jointly generated (4.6 percent), goes into continuous use by the producers (0.7 percent), or is destined for export (2.2 percent).[13]

COMPOSITION OF THE DEMAND

In 2010, Mexico's national energy consumption came to 8 151 petajoules, with an average annual growth rate of 2.0 percent beginning in 2000. Of that amount, 60.6 percent goes into final consumption, which had an average annual growth rate in the same decade of 1.7 percent; the other 39.4 percent went into intermediate consumption, which grew at an average of 2.5 percent. By sector, the energy sector itself absorbs four-fifths of intermediate consumption and 32.1 percent of overall national consumption. This is followed by the transport sector, with 27.6 percent of total consumption. Industry absorbs 16.8 percent, and the residential, commercial, and public sectors, 11.2 percent. Surprisingly, despite taking into account the consumption of firewood, the agricultural sector only absorbs 1.8 percent of the total, although 23 percent of the population resides in rural areas.

If this demand structure is compared to the one that existed three decades ago, what is surprising is how little it has

changed: both then and now, the energy sector is the country's main consumer of energy, and not all of it is used efficiently. It is followed by transportation, industry, residential, commerce, and the public sector, which has raised its consumption over that period by about three percentage points, and agriculture, which not only continues stagnant, but has even contracted its consumption by a few tenths of a percentage point.

Secondary energy production in 2010 was 5 263 petajoules, with refined fuels making up 55.1 percent of the total, followed by dry gas, with 26.3 percent. If we add solid combustibles (1.9 percent of the total), among which coal is the leader, we can deduce that hydrocarbons represent a whopping 83.3 percent of the total consumption of secondary energy. That is, electricity only represents the other 16.7 percent, a figure that has remained the same for decades and even tends to decline. This contrasts with the structure of the demand in other countries, particularly developed nations, where energy consumption per product unit is substantially greater, and electricity represents a very high percentage of secondary energy consumption. This reflects greater energy efficiency and better distribution in the use of the energy produced. Thus, for example, in 2007 in the United States, per-capita electricity consumption was 12 747 kilowatt/hours (kw/h); in Spain, 6 818.8 kw/h; in Chile, 3 518 kw/h; in China, 2 584.9 kw/h; and in Brazil, 2 116.7 kw/h. Meanwhile, Mexico, with the world's thirteenth largest GDP, only consumed 1 858.3 kw/h, putting it in 104th place worldwide.[14]

Foreign Trade

Clearly there is a great difference between total primary energy production presented in the previous section (9 251 petajoules) and the country's energy consumption (8 151 petajoules). The 1 100 petajoule difference can be explained by net exports (1 635.5 petajoules) and operational losses (-535.5 petajoules). However, we should make some very important observations: the country has a very high primary energy surplus (2 966.6 petajoules), but the secondary energy deficit is a concern. The first is the case because crude exports came to 3 167.7 petajoules and net coal imports only came to 201.1 petajoules. However, secondary energy showed a deficit of 1 333.1 petajoules, which can be explained, in order of importance, by net imports of gasoline and naphtha (635.7 petajoules), dry gas (492.7 petajoules), fuel oil (231 petajoules), liquid gas (122.2 petajoules), coke (92.1 petajoules), and kerosene (5.4 petajoules), and by the net exports of fuel oil (231 petajoules) and electricity (3.3 petajoules).

In terms of barrels, exports of crude oil came to 1 338 million barrels a day (MBD) in 2011; in 2004 they had been 1 870 MBD. However, thanks to the increase in international crude prices between 2002 and 2011, hard currency earnings rose from US$13.39 billion in 2002 to US$49.32 billion in 2011. On the other hand, net imports of refined oil products (gasoline, diesel fuel, oil fuel, liquid gas, and others) soared from 88 MBD in 2002 to 493.4 MBD in 2011, worth US$1.31 billion and US$23.19 billion respectively.

Clearly Mexico has not concerned itself with increasing its specialization in the production and export of raw materials in the first 12 years of the twenty-first century, despite the fact that the increase in its imports of derivatives has been more than proportional. This can be seen in the fact that it has not built new refineries; the last one built, in Salina Cruz, Oaxaca, dates from 1979. It has also opted for increasing its consumption of natural gas, used both for dual centers and vehicular transport,[15] without taking into consideration that the production of this type of energy peaked in 2009 at 7.03 billion cubic meters per day, and since then, by mid-2012 has declined 9.0 percent.

This has brought Mexico's hydrocarbon industry to a critical point: proven reserves of oil, gas, and gas liquids have dropped consistently since 1987, when they came to 69 billion barrels of crude oil equivalent (BBCOE), to 13.8 BBCOE in January 2012. What is needed now is to explore the ocean floor and pump crude out of low-yield areas like Chicontepec. This means that Mexico has left behind the era of cheap oil and gradually seems to be distancing itself from the possibility of continuing to create exportable surpluses. As a correlation to this, Pemex's investments in exploration have stayed very high: between 2004 and 2011, they came to between US$19 billion and US$34 billion a year at constant 2011 prices. This has pushed up the deficit in public finances, and the trend is that they continue to rise in coming years.

