



A QUARTERLY JOURNAL FOR DEBATING ENERGY ISSUES AND POLICIES

This issue of the *Oxford Energy Forum* is devoted to Mexico's recent energy sector reforms. The reforms were designed to open up the country's energy sector to international and local private players, inject competition, provide new partnering opportunities for PEMEX, establish new markets domestically, and potentially strengthen Mexico as a key link between the American and international markets for energy trade. However, these landmark reforms – which have significant implications for the country's overall economy and the role of Petróleos Mexicanos (PEMEX), the state oil company that hitherto dominated its energy sector – are also not entirely without wider economic implications which need to be carefully considered as the country moves forward. This issue presents a spectrum of views on energy sector reforms in a country that continues to be important to both the regional and international energy systems.

The issue opens with two articles presenting an overview of the reform and of the general challenges. *Aldo Flores-Quiroga* provides a general overview, from a government perspective, of the reform, arguing that well-functioning markets require a set of conditions including:

- clear rules of the game,
- strong property rights,
- unhindered information flows,
- low barriers to entry and exit,

- enough buyers and sellers to sustain a competitive process of price formation.

He argues that the government has paid considerable attention to the sequence, pace, and transparency of implementation, which are key for the credibility of the new investment regime and for maintaining the trust of the Mexican people. 'Shock therapy' – liberalizing everything at once – might be attractive in theory but is inadvisable due to market rigidities or the need to secure the social licence before launching new projects. The author summarizes the approach to upstream, midstream, and downstream reforms, emphasizing that these will be an incremental and gradual process, where investments are made for reasons that go beyond market liberalization and the quality of the new policy regime, acknowledging that Mexico constitutes a growing market for energy demand in its own right.

Armando Zamora identifies additional challenges to Mexico's energy sector transformation as the world moves towards a new era of more competitive, technologically-based innovation aimed at achieving the simultaneous goals of universal access, higher efficiency, lower prices, and cleaner sources. He traces the evolution of the sector in Mexico since its nationalization in 1938, arguing that the latest reform lays the groundwork for a transformation consistent with a future scenario of a

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market-oriented energy production, trade, and supply environment. Nevertheless, it will be the extent and depth of the implementation and deployment of the reform – through regulation and the restructuring of existing state institutions and companies – that will determine the degree to which the new players and consumers will achieve the full benefits of innovation, technology, diversification, investments, and consumer choice. The author identifies five major obstacles that need to be addressed for an optimal development of the energy reform:

- a level of financial dependence between the government and the energy sector that makes investment and operating decisions subject to government budget priorities;
- the veiled resistance of the incumbent state-controlled energy companies to relinquishing control over their assets and markets;
- existing political linkages that favour politicians rather than the public;
- the degree of independence of regulatory bodies;
- the disproportionate influence of domestic economic groups.

The issue then moves to four articles that present varied views on the role of PEMEX, which is an integral part of the reform process. In the first of these, *Fluvio Ruiz Alarcón* argues that Mexico's energy reform is reconfiguring the relationships between the Mexican state, PEMEX, and private oil sector operators, and that the new dynamic has already given rise to some tensions between the Mexican state and PEMEX. The author argues that in the name of the 'holy market', the fiscal and regulatory asymmetry between PEMEX and private operators has gone beyond the spirit of the legal framework created in 2013 and 2014, during the implementation of the oil reform, with the economic value of investments made by PEMEX in Round Zero not

having been fully recognized by the government – the author argues that as a result, the economic value to be recognized as being due to PEMEX has fallen from USD4 billion to USD300 million. Furthermore, he argues that the degree of autonomy supposed to be enjoyed by PEMEX, together with some of the benefits it was supposed to receive from the reform, have diminished, while the company's new fiscal regime is in many ways worse than before. The abolition of the formal autonomy of PEMEX, the resistance to recognizing the economic value of its investments, together with the maintenance of an onerous fiscal regime, are three elements which exemplify both the new oil sector dynamics and the changed position of PEMEX within these new dynamics. The author argues that the new relationship between the Mexican state and PEMEX is based on the premise that PEMEX should be weakened in order to 'make room', as fast as possible, for new private players, in order to avoid a reversal of the energy reform.

In the next article, *Luis Vielma* takes a different view, arguing that PEMEX has faced significant changes that demand a new vision and strategy to turn it into a productive asset that adds value to the state. The company currently faces several problems. On the upstream side:

- reserve replacement has been below 100 per cent for over 10 years,
- the company has suffered high decline rates from mature fields that account for more than 80 per cent of its active assets,
- there has been a slow pace of development of new fields.

There are other factors relating to:

- downstream inefficiencies,
- the dimension of the workforce size, or payroll.

The author reflects on experience from other state oil companies such as

Petrobras and PDVSA. These companies have generally followed three 'steps' to turn their operations around, including:

- an initial review of the different assets – then set the pace to sell, lease, and outsource all the subsidiaries not related to the oil business;
- a review of the oil portfolio to find out what percentage of the oil fields are unproductive, and in fact are cost centres – then close those fields and build the portfolio only with the assets that create value;
- retire personnel that do not have a position tied to a process sustaining any of the assets selected for the portfolio, helping to reduce the non-productive payroll.

The author analyses in detail several options to turn PEMEX into a major force, culminating with a medium-term (three year) plan to go to the market, in order to transform PEMEX into a semi-public international company, with the necessary competence and transparency to be successful around the world.

Adrian Lara then analyses PEMEX's *farmout strategy* – a special type of joint venture where the bulk of initial capital expenditure is carried out by a partner – which suits PEMEX's restricted cash liquidity. In all cases, the area offered for such a venture would include already discovered or producing fields and might even have initial infrastructure, thus requiring only an additional influx of capital investment before first oil. However, the author argues that even in a scenario where PEMEX is successful in completing its farmout schedule, it is likely that the company's production will at best grow by no more than 200 thousand barrels a day (kb/d) in the short term. The company expects to reach 2.19 million barrels a day (mb/d) of crude oil output by 2021 from its current 2 mb/d (at the end of the first quarter of 2017). Although this would, no doubt, be the



desired trend going forward, it is still a modest growth and significantly far from its 2004 peak production of 3.4 mb/d. Nevertheless, he argues that it is the upstream segment of PEMEX that has the greatest potential among the company's divisions, as downstream and petrochemical operations have a more challenging outlook since they have to reverse operational losses of close to USD5.23 billion and are having more difficulty in attracting other companies to form joint ventures.

In the next article, *Lourdes Melgar* focuses on the upstream reform, arguing that the new framework aims at attracting state-of-the-art technology and investment, through the creation of competitive energy markets and auctions of oil contracts. It defines a new institutional arrangement in which regulators play a central role as keepers of the process. Yet, Articles 27 and 28 of the constitution bestow significant power on the state in the governance of hydrocarbon resources. She argues that the awarding variable is an economic one with two components: increase in royalty (for licence contracts) or government share (for production sharing contracts) and additional work commitment, with no negotiation or room for discretion. The author argues that failing to fully understand the new model plays into the hands of critics who like to suggest that Mexico's upstream opening is a privatization that will lead to a backlash in 2018. She also argues that PEMEX was experiencing difficult conditions prior to the 2013 reform – years of underinvestment, poor management, and shady practices came to the forefront as the company had to undertake a draconian budget cut. At the same time, the reform cannot succeed without PEMEX, as the company holds the most valuable assets – the ones that could allow a rapid turnaround of the downward trend in oil and gas production. She argues that although the transformation of

PEMEX is underway, it will take time for Mexico's state oil company to come back in force.

The issue then moves to three articles which deal specifically with the upstream fiscal regime. First, *José Pablo Rinckenbach* argues that public policy has sought to achieve two conflicting objectives simultaneously: the maximization of Mexico's economic development via the competitive development of the oil sector, and the maximization of government take. The author argues that while the economic model of the contracts developed by Mexico is highly sophisticated and encompasses international best practice, the market environment has undergone a structural change in pricing and technology – particularly with the advent of shale, where the price of oil is set more by demand than by the supply of the commodity, implying lower prices and margins and thus affecting the income for government take. Given the drop in international oil prices and increased pressure on national public finances, fiscal policy in Mexico's oil sector has tended to favour the maximization of tax revenues from PEMEX over the optimization of oil industry development. A lower government take – to enable the development of the oil industry – would contribute to the development of enabling industries (such as construction and services) that would maximize GDP and generate both greater economic benefit and government take at the aggregate level.

Elisabeth Eljuri considers a variety of upstream contracts that are currently being used to provide a good set of conditions for the development of the different areas being offered, taking into account various features of these fields, such as their unique geological profiles and maturity. The author stresses that an alignment between the interests of the state and the investors throughout the life of the contract is key

to ensuring the longevity of upstream contracts; it is therefore in the best interest of the government to avoid future perceptions of unfair imbalances in favour of private operators. At the same time, the government should avoid the temptation – due to windfall profits made by investors after price hikes, or due to savings as a result of the adoption of new technologies – to reverse the reform process. The author lists some guiding principles that the government should follow to ensure both a successful long-term partnership between the state and its investors, and the stability of current reforms.

Rafael Sandra and Ivan Sandra examine the role of mature fields in reversing the decline in Mexican oil production. Mexico has several giant oil fields with high quality reservoirs but the application of improved/enhanced oil recovery (IOR/EOR) has been rather limited. This has been reflected in the overall recovery factor, which remains low in the case of Mexico. A recent CNH (Comisión Nacional de Hidrocarburos) report indicates that EOR can recover an additional 10 billion barrels of oil. But the authors argue that achieving such an ambitious target would require huge investments, which could only materialize if the government provided an attractive incentive structure and contracts that are geared specifically for the development of mature fields.