The country regressed enormously in the development of non-fossil forms of energy between 1999 and 2010, and it will take several decades to recover.

Financial Situation

In terms of sales, Mexico's first and fourth largest companies billed 13 percent of the country's GDP in 2011 (Pemex, Mex$1.55 trillion, and the CFE, Mex$291.9 billion, according to *Expansión* magazine.[16] However, their company reports show that only Pemex made operational profits (Mex$681.4 billion). The CFE suffered losses to the tune of Mex$27.1 billion, associated above all to absorbing the Central Mexico Light and Electricity Company (LFC), dissolved by the federal government in 2009. Once their taxes were paid to the federal government and federal government transfers made back to them, Pemex registered net losses for Mex$91.5 billion, and the CFE for Mex$17.2 billion.

Despite the rather more unfavorable circumstances of the CFE versus Pemex, the latter's liabilities/assets ratio was 111.2, with its liabilities in 2011 valued at 11.2 percent more than its assets, or a negative Mex$193.9 billion. The CFE's liability/asset ratio was 0.654 in the same year; that is, its liabilities were 34.3 percent less than its assets of Mex$313.2 billion. Finally, debt per worker came to Mex$11,448 in Pemex and Mex$6,029 in the CFE. All these figures suggest that Pemex is in deplorable shape, which might well serve to justify more privatization in the oil industry. However, most of the growth of Mexico's Central Bank international reserves since the beginning of the century can be explained by the money contributed by Pemex to the economy. One-third of federal tax earnings come from it, and 10.7 percent of the GDP is explained by Pemex's total sales.

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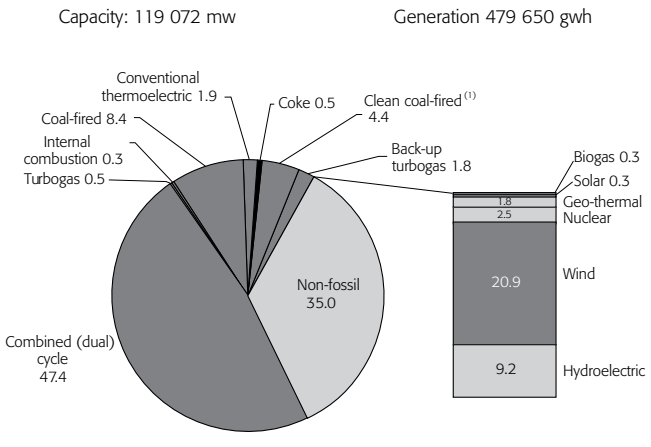
GRAPH 2
GOVERNMENT PROJECTION OF GROSS ELECTRICITY GENERATION (2026) USING RENEWABLES (PERCENT)



(1) Coal-fired electricity with CO_2 capture and sequestration.
Source: Sener (Ministry of Energy), *Estrategia nacional de energía 2012-2026*, Mexico City, 2012.

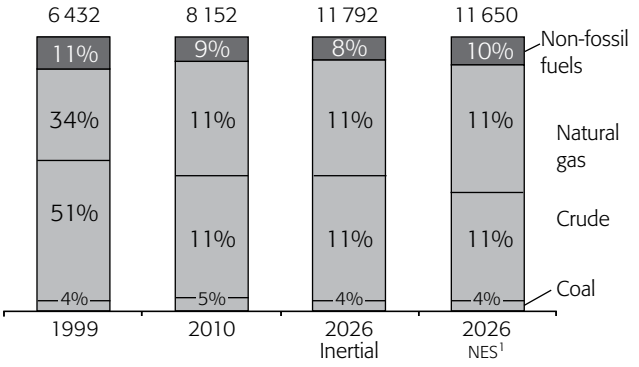
Perspectives and Conclusions

All official predictions since the 1980s have promised the country a reorientation of electric energy production toward alternative sources, from hydroelectricity and nuclear-generated electricity to renewable sources. This has been presented as the first step toward reaching an energy balance that is less dependent on hydrocarbons, better for the environment, and capable of taking advantage of the country's energy potential. However, to a great extent, the situation today is worse than it was 30 years ago. In the first place, dependence on both domestic and imported hydrocarbons has increased due to the spread of dual plants, which all use gas and are all operated by private companies, and therefore the greater use of gas as fuel. In the second place, no new nuclear-electric plants have been built, and it is possible that one reactor of the only plant Mexico has, at Laguna Verde, is suffering from operational problems. In the third place, the use of renewable sources has only increased, such as in the case of wind energy, after important investments by private business in Oaxaca and Baja California; the increase in the use of solar energy has been imperceptible; hydro-energy has structurally contracted; and, if we compare ourselves to countries like Brazil, we can say that there has been no advance in biofuels. Therefore, 2012 CFE and Sener predictions that by 2026 non-fossil-fuel energy generation would make up 35 percent seem very optimistic (see Graph 2).