Adrián Lajous then examines recent developments in the midstream and downstream sectors. He argues that while there has been some success in reforming midstream and downstream natural gas, this has not been matched by developments in the midstream and downstream sectors of the refining industry. So far, these latter sectors have attracted little private investment, while market liberalization is advancing more slowly than originally anticipated. He highlights a number of major issues that need to be resolved for key

objectives to be achieved within the proposed time frame, arguing that policy makers and regulators were unprepared for the greater complexity involved in liberalizing the larger, multi-product, and multi-market refining and marketing industry.

The issue then moves to the recent reforms in the Mexican electricity sector. *Rolando Fuentes* identifies some structural inconsistencies that could eventually hinder the success of electricity reform, not only in Mexico but also in other countries pursuing similar agendas. He argues that liberalizing a centralized electricity system today, with the prospect of near-future penetration of decentralized technologies, raises the question of whether newcomers can leapfrog the standard reform process and, if so, how. He suggests three propositions which are highly relevant to Mexican power sector reform:

- market liberalization and renewable penetration are ultimately incompatible;
- the new focus of business and regulations will be downstream, but the future of retail is uncertain;
- new regulations need to create markets for services that are latent, to avoid permanent transition costs.

He concludes by arguing that Mexico can benefit from being a latecomer in the electricity reform wave, which would allow it to incorporate international best practice, but the government should be fully aware of the macro trends in the power sector.

The final two articles of the issue focus on Mexico–USA energy relations. *Lucian Pugliaresi* argues that the emergence of the North American petroleum renaissance and its reliance upon an integrated North American market is not sufficiently appreciated. He argues that the integrated North American energy market has huge potential for rapid growth, offering both energy security and growing abundance in oil and gas supplies for consumers among all members of NAFTA. He stresses that such a market is especially important for the USA, as it provides a growing market (in Mexico) for higher volumes of US natural gas production and refined products, as well as for exports of advanced oil field services and equipment. He therefore recommends that as negotiations get started on the future of NAFTA, it is essential to have a full understanding of not just trade concerns in the manufacturing sector, but of the long-term economic and security stakes for the USA of sustaining and

promoting full integration of the North American energy market.

Adrián Lajous highlights Mexico's increasing hydrocarbon import dependency on the USA. This dependency is reflected in two main areas: petroleum products and natural gas. The author argues that PEMEX refineries have fallen behind their peers, with product yields deteriorating and throughput diminishing sharply since 2013. Accompanied by an increase in domestic demand, Mexico's imports of petroleum products have consequently increased, with most of these products coming from US Gulf Coast refineries. While products markets are global and Mexico can import from other parts of the world, the author argues that the dependence on natural gas imports is a more serious source of concern. Lajous argues that the potential political and economic crisis associated with a deteriorating bilateral relationship between the USA and Mexico since Trump's election is a warning signal to Mexican policy makers, stressing that the government should review the assumptions under which they have operated for years, and urges the government to consider alternative strategies that strike a better balance between economic and security of supply objectives.

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Making oil market reform work in Mexico

Aldo Flores-Quiroga

Much has changed in Mexico's oil and gas industry since 2014, when historic reforms ended PEMEX's 80-year old monopoly and opened the door to private sector participation. PEMEX is no longer the country's sole E&P operator, but one among 54 companies from all continents seeking to find and produce oil. Private firms are expanding the country's natural gas pipeline system, while 24 firms have begun to participate in the natural gas market through competitive supply and purchase contracts. Projects to increase storage and transportation for refined products are under way. In retail, the days of a single gasoline brand are gone, with growing differentiation picking up speed as 12 new brands compete with PEMEX. In each and every segment of the hydrocarbons sector, from oil exploration to retail sales, new markets are emerging.

To get to this point the government has been working on multiple fronts. Functioning markets require, at least:

- clear rules of the game,
- strong property rights,
- unhindered information flows,
- low barriers to entry and exit, and
- enough buyers and sellers to sustain a competitive process of price formation.

Mexican authorities have crafted regulations to ensure that the rules for doing business and the rights of public and private actors are clearly defined. Newly minted and strengthened institutions have specific mandates that separate the roles of policymaker, regulator, and producer. New laws and procedures guarantee open access to public information on the sector's performance. Also, the anti-trust authority has new powers to prevent

the still dominant PEMEX from exercising its monopoly power.

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'IN EACH AND EVERY SEGMENT OF THE HYDROCARBONS SECTOR, FROM OIL EXPLORATION TO RETAIL SALES, NEW MARKETS ARE EMERGING.'

The government has paid considerable attention to the sequence, pace, and transparency of implementation. These are key for the credibility of the new investment regime and for maintaining the trust of the Mexican people.

Constitutional and legal safeguards, along with the institutions to guarantee their observance, were established before inviting private sector participation. Competitive and transparent processes have allocated exploration and production rights in upstream areas (private ownership of reserves is not permitted under Mexico's constitution) and property rights in mid- and downstream activities. To the extent possible, liberalization of output markets has advanced in tandem with that of input markets, through a gradual approach. Shock therapy – liberalizing everything at once – might be attractive in theory but it's hardly advisable in our circumstances, due to market rigidities or the need to secure the social licence before launching new projects. In any event, adjustment costs are usually lower under a gradual approach.

Muddling through has been at times inevitable. The scope, depth, and speed of this reform includes every market segment, type of fuel, pipeline system, storage tank, and pricing mechanism. Moreover, just about every authority is playing a role in its implementation. It is impossible to plan for every contingency – new realities

emerge on the ground as each of these markets is opened up. While keeping to its strategy, the government has made tactical adjustments to take into account new information from companies, civil society, and local communities. The private sector provides valuable feedback on market conditions, regulatory insufficiencies, and red tape excess. Constant contact with NGOs and communities has contributed to identifying salient social and environmental issues that companies and authorities must address.

Upstream reform: an incremental process

Upstream, implementation has progressed in incremental steps, taking note of results from auctions and adjusting the strategy where required. Mexico lacked a model contract for E&P activities beyond PEMEX at the outset. For this reason, the country's energy authorities selected a limited amount of blocks per auction, taking time to develop new contracts for onshore and offshore activities. The first auction of shallow-water blocks showed that some of the financial requirements imposed on companies were too stringent and that the minimum production share the government expected to receive had to be published in advance. (Otherwise, companies wouldn't know whether their bidding positions were too low.) Similarly, the first auction of onshore fields demonstrated that without a cap on additional royalty rates companies could overbid, increasing the risk for potential projects. It also revealed that the tariff structure for oil transport through PEMEX's infrastructure (in most areas the only route available) was inadequate, because it could turn otherwise profitable projects into losing ventures. This prompted a revision

of contractual terms and greater coordination between PEMEX, the Ministry of Energy, and the National Hydrocarbons Commission to ensure that the whole business ecosystem for oil and gas production works appropriately.

The model contract for the first auction of deepwater blocks incorporated these lessons with considerable success. Most of the world’s major oil companies participated and committed potential investments of up to USD41 billion. Significantly, PEMEX competed in this auction, in consortium with Chevron and Inpex, and gained rights to a block through a competitive process for the first time in its history. Another first was the successful auction to find a partner for a PEMEX farmout, won by BHP Billiton with an additional investment of USD8 billion.

The accumulated learning from these auctions now makes it possible to consider standardizing and scaling up the auction process. The latest Five-Year Plan includes over 500 offshore and onshore blocks, which will be presented in auctions designed to cover a greater surface area. This will align Mexico with international practice, increasing its competitiveness and creating incentives to expand exploration and production in new areas.

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‘THE ACCUMULATED LEARNING FROM THESE AUCTIONS NOW MAKES IT POSSIBLE TO CONSIDER STANDARDIZING AND SCALING UP THE AUCTION PROCESS.’

Midstream reforms – geared towards efficiency

Midstream, the first step was to take the natural gas pipeline system away from PEMEX’s control, and to put an autonomous system administrator in charge of its operation and supervision. This administrator held two open

seasons to allow private companies to reserve transportation capacity and set a market price for tariffs. Also, the Energy Regulatory Commission required PEMEX to relinquish up to 70 per cent of its supply contracts with the private sector and issued a decision to free natural gas prices. In addition, companies are under an obligation to provide information on production, consumption, and related flows. A more efficient natural gas market is thus developing with clearly established property rights, more market participants, free prices, and better information.

Downstream reform: crucial to ‘get it right’

Downstream, the government chose a gradual process to phase out gasoline and diesel price controls. A schedule known to all interested participants and the public specifies the dates when prices will be liberalized in each of the five main market regions. To create competition in storage and transportation, PEMEX is required to run an open season in each region to allow private companies to bid for the right to reserve a share of existing capacity. The process started early in 2017 in the north-west, where infrastructure on the US side of the border can support market development on the Mexican side, and it will conclude by the end of the year, when the last of the five regions is liberalized. By then, the market for these fuels will be completely free.

As Mexico’s oil industry moves from monopoly to market, the government has recognized that its emergency supply policy must also change. PEMEX remains the supplier of last resort, holding fuel inventories to cover just three days of consumption. With new market participants and a less dominant PEMEX, security of supply must be a responsibility shared by all companies. A new policy requires

companies to hold a minimum of 10–15 days of inventories. Companies are expected to comply with this requirement within the next 10 years. A similar policy is currently under development for natural gas markets.

Conclusions: transformation through gradual reform

Many more changes will transform Mexico’s petroleum industry in the space of five to 10 years. A careful balancing act will be required to ensure that, as PEMEX’s monopoly disappears, the oil and gas supply chains work smoothly. Removing every obstacle will call for constant and sustained coordination among several agencies at the federal, state, and local level. By the end of 2017, the oil and gas industry will be completely liberalized, but additional fine tuning of the strategy and its associated policies will no doubt be necessary.