In contrast to this panorama, 2012 Sener predictions regarding the composition of primary energy production seem to reflect the country's inability to change. It is expected that if appropriate energy substitution and savings policies are implemented, the participation of non-fossil-fuel energies in the

GRAPH 3

PRODUCTION OF CRUDE OIL BY REGION AND OVERALL ASSETS
(MILLIONS OF BARRELS PER DAY)



[1] NES stands for National Energy Strategy.

Source: Sener (Ministry of Energy), *Estrategia nacional de energía 2012-2026*, Mexico City, 2012.

gross domestic energy supply will come to 10 percent in 2026, a figure which, paradoxically, will be one percentage point less than that of 1999, as Graph 2 shows. This reflects the country's enormous regression in the development of non-fossil forms of energy between 1999 and 2010, from which it will take several decades to recover.

In other words, the Sener's intention is to intensify its efforts to produce hydrocarbons. It is betting on being able to mitigate the irreversible decline of Cantarell and later on Ku-Maloob-Zaap, the reservoir that peaked in 2012. It is basing its plans on the production of hydrocarbons from the deep waters of the Gulf of Mexico; this implies a titanic technological effort, in the event that crude oil is even found, since by mid-2012, of the 19 wells drilled in the area that Pemex calls "Mexico B," only one of them hit gas, after an investment of Mex$20.99 billion.[17]

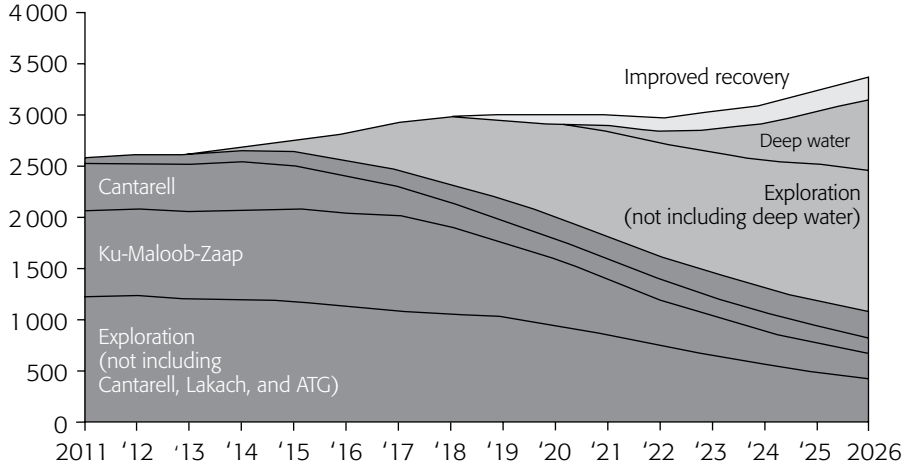
But gas is not exactly the energy Pemex and the exploring companies are interested in finding in that region, given the enormous needs and the international price of oil (see Graph 3).

In addition, hopes for gas extraction are placed on the rich deposits of shale gas inland. No one yet knows what will happen when the decision is made to exploit them since the debate is raging worldwide about their effects on global warming. This is because, if these hydrocarbons are extracted, it is necessary to hydraulically fracture the rock (a process known as "fracking") and it is presumed that this generates very severe environmental transformations (see Graphs 4 and 5).

Fortunately, the country's energy consumption elasticity today is approximately one, which means that the price policies implemented since 2008 have had a certain effect on demand. Now is the time to decidedly transition to the substitution of conventional sources of energy to non-conventional sources, above all renewable ones. In this process, Pemex must stop being the most important source for federal government resources; the export of hydrocarbons must be gradually reduced to insure their existence for domestic use for more years; the sector's research and technology development institutes