When Mexico launched its reform and the oil price was high (in 2012), some observers were surprised and noted that it is uncommon for a country to open up its oil industry when potential revenues are also high. They were even more surprised when the first upstream auction was launched despite a low oil price (2014), because in such a situation companies tend to be cash strapped, making it difficult to attract the best bids in an auction. But Mexico decided to open its oil and gas industry because it makes sense. Competitive and transparent markets are better regardless of the price environment. Mexico’s fiscal regime has built-in mechanisms to adjust the government’s take depending on the oil price level. If and when oil prices return to a higher level, Mexico will be in a good position

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‘BY THE END OF 2017, THE OIL AND GAS INDUSTRY WILL BE COMPLETELY LIBERALIZED ...’



to compete and attract investments. Moreover, Mexico's success so far demonstrates that the price cycle is but one factor influencing company strategies upstream.

It is tempting to say that market liberalization and the quality of the new policy regime have been instrumental in attracting investments to Mexico's petroleum industry. Yet a balanced perspective must acknowledge that companies are investing in Mexico's energy sector for additional reasons.

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'MEXICO IS ONE OF THE BEST-VALUE PROPOSITIONS FOR THE OIL AND GAS INDUSTRY AROUND THE WORLD.'
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A large share of the country's potentially vast oil and gas resources remains untapped. Mexico is a large market on its own. It is the world's twelfth largest market economy, with a manufacturing sector that grows in size and sophistication. It offers a business platform supported by a network of free

trade agreements that allows unimpeded trade in virtually all continents. Its population is growing along with its income level, making it one of the few emerging countries where demand for energy continues to increase. Put simply, Mexico is one of the best-value propositions for the oil and gas industry around the world. The evidence so far is encouraging. The opening has been sufficiently credible to attract investment commitments of up to USD74 billion through the entire petroleum value chain.



Structural challenges in Mexico's energy sector transformation

Armando Zamora

Mexico's Energy Reform of 2013 not only released an immense network of energy-related industries from the hands of a few political groups of nationalistic orientation, but also relieved the government finances of an unsustainable burden, as the world moves to a new era of more competitive, technologically-based innovation aimed at achieving the simultaneous goals of universal access, higher efficiency, lower prices, and cleaner sources.

This article examines the alternative paths that the Mexican energy sector faces in adapting to future industry structure and market scenarios, and the impact that the reform is having in the deconstruction of the former state monopoly, laying the foundations for a totally different system from the one Mexicans have known for the best part of the last century.

A state monopoly no more

The state monopoly that was established following the nationalization of the petroleum industry in 1938 may have had its origins in the deterioration

of relations between multinational companies and the particularly unfavourable administrative practices perceived as being damaging to workers, wider communities, and the government.

Massive technological developments in the energy sector at the time gave large integrated western multinational companies an unprecedented advantage in the exploitation of petroleum resources all along the value chain *vis-à-vis* the Mexican state as the owner of the resource. This created insurmountable disadvantages to local players that had no tools to compete in these new, massive businesses.

The Mexican government, just like other governments in resource-rich countries outside the USA and Europe, had few resources to confront the dominant and powerful multinational companies that not only had access to unlimited financial resources, but also enjoyed the support of their governments (who had diplomatic, intelligence, and military bodies at their disposal). The 1938 petroleum nationalization had practical and symbolic value in

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'THE 1938 NATIONALIZATION HAD PRACTICAL AND SYMBOLIC VALUE IN REAFFIRMING THE PRIDE AND THE INDEPENDENCE OF THE MEXICAN GOVERNMENT ...'
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reaffirming the pride and the independence of the Mexican government from foreign powers.

With a much-evolved world political panorama in 2013, and especially in North America after almost 20 years of free intraregional trade under the NAFTA, as well as the emergence of capable state institutions to control powerful multinational and national companies, the fundamental reasons that had justified the nationalization of 1938 had all but disappeared. On the contrary, the capture of the monopoly by politicians, together with the perceived corruption and inefficiency of the energy operators and, more importantly, the financial unsustainability of the monopoly (due to the need to maintain subsidies and sustain large investments), all called for a reversal of state control for such a



The third WEC alternative scenario, called *Hard Rock*, is driven by protectionist and nationalistic policies, with security of supply, energy independence, and local content as dominant drivers, both in producing and consuming countries. The main players would be governments, state companies, and local companies, chosen by the governments.

The Mexican Energy Reform, or *Reforma Energética*, lays the groundwork for a transformation consistent with the *Modern Jazz* scenario of a market-oriented energy production, trade, and supply environment. Nevertheless, it will be the extent and depth of the implementation and deployment of the reform, through regulation and the restructuring of existing state institutions and companies, that will determine the degree to which the new players and consumers will achieve the full benefits of innovation, technology, diversification, investments, and consumer choice.

Mexico’s options

For each of the possible scenarios that the future may bring, there will be an optimal internal market design for Mexico. Under the reasonable assumption that the most attractive scenario for the world is the *Unfinished Symphony*, followed perhaps by *Modern Jazz*, the best option would be to adapt the regulatory deployment for such scenarios as fast as possible and in a way that allows the adoption of the new business models that are being developed in all corners of the world in anticipation of these futures.

Future business models are not easy to predict, but following the example of innovations and digital transformations in other industries, some dominant trends can be identified to illustrate the types of novelties that can be expected. The World Economic Forum exercise

gives a glimpse of those possible future models involving, among others, the digital-based revolution of production processes or the development of better services for final customers.

In all scenarios, the transformation of the energy industry requires that the existing infrastructure still under control of the state is transferred to capable operators – in those cases where the state lacks the resources or the capabilities to maintain, operate, and modernize.

As an example of the slow progress in this respect: the first open season for access to transport capacity for liquid products took place only this year, three years since the enactment of reform. The results were disappointing for aspiring players as most of the capacity was retained by the transportation subsidiary of *Petróleos Mexicanos (PEMEX)*, which maintained a dominant position in the transport of their own products to distribution centres. A more competitive arrangement for opening spaces to new players should separate the transport activities from those other activities at either end of the pipelines, so that transport is free of dominant positions or cross subsidies.

Major challenges

The road to a future of open and equal access for new players – a future that brings innovative approaches, management capabilities, and financial resources, so that the Mexican markets can best adapt to future energy scenarios for the benefit of consumers and the most efficient operators – requires appropriate regulation and a restructuring of the state companies that dominate the market.

Beyond the specific details of market design that should govern the regulatory deployment, but are beyond the scope of this discussion, there are

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‘... OPEN AND EQUAL ACCESS FOR NEW PLAYERS ... REQUIRES APPROPRIATE REGULATION AND A RESTRUCTURING OF THE STATE COMPANIES THAT DOMINATE THE MARKET.’

five major obstacles that need to be addressed for an optimal development of the Energy Reform:

- 1 *The financial dependence between the government and the energy sector that makes investment and operating decisions subject to government budget priorities.* This affects the independence of the energy institutions and their capacity to deploy the necessary resources on maintenance, modernization, and growth projects; it has also generated a growing backlog that negatively affects the quality and reliability of energy supply and the integrity of the asset base.
- 2 *The veiled resistance of the incumbent state controlled energy companies to relinquish control over their assets and markets.* The benefits of the reform can only be realized if incumbent players undertake the required transformations to reposition themselves appropriately within the new landscape. So far, after three years of the reform, progress has been rather slow, and the restructuring of the most important state companies has only seen some form of progress on paper. The rotation of top managers at *PEMEX*, for example, has been excessive. No major repositioning can make steady progress in the absence of stable and well-coordinated leadership.
- 3 *The existing political linkages that favour politicians rather than the public.* The political links between energy institutions, regulators, congress, and government that drive the selection of senior officers and directors, as well as other key

personnel in the most important state institutions, and influence the selection of their strategic direction, better serve the political masters than the public at large and prevent progress on key strategic objectives and the continuous improvement of the energy production and supply systems.

4 *The degree of independence of regulatory bodies.* The lack of political independence of regulatory bodies and their vulnerability to political pressures (including the risk of personal liability for administrative decisions) only contributes to slowing down the objectivity of, and opportunities for, administrative choices. The structure of regulatory governance gives some independence to the regulators, but key decisions are ultimately taken by government ministries. For example, the National Hydrocarbons Commission (or Comisión Nacional de Hidrocarburos, CNH) is subject to the decisions of the ministries of energy, finance, and economy on the most important decisions for resource development – such as the design and timing of bidding rounds, the choice of contract and their terms

and conditions, or the fiscal terms.

5 *The influence of domestic economic groups.* This has been historically significant in Mexico, as the experience of reform in the telecommunications sector shows. For the energy system to open spaces to the best and the more efficient providers of innovative solutions, know-how, and capital, the authorities should ensure that all areas of the value chain are open to the best actors under conditions of transparency and equal access, irrespective of national origin or political affinity.

- Finally, the presence of the energy sector across different and difficult geographical regions requires assurances of security and protection from threats posed by illegal groups. The dominant presence of such groups in some regions is no secret, and the growing problem of extortion and the theft of energy products is a major cause of concern to those

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‘THE ENERGY REFORM OF 2013 MARKED THE END OF AN OLD MODEL OF ENERGY SUPPLY ...’

companies that aspire to enter the business and would need to be present across the Mexican geography.

Conclusion

The Energy Reform of 2013 marked the end of an old model of energy supply and the exploitation of a rich natural resource for the benefit of the government but, more importantly, it set the foundations for the transition to a modern energy industry. However, and notwithstanding the breath and scope of the reform, it was only the beginning of a long and difficult road to modernity, plagued by obstacles and challenges.

As the world energy industry moves forward, by undergoing a fast and massive transformation, Mexico has a unique opportunity to deconstruct the old model and embrace the new and innovative business models that are being developed across the world, to benefit both consumers and the environment. However, this can only take place to the extent that the government and its institutions address the fundamental barriers and challenges that the replacement of old institutions and state companies implies.



The Mexican state and PEMEX: building a new relationship

Fluvio Ruiz Alarcón

The implementation of the Energy Reform in Mexico is reconfiguring the relationships between the Mexican state, Petróleos Mexicanos (PEMEX), and the private operators of the oil sector. The new relationships will be very important for reshaping both the regulatory framework and the fiscal regime, and the implications will extend beyond the oil sector, given the importance of the oil sector to the Mexican economy and government

finances. One of the most important challenges accompanying the entry of new actors and liberalized markets will be the maintenance of a coherent set of public policies within a decentralized decision-making framework. The new

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‘... THE GOVERNMENT IS LOOKING TO WEAKEN, AS QUICKLY AS POSSIBLE, BOTH THE POSITION AND THE ROLE OF PEMEX ...’

dynamics of the sector will be shaped by the legal framework, economic expectations, production goals, and political negotiations about the best way to achieve the goals of the reform.

As a result of this new dynamic, some tensions have already appeared between the Mexican state and PEMEX. It seems clear that the government is looking to weaken, as quickly as possible, both the position and the role of PEMEX in the new



model. In the name of the 'holy market', the fiscal and regulatory asymmetry between PEMEX and private operators, has gone beyond the spirit of the legal framework created in 2013 and 2014, during the implementation of the oil reform. Furthermore, as this article argues, the degree of autonomy supposed to be enjoyed by PEMEX, together with some of the benefits it was supposed to receive from the Reform, have diminished, while the company's new fiscal regime is worse than before.

Round zero: the tied hands of PEMEX

The first step of the Energy Reform in the oil sector was the so-called Round Zero. According to the constitutional reform of 2013, PEMEX had 90 days to decide which exploration areas it would request from the Energy Minister to keep as part of its portfolio – this would be a key determinant of its future performance. Despite the importance of this request (a key decision that could shape a sustainable geological portfolio), in a split vote, and following a proposal by the government, the board of PEMEX decided to delegate this responsibility to a Strategy and Investment Committee. (This committee comprised five members: four government officials and only one independent board member.)

The government thus imposed its point of view on one of the most important decisions in PEMEX's history. The PEMEX board's lack of autonomy *vis-à-vis* the government becomes more significant given that there was no legal disposition to protect the interests of PEMEX in a fair process and that's why it was critical to provide PEMEX with the strongest institutional support and representation on the board. Instead of this, however, an auxiliary committee took the decision that was to shape the size and profile of the company's future. In that sense, the

PEMEX board of directors chose a bureaucratic way of avoiding historical responsibility in the transformation – not only of the National Oil Company, but also of the Mexican oil sector. The board in effect internalized a significant portion of the responsibility of the Energy Ministry in deciding the geological borders of PEMEX, and put the government's goal of promoting private investment above the need to give PEMEX a solid material basis that would allow it to become the dominant player in the new institutional arrangement of the oil sector.

Unsurprisingly, the Energy Ministry gave PEMEX almost all the exploration areas the oil company requested. However, despite the fact that the constitutional reform stated that all the fields in production should be assigned to PEMEX, some of these fields were kept by the state and bid out in Round 1.3.

Non-recognized investments

In order to compensate PEMEX for the investments it had made in areas that were eventually not retained after Round Zero, the constitutional reform stated that *'in case of that, as a result of the process to assign the areas to realize activities of exploration and production ... investments of PEMEX were affected, these shall be recognized in its fair economic value in the terms determined'* [direct translation from an article of the constitutional reform] by the Energy Ministry. Despite this explicit order, during two years the Energy Ministry did not establish any measures to recognize the economic value of the investments of PEMEX affected by Round Zero. For that reason, during discussions over its 2016 National Budget, the Mexican Congress instructed the Energy Ministry to develop the terms to recognize the economic value of the investments of PEMEX affected by Round Zero. At the same time, the

Congress established that PEMEX should receive the amounts corresponding to the investments it had made in the areas that were part of the three bidding rounds administered by the National Hydrocarbons Commission, during the year 2015.

PEMEX estimates that the economic value of the investments it had made in the exploration and production fields affected by Round Zero was around USD4 billion.

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'THIS INTERPRETATION OF THE CONSTITUTIONAL REFORM, MADE BY THE ENERGY MINISTRY, IMPLIES A HUGE DIFFERENCE IN THE ECONOMIC VALUE ... DUE TO PEMEX'

It seems clear that the will of the members of Congress who enacted the constitutional reform was to recognize the investments made by PEMEX over the years in areas and fields that it did not retain after Round Zero. The obvious reason for this is that as a result of many of those investments, PEMEX added reserves (or at least reduced the geological risk) and production to the country, and also developed the infrastructure. Unfortunately (for PEMEX, of course) the Energy Ministry did not share this point of view: according to the rules stated by the ministry, PEMEX should receive a payment for the investments in *assets* made in the *areas included in the request of Round Zero* that were then not granted by the Mexican state. This interpretation of the constitutional reform, made by the Energy Ministry, implies a huge difference in the economic value to be recognized as being due to PEMEX: it falls from USD4 billion to barely USD300 million. Besides, this interpretation was clearly in contradiction with the order of the Congress – to recognize the investments of PEMEX in the three rounds of biddings made in 2015 –

because any of the areas or fields included in those rounds were part of the request made by PEMEX.

Given the contradiction between the original spirit of the constitutional reform and the rules made by the Energy Ministry, this issue was again part of the budget discussions for the year 2017. This resulted in the Congress adding an article to the Income Act, ordering the Energy Ministry to estimate, during 2017, the correct economic value of the investments of PEMEX that had been affected by Round Zero. To achieve that task, the Energy Ministry shall consider *all the investments* (not only in assets) made by PEMEX, but only in the areas included in its Round Zero request. The Congress, as it did the year before, ordered the government to pay PEMEX for the investments that the company had made in the areas included in Round 1.4 (this took place in 2016). These rules are slightly better for PEMEX than those established in 2016 by the Energy Ministry, but they are still in contradiction with the constitutional reform. The good news for the National Oil Company is that the Mexican state is about to recognize all the investments, but the bad news is that it seems the Energy Ministry considers *'the process to assign the areas to realize activities of exploration and production'*, started when PEMEX made its Round Zero request. The reality is that the process started with the promulgation of the constitutional reform that gave PEMEX 90 days to decide which exploration areas to request.

In summary, in the process of assigning areas and recognizing PEMEX's past investments, the Energy Ministry has:

- enforced the mechanism which PEMEX used, to integrate its Round Zero request and its content;
- decided, with no legal restrictions, which areas to assign to PEMEX, without granting all the production

fields in spite of the explicit mandate of the constitutional reform;

- has, so far, avoided the obligation to recognize the economic value of PEMEX's investments affected by Round Zero and, following the intervention of Congress, has attempted to reduce the scope of the payments to the company.

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'[PEMEX'S] CONTRIBUTION TO OIL REVENUES HAS REPRESENTED AS MUCH AS 40 PER CENT OF THE TOTAL INCOME OF THE MEXICAN STATE.'

The new fiscal regime of PEMEX: a lost opportunity

It is well known that since the economic crisis of 1981–2, the role of PEMEX within the Mexican development model has radically changed. Originally conceived as being the entity responsible for fulfilling the demand for oil and refined products, PEMEX became the most important source of revenues for the Mexican state: between 1993 and 2014, it gave 110 per cent of its profits to the Finance Ministry. In other words, PEMEX had to increase its debt just to pay taxes. The fiscal regime was so harsh that, despite PEMEX typically being rated as one of the best oil companies in the world in EBITDA results, after taxes, in this century the company has only twice had positive annual results (2006 and 2012). On the other hand, its contribution to oil revenues has represented as much as 40 per cent of the total income of the Mexican state.

Thus, the Energy Reform introduced a new fiscal regime for PEMEX in an attempt to reduce the fiscal burden on its finances. It is important to underline that the review of the new fiscal regime took place in a period when the price of the Mexican mix oscillated in the range USD95–98 per barrel. It is also

important to remember that the last important adjustment to the fiscal regime applied to PEMEX was made in 2005, when a cost cap of USD6.50 per barrel was established; this lasted through the years despite the increasing production costs of the industry. As a matter of fact, high production costs made the cost cap the most important variable modifying PEMEX's fiscal regime. Indeed, in recognition of the higher production costs, some particular cases were recognized as having higher limits (USD16.50 per barrel in deepwater, 32.50 in the Chicontepec Paleochannel).

Finally, Congress approved a new fiscal regime for PEMEX, with a cost cap no longer represented by a fixed number, but as a percentage of the production value. This percentage would increase each year to reach 12.5 per cent in 2019, starting from around 10 per cent in 2015. Considering a price range of USD95–98 per barrel, this seemed a good deal for PEMEX: the cost cap would be a little more than USD10 per barrel for the greatest part of PEMEX's oil production. The problem was that as soon as the new fiscal regime was approved, the prices started to fall. The Mexican mix fell to a range of USD20–25 per barrel, so the cost cap in 2015 was barely over the line of USD2. Currently, the price is in a range of USD40–45 per barrel, but the cost cap remains below the historic figure of USD6.50. To give some breathing space to PEMEX, the fiscal regime was partially fixed. President Peña made an executive order to give PEMEX the option of choosing between the percentage-based cost cap or a fixed one of USD8.30 per barrel for onshore

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'THE NEW FISCAL REGIME IS, IN SOME WAYS, MORE ONEROUS THAN THE ONE THAT WAS IN PLACE BEFORE THE ENERGY REFORM.'



production, and USD6.10 per barrel for shallow-water production.

The new fiscal regime is, in some ways, more onerous than the one that was in place before the Energy Reform. A review of this fiscal regime is necessary, as giving PEMEX a better fiscal regime remains as an unachieved goal of the Energy Reform.