GRAPH 4

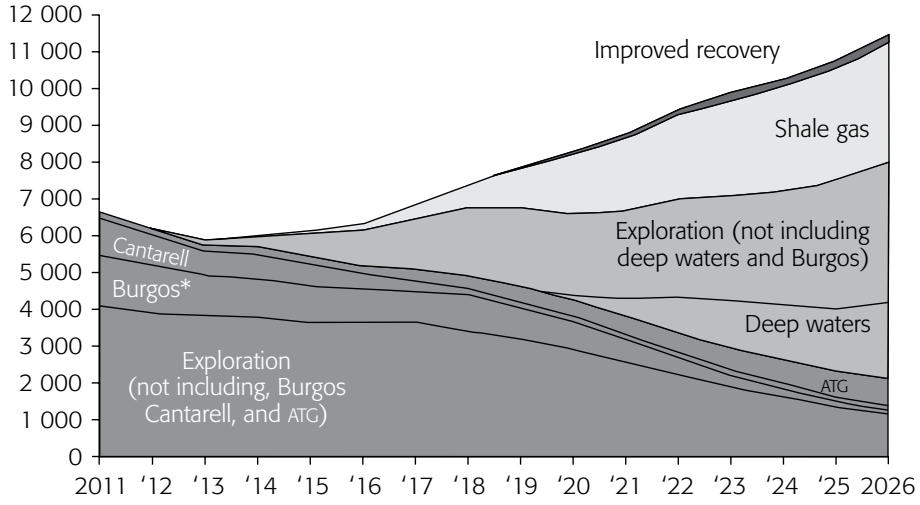
GOVERNMENT PROJECTION OF CRUDE OIL PRODUCTION BY LARGE PROJECTS (2012-2026)
(MILLIONS OF BARRELS PER DAY)



Source: Sener (Ministry of Energy), *Estrategia nacional de energía 2012-2026*, Mexico City, 2012.

GRAPH 5

GOVERNMENT PROJECTION OF NATURAL GAS PRODUCTION BY LARGE PROJECTS (2012-2026)
(MILLIONS OF CUBIC FEET PER DAY)



Gas production does not include nitrogen.
***Includes financed public works contracts (COPF).**
Source: Sener (Ministry of Energy), *Estrategia nacional de energía 2012-2026*, **Mexico City, 2012.**

must be promoted; and investment must once again be channeled into refining and primary petrochemical plants to reduce our dependence in these areas and strengthen the country's industrialization. VM

FURTHER READING

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NOTES

[1] Lorenzo Meyer, "El desarrollo de la industria petrolera en México," in Enrique Cárdenas, comp., *Historia económica de México*, readings from *El trimestre económico* no. 64, vol. 4 (Mexico City: FCE, 1994).

[2] Regulations for the oil industry date from 1958 and were last modified in 2008; for the electricity sector, they date from 1975 and were last changed in 2012; and for nuclear energy, from 1985, and were last changed in 2012.

[3] PMI Comercio Internacional is part of the PMI Group, made up of 11 different companies: PMI Comercio Internacional, S.A. de C.V.; PMI Holdings Petróleos España, S.L.; PMI Holdings B.V.; PMI Norteamérica, S.A. de C.V.; PMI Trading, Limited; PMI Marine, Limited; PMI Services North America, Inc.; Pemex Services Europe, Limited; Pemex Internacional España, S.A.; PMI Holdings North America, Inc.; and PMI Services B.V.. See http://www.pmi.com.mx/onepage/public/pmi_english.jsp.

[4] Some of Repsol's subsidiaries and/or partners, all for-profit corporations, are Gas Natural México, Gas Natural Vehicular El Norte, Gas Natural Servicios (distribution), Comercializadora Metrogás, Unión Fenosa, México Unión Fenosa Cogeneración, Fuerza y Energía de Naco Nogales, Transnatural, Central Anáhuac, La Propagadora del Gas, Fuerza y Energía de Tuxpan, Fuerza y Energía del Norte de Durango, and Fuerza y Energía BII Hioxo.

[5] A duopsony exists where there are only two buyers for a good or service. It is analogous to the duopoly, except the latter involves supply, while the duopsony involves demand. [Editor's Note.]

[6] See www.inin.gob.mx.

[7] Gobierno de México, "Decretos de la reforma energética," *Diario oficial de la federación* (DOF), November 28, 2008.

[8] A petajoule is equivalent to 10^{15} joules, and 210 joules is the equivalent of 50 megatons of TNT, the amount of energy produced by a Tsar bomb, which caused the biggest nuclear explosion known to humanity.

[9] Sener, *Balance nacional de energía 2010*, 2011, www.sener.gob.mx.

[10] Comisión Nacional de Hidrocarburos (CNH), "Producción de hidrocarburos por regiones," 2012, www.cnh.gob.mx.

[11] Extenda, "El sector de las energías renovables en México," Oficina de Promoción de Negocios en México, October 2011.

[12] Roberto Gutiérrez R., "La reforma petrolera de México: ¿Dos sexenios sin política energética?" *Argumentos* no. 58, September-December 2008.

[13] Extenda, *op. cit.*

[14] EIA (Energy Information Administration), 2012, www.eia.gov.

[15] Dual centers are thermoelectric plants that reutilize the steam produced from heating the water, unlike the others, which release it into the atmosphere. [Translator's Note.]

[16] "Las 500 empresas más importantes de México," *Expansión*, June 2012.

[17] Atzayaelth Torres, "Exploraciones fallidas," *Excélsior* (Mexico City), July 3, 2012.