Conclusions

The new relationship between the Mexican state and PEMEX is based on the premise that the National Oil Company should be weakened in order

to 'make room', as fast as possible, for new private players, in order to avoid a reversal of the Energy Reform in the event of the triumph of a leftist coalition in the 2018 presidential elections. The abolition of the formal autonomy of PEMEX, the resistance to recognizing the economic value of its investments, together with the maintenance of an onerous fiscal regime, are three examples, among others, that would need much more space to be treated properly. These elements exemplify both the new oil sector dynamics and the changed position of PEMEX within these new dynamics. At a more

fundamental level, they also represent the end of a cycle that reflects the way in which the Mexican state approaches the oil sector. This cycle started with the creation of the Technical Commission of Petroleum in 1915 and was consolidated with the nationalization of the oil industry in 1938. One highly symbolic fact marking the end of this cycle is the reversion of the Cuichapa Poniente Field to private hands. This field was drilled in 1934 by the Company El Aguila; it was nationalized by Lázaro Cárdenas; and is now is back in private hands. Is this the end of the story ... or the beginning of a new one?



How to turn PEMEX into a major force?

Luis Vielma

Petróleos Mexicanos (PEMEX), the Mexican state oil company (SOC) has been under continuous scrutiny from both society and the political establishment. Since the start of the implementation of Mexico's Energy Reforms in 2014, the company has faced significant changes that demand a new vision and strategy to turn it into a productive asset that adds value to the state. PEMEX can draw from lessons learned by other SOCs and adapt these profitably to its particular context.

In this world of volatile markets, oil companies require new capabilities to remain competitive: agility, flexibility, and fast responses to changes have become the 'core values' necessary for survival and growth. Throughout the history of the oil business, never before have two words – *change* and *adaptability* – had more meaning and importance than they now attract.

Companies with clear strategies and fast decision making will prevail, and benefit from a greater chance of success. Back in the late nineteenth

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'AGILITY, FLEXIBILITY, AND FAST RESPONSES TO CHANGES HAVE BECOME THE "CORE VALUES" NECESSARY FOR SURVIVAL AND GROWTH.'
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century, oil companies with a better understanding of subsurface geology decided to move out of their national territories and explore for new hydrocarbons basins, taking the first steps towards the internationalization of the oil business. New ideas and approaches have arisen in oil companies, enabling them to develop relationships with governments and kingdoms (in the cases of Arabic countries), and allowing foreign companies to initiate exploration activities and business relationships, with a 'will to win' spirit that make sense for them, and brings benefit to the relationship.

Within this context, in 1901 the Mexican president, empowered by the first petroleum law approved by the National Congress, authorized oil

licences to international companies interested in exploring for hydrocarbons. Later, in 1912 under President Francisco Madero, the government decreed the first special tax law to be applied to foreign companies exploring for and producing oil in the country, to increase revenues from this relatively new activity.

A few years later, in 1917, Mexico changed its constitution, and the new document established, in article 27, '*that all the subsurface mineral reservoirs belonged to the nation and not to particulars*'. Despite private companies' arguments and discussions, this was the rule that governed the relationship between the state and private investors from then on. Within this legal framework, one year later in 1918, under President Venustiano Carranza's government, a new tax law was approved. This law applied an annual fee, based on the accumulated oil production, and a 5 per cent royalty, over each piece of land developed as an oil field, to all foreign oil companies.

After a slew of litigation, labour relations improved and with this came an increase in exploratory activity, especially in the country's northern and southern regions. In 1933 a new oil region with great potential was discovered: the Poza Rica area of the Veracruz state. This discovery strengthened the relationship between the government and the companies, and set the basis for the creation of the first Mexican oil company – Petróleos de México (Petromex) – a partnership between the Mexican government and private investors.

This brought a range of labour situations and workers' claims for better social and living conditions to the table, particularly in those areas where they worked and lived. However, the attitude and lack of understanding shown by the company's representatives impeded both the company's performance and its labour relations. This pushed workers towards the creation of a unique national representation, empowered as the sole valid counterpart to run talks with the companies, and thus the National Oil Workers Union, NOWU, was born in 1935.

This tense relationship between companies and workers affected the government's relationship with the companies, and in several occasions the union demanded stronger action from the government to force companies to accept their demands. After several legal discussions attempting – without success – to negotiate an understanding, President Lázaro Cárdenas decreed the expropriation process on 18 March 1938, forming Petróleos Mexicanos, or PEMEX; ever since then, the NOWU has been the most powerful union in Mexico.

Thus, since its creation in 1938, up until 2014, PEMEX has lived through numerous changes. Initially it was a

company created in response to the expropriation process, in order to take control of all the oil activities in Mexico; later it also had the responsibility of strengthening its capabilities to create a presence in the international oil sector. These two experiences were a tremendous challenge for the SOC, and ever since then, PEMEX has faced a continuous day-to-day challenge to its survival.

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'SINCE ITS CREATION IN 1938, UP UNTIL 2014, PEMEX HAS LIVED THROUGH NUMEROUS CHANGES.'

As an institution PEMEX has set the pace in Mexico; not many companies in the world can celebrate 79 years of life and PEMEX is one of those few exceptions. To survive the passage of time and the challenges of evolution, this institution has resisted not only business changes and global crises, but has also had to survive the impact of changes in political decisions every six years, the average period of sitting governments.

Hydrocarbon reserves are an extraordinary asset that allow SOCs to have tremendous influence over all the activities of the business. However, SOCs also have to comply with two main government requirements:

- revenue generation – at any cost – to satisfy social needs,
- political commitments.

The first purpose is not always the best approach to maximize value for the stakeholders, and the second is not the best practice to cultivate effectiveness and productivity.

PEMEX has been affected by the pace of change. On several occasions its reserves have been reduced following the recommendations of the Securities and Exchange Commission (SEC), after careful reviews of international

certifications. The reserves replacement process that guarantees the way forward has also been affected by its exploration results, and exploratory effort has decreased since 2012, due to budget limitations. Currently, the value of PEMEX's reserves is a big concern, because 10 billion barrels of proven reserves does not guarantee a long-term plan, and its exploratory effort has been reduced to a minimum. Its future depends on its prospective resources located in deep and ultra-deep waters, accounting for more than 30 billion barrels; this has been its most important offer to attract investment.

Production has been the other big concern for PEMEX. Since 2004, the year of its peak performance – 3.4 million barrels a day (mb/d) – its production has decreased by over a million barrels a day, and its current production is little more than 2.1 mb/d. This production loss has been caused by the natural decline of its main field – Cantarell – and so far, it has been impossible to mitigate the decline rate, because new discoveries and new production have been difficult and scarce. But the critical issue is the impact of this production loss in combination with the downward trend in the economy and its impact on state revenues: a reduction of more than 20 per cent between 2006 and 2016.

This previous analysis raises two questions regarding the Mexican SOC:

- What is happening with PEMEX?
- What are the options to turn the company into a more efficient National Oil Company (NOC)?

There are no simple answers.

Problems currently faced by PEMEX

For the first question, various factors may explain the recent performance of PEMEX. On the upstream side of the business, there are three significant



technical factors: reserve replacement has been below 100 per cent for over 10 years, meaning that each barrel produced has not been replaced; the company has suffered high decline rates from mature fields that account for more than 80 per cent of its active assets; and there has been a slow pace of development of new fields.

There are other factors relating to downstream inefficiencies and the dimension of the workforce size, or payroll. Both themes are critical and certainly affect the efficiency of the company; strategic alliances could be an interesting approach to resolving the first factor, while political commitments from the government and the congress to conduct open negotiations with the union, are a must for the second. Last but not least, monopolies tend to develop an internal culture that shows strong resistance to change and to the acceptance of different practices or points of view. For this reason new technologies and practices are difficult to implement.

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‘... THE COMPANY HAS SUFFERED HIGH DECLINE RATES FROM MATURE FIELDS THAT ACCOUNT FOR MORE THAN 80 PER CENT OF ITS ACTIVE ASSETS;’

What are the options to turn the company around?

If we have a quick look at some successful transformations of SOCs in the past – including: BP, Aramco, Petrobras, and PDVSA – all of them followed similar steps to achieve an effective change.

- 1 An initial review of the different assets; then set the pace to sell, lease, and outsource all the subsidiaries not related to the oil business.
- 2 A review of the oil portfolio to find out what percentage of the oil fields are

unproductive, and in fact are cost centres; then close those fields and build the portfolio only with the assets that create value.

- 3 Retire all the people that do not have a position tied to a process sustaining any of the assets selected for the portfolio. This helps to reduce the nonproductive payroll. This step is not easily accomplished because the company has to face discomfort and threats from employee unions; however, with government support, the situation can be resolved.

After the companies had achieved these objectives, the way forward to improved competitiveness was to internationalize the business, look for reserves, and also take advantage of downstream opportunities. These experiences were part of an integral transformation of the oil sector in different countries; in some of them, laws had to be changed or new laws had to be introduced, with the legal and fiscal adjustments necessary to regulate the different processes. Such endeavours set the legal and contractual guidelines to attract private investment. It was also helpful to develop oil services, together with their Research and Development (R&D) sector, and all of them shared alliances with the most important service companies. Some of these companies have made an additional move to bring in private investment to strengthen their finances, offering part of their market value through IPO processes.

How to turn PEMEX E&P into a major force?

Mexico faced a critical decision, to reform not only the oil sector but also its entire energy sector. The government and congress agreed on the changes required in the constitution to allow private investment in the energy sector. As part of the 2014 Energy Reform, the law has accordingly been reviewed and adjusted to support

the necessary constitutional changes. The law also supports the transformation of the SOC. PEMEX is now allowed to develop alliances with private oil companies and obtain investment from the private sector, enabling it to make the changes required to improve productivity. However, three years on, PEMEX continues to face difficulties in improving its performance, and therefore its management needs to review its long-term strategy with reference to international experiences that may help to update the company’s transformation plan. A summary of steps taken by international companies to this end is given below:

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‘PEMEX IS NOW ALLOWED TO DEVELOP ALLIANCES WITH PRIVATE OIL COMPANIES AND OBTAIN INVESTMENT FROM THE PRIVATE SECTOR ...’

- 1 A review of all assets, including upstream and downstream, and also of all types of service centres or organizations other than the core business. For example: telecommunications, information technology, hospitals and clinics, human resources, and transactional services.
- 2 Once this is done, PEMEX will have a corporate portfolio of assets that add value; a second portfolio with businesses that may be selected for strategic alliances with special partners; and a third portfolio with assets to sell, lease, or outsource.
- 3 The downstream business must be reviewed; some of the six refineries will have to be sold or closed and the most productive ones given the chance for leasing or alliances with specialized partners; more processing capacity for future production must be added through international partnerships (following

the experience of the Shell Deer Park refinery is also an option).

- 4 The petrochemical business must be sold or shared in alliances with a minimum size of equity.
- 5 For the most important business – E&P – an intense review of its business portfolio is also necessary to:
 - (a) Focus exploration only in areas that guarantee a high probability of discoveries, with preference given to shallow waters; those options in deepwaters must be shared – through farmouts – with majors interested in the areas.
 - (b) Select those 20 per cent of assets that produce 80+ per cent of the revenue along the integrated value chain. Those are the assets that PEMEX will keep, the rest may be returned to the state. Alternatively, business cases with

small and medium operators and clusters of services companies should be developed, to lease the operation and maintenance of particular assets.

- (c) Develop a complete sharing farmout strategy with specific allies, specifically in those fields requiring technologically advanced techniques, to make them productive and efficient.
- 6 Define a labour strategy enabling the company to reduce its workforce or personnel, based upon the real needs of the assets. Clear and transparent negotiations with the Union, with political support from the government and the congress, is a must; however, whatever decision is taken, it should include options for the workers to be transferred to alternative productive business and assets, or to take a retirement plan

with good social benefits.

- 7 In the medium term (three years) have a plan to go to the market, initially with a 15 per cent share of its current market value – a move similar to that of BP and Petrobras. This decision will transform PEMEX into a semi-public international company, with the necessary competence and transparency to be successful around the world.

These reflections may be considered just an opinion, possibly facilitating a particular route, and they may provide authorities with ‘food for thought’ in the context of critical discussions that they should be having. However, a sense of urgency is necessary to take decisions that will move PEMEX on and leave a legacy, before the political calendar resets and its business activities begin to slow down.



The evolving role of PEMEX and its future position in the upstream sector

Adrian Lara

PEMEX: new structure and recent adjustments

Ending the monopoly of Petróleos Mexicanos (PEMEX) and establishing a new organization for the hydrocarbon sector has been one of the key elements of the Mexican Energy Reform (or Reforma Energética). The objective was to make PEMEX more productive while also setting the conditions that will allow future partnerships with experienced oil and gas operators. New participants are also entering the sector on their own and forming partnerships with peers other than PEMEX; this is certainly increasing competition in the sector. In the short term, PEMEX’s position still has some advantages, in that it remains the key operator by number of

assets and by reserves. However, in the medium to longer term this position will be challenged even in shallow waters, where the company has developed its operational expertise.

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‘PEMEX’S POSITION STILL HAS SOME ADVANTAGES, IN THAT IT REMAINS THE KEY OPERATOR BY NUMBER OF ASSETS AND BY RESERVES.’

By the end of 2014 and with the aim of streamlining the operation of the company, PEMEX’s subsidiaries were reduced from four to two:

- *Exploration and Production*, focusing on upstream activities;
- *Industrial Transformation*, a division

grouping gas processing, crude oil refining, and petrochemical production.

Other functions such as procurement, legal, and human resources were centralized and the company’s board was restructured from 15 to 10 members. The numbers on the board of both worker representatives associated with the unions, and government representatives, were decreased, while public members were introduced. All of this was regarded as a long-awaited adjustment, but it was the sustained low-price environment and the deterioration of industry trends during the previous two years which made PEMEX face the harsh reality of its structural troubles. This resulted in the company implementing a drastic



and immediate cost-reduction strategy that included the overhaul of the company's pension system, the cancellation of unprofitable projects, as well as the delay in planned developments. Furthermore, it is now clear that the company's strategy will continue to centre on the upstream opportunities which have been its core business and have compensated for the losses in other divisions.

After reporting 17 consecutive quarterly losses, PEMEX reported its first profit since 2012 in May 2017. The company had accumulated losses of 1.47 trillion Mexican pesos (MXN), or 76 billion US dollars (USD), since the end of 2012. Due to the drop of the oil price at the end of 2014 and the company's continuous crude oil production decline, even the historically profitable upstream division was reporting losses, increasing the overall loss of the company. Although the recovery of the oil price had a clear impact on the loss reversal in 2017, the positive result was also supported by a series of measures aimed at reducing costs. Many of these cost reductions occurred outside the upstream division, but in general during the last year the company has managed to cut MXN35.5 billion (USD1.85 billion) by the renegotiation of service contracts, workforce adjustments, and the reduction of administrative expenses. Specifically in the upstream division, the operation of assets with wells operating at an average cost of USD25 per barrel were halted and this, according to PEMEX, translated into a cost reduction of MXN6 billion (USD300 million).

However, these adjustments have not yet been translated into output growth for the company. They have only been a necessary condition to bring the company to a healthier position, in order to take advantage of the new partnering schemes available through the Energy Reform. The company has consistently emphasized the pertinence

of farmouts – a special type of joint venture – where the bulk of initial capital expenditure is carried out by the partner, which suits PEMEX's restricted cash liquidity. In all cases, the area offered for such a venture would include already discovered or producing fields and might even have initial infrastructure, thus requiring only an additional influx of capital investment before first oil. However, even in a scenario where PEMEX is successful in completing its farmout schedule, it is likely that the company's production will at best grow by no more than 200 thousand barrels a day (kb/d) in the short term. The company expects to reach 2.19 million barrels a day (mb/d) of crude oil output by 2021 from its current 2 mb/d (at the end of the first quarter of 2017). Although this would, no doubt, be the desired trend going forward, it is still a modest growth and significantly far from its 2004 peak production of 3.4 mb/d.

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**'... THE FARMOUT OF ASSETS HAS
 BECOME THE PREFERRED SCHEME FOR
 SHARING FINANCIAL BURDEN AND RISK.'**

PEMEX and the farmout strategy

Today PEMEX emphasizes the need for a business strategy that is strictly centred on profitability. The company also reiterates the need to take advantage of the partnering opportunities now available thanks to the Mexican Energy Reform. Indeed, the farmout of assets has become the preferred scheme for sharing financial burden and risk. However, it has proved difficult to meet the farmout plan announced at the end of 2014, which included at least ten assets. The list has changed continuously and in fact only one, the Trion field in deepwater, has materialized into a signed joint venture contract. As with other offered areas, farmout assets are to be awarded through a competitive bidding

process. In 2017 three other assets – Ayin-Batsil, Cárdenas-Mora, and Ogarrio – already have an auctioning date set for October. However, for Ayin-Batsil the original bidding date was expected in June 2017 but this has been delayed to October, possibly to give more time for companies to assess contract terms and show interest. At the time of writing, only two companies have initiated the pre-qualification process for Ayin-Batsil and no company has entered the data room for the Cárdenas-Mora and Ogarrio. Moreover, in its 2017–21 business plan, the company outlined an ambitious farmout schedule for at least four other assets in 2017, and about three clusters grouping 156 fields in 2018. These additional farmouts will still need to pass some bureaucratic procedures, potentially delaying their final approval and bidding date. Therefore, even for a scenario in which partners for farmout opportunities are successfully attracted with the hope of additional output, a reversal of PEMEX's production decline is likely to be challenging before the end of this decade.

According to PEMEX's own estimates the expectation for output growth is 15 per cent, or approximately 200 kb/d, within the next five years. By taking a closer look at the list of farmouts shown in the table overleaf, this estimate seems optimistic. Trion, the only farmout with a signed joint venture contract, is not expected to start production before 2022, and its peak production of around 70 to 80 kb/d would be reached by 2025. Similarly, and leaving all timing issues aside, the recent announcement for the farmout of the Nobilis-Maximino discoveries, also in the deepwater Perdido Fold region and with prospective resources of approximately 500 million barrels of oil equivalent, would have first oil production only within the next eight years. Ayin-Batsil is a heavy crude oil asset which could reach a peak

Assets considered for a farmout schedule

Asset	Project type	Farmout status	Bidding date
Trion	Deepwater	Awarded	Dec. 2016
Ayin-Batsil	Shallow water HCO	Approved for auction	Oct. 2017
Cárdenas-Mora	Mature onshore	Approved for auction	Oct. 2017
Ogarrio	Mature onshore	Approved for auction	Oct. 2017
7 onshore PEMEX assignments (North & South regions)	Onshore (North & South regions)	Announced	2017 (tentative)
Ayatsil-Tekel-Utsil	Shallow water HCO	Announced	2017 (tentative)
Nobilis-Maximino	Deepwater	Announced	2017 (tentative)
Chicontepec	Unconventional (Chicontepec)	Announced	2017 (tentative)
6 shallow water PEMEX assignments	Shallow water	Announced	2018 (tentative)
64 onshore assignments (North region)	Onshore (North & South regions)	Announced	2018 (tentative)
86 onshore non-associated gas (Burgos & Veracruz regions)	Onshore non-associated gas (Burgos & Veracruz regions)	Announced	2018 (tentative)
Ek-Balam	Mature shallow water	Approved for migration	n/a
Bolontiku-Sinan	Mature shallow water	Announced	n/a
Exploratus	Deepwater	Announced	n/a
Kunah-Piklis	Deepwater (gas)	Announced	n/a
Rodador	Mature onshore	Announced	n/a
Samaria	Mature onshore	Announced	n/a

Source: PEMEX and National Hydrocarbon Commission (CNH).

Production and additional capital expenditure for key farmout assets

Asset	Project type	Farmout status	Bidding date	3P reserves or recoverable resources (mmboe)	Expected peak production year or redevelopment peak	Expected peak production or redevelopment peak capacity ³ (mmbd)	Estimated additional capital expenditure (USD)
Trion	Deepwater	Awarded	Dec. 2016	485	2025	72.4	4–6 billion
Ayin-Batsil	Shallow water HCO	Approved for bidding	Oct. 2017	297	2025	62.9	2.5 billion
Cardenas-Mora	Mature onshore	Approved for bidding	Oct. 2017	41.3	Not before 2020	8.1	667 million
Ogarrio	Mature onshore	Approved for bidding	Oct. 2017	53.9	Not before 2020	7.9	473 million
Ayatsil-Tekel-Utsil ¹	Shallow water HCO	Announced	2017	856	Not before 2024	192.9	12 billion
Nobilis-Maximino	Deepwater	Announced	2017	500 ²	Not before 2025	Approx. 100	6–8 billion
Ek-Balam	Mature shallow water	Approved for migration	n/a	529.8	2022	112	5.5 billion
Bolontiku-Sinan	Mature shallow water	Announced	n/a	94	Not before 2022	48.5	3.8 billion
Exploratus	Deepwater	Announced	n/a	234	Not before 2025	Approx. 60	3–5 billion
Kunah-Piklis	Deepwater (gas)	Announced	n/a	410	Not before 2028	537 mmcf/d	8.2 billion

1 Considers full incremental development as presented to CNH.

2 Estimated resources.

3 All for crude oil except Kunah-Piklis gas fields.

Source: PEMEX, National Hydrocarbon Commission (CNH) and own estimates.



production of approximately 63 kb/d, but not before 2025. Ayatsil-Tekel-Utsil is an extra-heavy crude oil project which has infrastructure in place and could bring additional crude production of around 70 kb/d after 2020, but this still requires definition in its development plan (it will need lighter crude oil and additional processing facilities). The Cárdenas-Mora and Ogarrío are mature onshore assets which will require secondary recovery to stabilize and reverse their decline. For these two mature fields, their expected increase in recovery is of 20 to 30 per cent, which could bring production of crude from approximately 13 kb/d to just 15–17 kb/d in a few years.

PEMEX has also indicated, in its 2017–21 business plan, the farming out of approximately 156 onshore medium to small fields in 2017 and 2018; these are likely to be clustered in specific areas or blocks. Here the strategy seems to be to first request the hydrocarbon authorities to migrate these fields to a different and more attractive fiscal regime, and then look for a partner through a farmout process. This is already exemplified by the case of the Ek and Balam fields which have just been migrated to a Production Sharing Contract that will apply better fiscal terms. These two fields amount to a 3P reserve figure of more than 535 million barrels of oil equivalent, and have infrastructure in place corresponding to the Cantarell production complex. The expectation is for PEMEX to farmout and bring in the required investment to increase production from 30 to 90 kb/d. However, as with other farmouts the process will still need a set of approvals before there is a call for bids and initial terms for the joint venture contract.

In addition to the assessment of the economic profitability of these projects at current oil prices, there is also the issue of how much partners will be willing to carry in terms of cost. This will

ultimately be set in the contract terms designed for each joint venture, but the bidding process can allow for an increase of the cost carry. As seen in the Trion field auction, the hydrocarbon agency can establish a minimum biddable payment to the state that is easily met by the participants, forcing a tie break via an additional cash payment. A set percentage of this cash payment is then transferred to PEMEX as an additional amount for cost carry; this maximizes the length of time before investment in the project by PEMEX itself is required.

Outlook

In the short term, PEMEX’s upstream strategy will certainly be focused on maximizing joint ventures via the farmout scheme. However, it is unlikely that the timing of these farmouts will occur in a manner that would allow for a significant increase of production in the next five years. Potential delays in the institutional process for approving the bidding for these assets will mean shifting auctioning dates beyond 2018. This, in conjunction with the different timings for developing shallow heavy crude, deepwater, or mature onshore, will likely result in additional production being scattered not over, say, five years, but over a longer period of time.

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‘... THE EXPERTISE AND BEST PRACTICE LEARNED THROUGH THE INITIAL JOINT VENTURES WILL PROVE DECISIVE IN SELECTING FUTURE FIELDS TO DEVELOP?’

With respect to entitlement of reserves, PEMEX will likely remain in a dominant position over at least the next five to ten years. At the beginning of 2016 the company reported 3P reserves amounting to 22.22 billion barrels of oil equivalent. In this scenario, the expertise and best practice learned through the initial joint ventures will

prove decisive in selecting future fields to develop. A financially and technically improved PEMEX will give the company the option of either continuing to develop this reserve base on its own, or negotiating more favourable terms with future partners. The current CEO believes the company will be profitable by the year 2020. In this scenario, the decade of 2020 to 2030 will be the time for PEMEX to start building a stronger position outside its already mastered shallow-water niche and into deepwater or onshore unconventional production. Also, with respect to exploration activity, the company has significantly reduced its number of rigs to only two in 2017 and with a focus only on shallow water. The company will eventually need to allocate more investment to exploration activities, in order to increase the rate of reserve replacement and strengthen the company’s longer-term position.

It is the upstream segment of PEMEX in particular that has the greatest potential among the company’s divisions. The downstream and petrochemical operations have a more challenging outlook, since they have to reverse operational losses of close to MXN100 billion (USD5.23 billion) and are having more difficulty in attracting other companies to form joint ventures. The financial recovery of the company, together with successful and timely success in forming joint ventures, is just the necessary prerequisite enabling the company to get back on track and move ahead in the right direction. Gaining a competitive foothold in deepwater or unconventional areas, where the bulk of the country’s prospective resources are located, will start with PEMEX participating in joint ventures as a learning partner. In the longer term, this will determine how PEMEX makes the most out of the learning process embedded in the farmout schemes where best industry practice and state of the art technology are used.



Mexico: an energy revolution in progress

Lourdes Melgar

Mexico is poised to become a key player in the international energy arena. The landmark Energy Reform of 2013 provides the foundations for the sound development of Mexico's hydrocarbon and power industries. The new architecture sets the ground to reverse the downward trend in oil production, enhance energy security, and attain sustainable development. The implementation of the reform is yielding results, transforming the landscape and the outlook of the energy sector. Challenges remain. Overcoming them will be central to realizing its full potential. Within a decade, the country could become an energy hub. Mexico is finally taking its seat at the table of the world energy industry, attracting investment flows, defining the approaches needed to reconcile contending policy objectives, and making innovations in a realm it had long ignored.

This article analyses the energy revolution currently underway in Mexico. Given the depth of the reform, it centres on the upstream, notwithstanding developments in the creation of energy markets, and it proceeds to:

- consider the key premises that define the new model, as well as the contributions that Mexico is putting forward in the implementation phase, as it adopts and adapts international best practice;
- assess the initial results of the opening of the upstream, highlighting landmarks as well as challenges ahead.

A design based on principles of a technical nature provides strength to the Energy Reform

On 20 December 2013, Mexico enacted an all-comprehensive Energy

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'NEW ARCHITECTURE SETS THE GROUND TO REVERSE THE DOWNWARD TREND IN OIL PRODUCTION, ENHANCE ENERGY SECURITY, AND ATTAIN SUSTAINABLE DEVELOPMENT.'

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Reform at the constitutional level. An OECD member and free trade champion, Mexico was close to being one of the last countries to open its energy sector to private participation. For a long time, ideology had prevailed over technical necessity, despite growing evidence that the monopolistic arrangement had reached its limits. Early on, the Peña Nieto administration generated the conditions necessary to undertake a constitutional amendment of the energy framework. In order to foster energy security, promote climate change mitigation, and boost economic development, the country adopted a model based on the principles of open-market competition, sustainability, and transparency, in which the nation retains ownership of oil resources in the subsoil.

The new framework aims at attracting state-of-the art technology and investment, through the creation of competitive energy markets and auctions of oil contracts. It defines a new institutional arrangement in which regulators play a central role as keepers of the process. Yet, Articles 27 and 28 of the constitution bestow significant power to the state in the governance of hydrocarbon resources.

The state can exploit resources through entitlements granted to its national oil company, Petróleos Mexicanos (PEMEX), or through contracts awarded in competitive bidding processes. Concessions are banned; policy makers can choose among licence

contracts, production-sharing, profit-sharing, or service contracts to hire oil companies to develop hydrocarbon resources on behalf of the state. The booking of reserves is allowed.

The distinction between awarding contracts through competitive bids and selling acreage in a leasing process is profound, but for political purposes, ideological detractors of the reform brush aside this significant point: the state is not selling domain, it is sharing risk with companies interested in working for the Mexican state under the terms of the contract. The state, through the National Hydrocarbons Commission (or Comisión Nacional de Hidrocarburos, CNH), maintains oversight of Exploration and Production (E&P) activities.

The state also decides on the pace and type of the geological opportunities it bids, although it welcomes nominations. Since predictability is essential to attract investment, it issues a Five-year Plan for E&P.

Mexico has innovated in the process of awarding oil contracts. It has set a high bar in terms of transparency throughout the tendering process. The awarding variable is an economic one with two components: increase in royalty (for licence contracts) or government share (for production sharing contracts) and additional work commitment. There is no negotiation or room for discretion. Transparency is intended to grant assurances to society over the development of resources and provide certainty to investors.

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'MEXICO HAS INNOVATED IN THE PROCESS OF AWARDING OIL CONTRACTS.'

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Sustainability is inscribed in Article 25 of the constitution. Its significance in



terms of paradigm shift is paramount: the Mexican Petroleum Fund for Stabilization and Development manages oil revenues, precluding the discretionary use of resources; environmental stewardship is enforced, as are policies to mitigate greenhouse gas emissions; social licensing is required for all energy projects, and the law spells out steps to fairly compensate land owners. Compliance with the indigenous populations' consultation process is mandated.

Mexico has joined the international conversation on the design of petroleum contracts. How should they be structured to both attract investment and protect the interest of the state and guarantee its long-term viability? The first contract models issued in December 2014 were viewed as being too close to previous PEMEX service contracts. A dynamic process of dialogue and feedback between government and industry ensued. Revised versions began to delineate the Mexican Production Sharing Contract and the Licence Contract. Adjustments were undertaken, in a context of collapsing oil prices. Striking the right balance, precluding future renegotiations, and protecting the interest of the state all became critical. Mexican contracts include administrative and contractual rescission clauses and they establish a corporate guarantee and an adjustment mechanism for fiscal purposes that is activated when oil prices rise or the field is overly productive. The contract is designed to do what the constitution allows for: hire a company to do E&P activities on behalf of the Mexican state. Risk is shared and contractors get a fair return for their investment. In the tendering process, the bidder defines the increase in work commitment and the royalty, or share, it will pay to the state.

The reader may wonder why it is necessary to reframe a narrative that

could be most appealing if it was just stated in terms of private participation. The reason is simple: failing to fully understand the new model plays in the hands of critics who like to suggest that Mexico's upstream opening is a privatization that will lead to backlash in 2018. Venezuela at the turn of the century is often mentioned as a case in point. Concerns over the outcome of the next presidential election are brought to the forefront.

I pose that the Energy Reform will prevail, regardless of who becomes Mexico's head of state. The reform is spelled out in three articles of the constitution and 21 transitory articles, rendering difficult a departure from the blueprint. More importantly, it is not defined by ideology, but by technical necessity. The modernization of the energy sector is a precondition to achieving energy security and economic growth. The incoming administration will capture the initial benefits of the transformation of Mexico's petroleum sector. An attempt to return to the past would lead Mexico to a deep energy crisis.

The implementation of the reform is still a work in progress. Central issues will continue to be debated and refined. Time will tell whether the fiscal regime of oil contracts with its adjustment mechanism will lead to severe gold plating, as some argued, or was a sound inclusion to preserve the viability of the agreement. Policy makers will continue debating over the weight ascribed to increases in government share, as opposed to work commitments, in the bidding variable, or over approaches to implementing administrative rescission and arbitration clauses in petroleum contracts.

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'THE IMPLEMENTATION OF THE REFORM IS STILL A WORK IN PROGRESS.'
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The new ecosystem of Mexico's petroleum industry

The secondary legislation of the Energy Reform was issued on 11 August 2014, and two days later, PEMEX was granted its entitlements in Round Zero. On average, WTI was around USD96 a barrel, but oil prices were already declining. The opening of the upstream and the transformation of PEMEX into a State Productive Enterprise would take place under the collapse of oil prices (which reached their lowest point in February 2016, with WTI below USD30 a barrel).

In terms of Round 1, which began on 11 December 2014 and ended on 5 December 2016, the decline in oil prices allowed for the extension of an unrealistic nine month schedule (to complete five bids) into a two-year period in which policy makers improved their skills in designing bids and strengthened their institutional capabilities. Strategically, it was decided to initiate the process with shallow waters, exploration areas first, then continue with extraction, both with a Production Sharing Contract. The third bid was designed to generate opportunities for new Mexican oil companies, while the fourth bid was set as the litmus test of the reform: attracting major oil companies to the deep waters of the Mexican section of the Gulf of Mexico. Licence Contracts were chosen for the last two tenders.

The fifth bid, of unconventional resources, has been deferred to Round 2, opportunities would not be competitive at low oil prices. More importantly, the specific regulation and licensing permit procedures were not in place at that time. Obtaining the social licence will be key to succeeding in the development of unconventional plays, something that could prove difficult in some regions unless grass root efforts are undertaken to generate favourable conditions.

Round 1 has been called a success. The level of transparency has been commended. Thirty-eight contracts

have been signed and 48 companies, in addition to PEMEX, are now participating in Mexico. The highlight took place on 5 December 2016, when eight out of the ten blocks put up for auction in the deep waters of the Gulf of Mexico were awarded.

A more telling assessment comes from delving into the results: *the first bid*, considered by some a failure, showed the value of having other eyes look at the same geology. An area forsaken by PEMEX received offers from ENI International, Hunt, Statoil, and Sierra Oil & Gas (a newly created company that won the two contracts awarded in this tender).

In *the second bid*, ENI International won a contract under strong competition. Having an international major sign a Mexican contract meant that these were competitive by international standards. The bid was geared towards oil companies that had proven experience in producing offshore. In March 2017, ENI was the first company, apart from PEMEX, to announce a discovery and successfully drill an exploratory well in Mexico. True success will be measured in terms of oil production and reserve replacement in the years to come.

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‘TRUE SUCCESS WILL BE MEASURED IN TERMS OF OIL PRODUCTION AND RESERVE REPLACEMENT IN THE YEARS TO COME.’

The *third bid*, comprising small mature fields, was designed to spur the creation of Mexican oil companies. For former contractors of PEMEX, this was an opportunity to become operators and begin the journey to tackling greater challenges. It was also a way of putting to work idle teams and equipment, and lessening the economic strains of lost activity and deferred payments by PEMEX, which explains the eagerness to embrace the reform at a time of persistently low oil prices. The bid also

attracted some foreign companies – Canada’s Renaissance Oil signed three contracts. This was the first incursion onshore, a challenge that needs to be tackled properly if Mexico is to succeed in developing its vast resources.

The *fourth bid* is the one that truly grants Mexico a seat at the table of the world petroleum industry. Almost all the majors are now present in Mexico. The bid in deep and ultra-deep waters promises significant investment, yet production will begin around 2025.

With the implementation of Round 1 (which included four bids) Mexico was able to increase its upstream activity, adding more players in areas that would otherwise have been idle. In addition, seismic companies have invested over USD2.5 billion, producing significant geological information, valuable to policy makers and industry alike.

Mexico’s Energy Reform has treated PEMEX on an equal footing with other oil companies (except for Round Zero). PEMEX was granted entitlements to the areas where it complied with the constitutional mandate of proving that it had the technical, financial, and managerial capabilities to develop them in a competitive manner. PEMEX received 83 per cent of Mexico’s 2P reserves and 21 per cent of its prospective resources. *‘A base to produce in the order of 2.5 million barrels a day over the next two decades’* was the adage, when oil prices were at a USD100 a barrel. Today, PEMEX is barely producing 2 million barrels a day and reserves replacement has continued to decline.

The results for PEMEX, however, have been abysmal. Critics claim that the aim of the reform was to dismantle PEMEX. The truth is far from this: PEMEX was in strained conditions prior to 2013. Years of underinvestment, poor management, and shady practices came to the forefront, as the company had to undertake a draconian budget cut.

The financial account is well known. An additional element that played against the company was the internal resistance to the reform. Some opposed it for ideological reasons, others were defending their vested interests, while some had a different reform in mind.

The internal debates that ensued in 2014 came to light as PEMEX and the Energy Ministry presented contradictory views of the reform. The leadership at PEMEX seemed eager to follow a Malaysian model – where the national oil company (NOC) has a central role in the decision making process. But Mexico had already opted for a route that was different from that taken by Brazil, Colombia, or Malaysia. PEMEX is to become a State Productive Enterprise, while decision-making is with the Ministries of Energy and Finance, and oversight resides with CNH and other regulatory bodies.

It took a severe financial crisis and a change in leadership for PEMEX to embrace the opportunities opened by the reform. In December 2016, CNH conducted the bid for the first farmout of PEMEX, which went to BHP Billiton. PEMEX successfully competed in Round 1 for a block in the Perdido Fold Belt, in association with Chevron and Inpex. The transformation of PEMEX is underway. It will take time for Mexico’s state oil company to come back in force. It now has the tools to face the challenges of an increasingly complex environment. The reform cannot succeed without PEMEX, the company holds the most valuable assets – the ones that could allow a rapid turnaround of the downward trend in oil and gas production. Mexico’s energy security depends on it.

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‘IT TOOK A SEVERE FINANCIAL CRISIS AND A CHANGE IN LEADERSHIP FOR PEMEX TO EMBRACE THE OPPORTUNITIES OPENED BY THE REFORM.’



Government rents and other policy goals for private investment in oil exploration and production

José Pablo Rinkenbach

In 2013 Mexico undertook a comprehensive Energy Reform in order to promote the economic development of the country and to ensure energy security, sustainability, and environmental protection.

As part of this process of transformation, the Mexican state has modernized its stewarding role in the energy industry. The jurisdictions of various agencies involved in the sector were adjusted and various regulatory bodies and agencies were created and/or modified for the oversight and management of oil revenues. The Ministry of Finance and Public Credit (Secretaría de Hacienda y Crédito Público or SHCP) has been a leading actor, since it is the agency responsible for fixing oil revenues (the 'government take'); this directly affects the viability of the oil industry and therefore the economic growth of the country.

Originally, the main objective of the hydrocarbon fiscal system policy was to establish a competitive tax regime level to promote the development of Mexican oil fields. However, the Mexican hydrocarbon tax system that was developed in 2014 was designed within a paradigm of high oil prices; the regime has therefore needed to be continuously adapted to subsequent market conditions, on an ongoing basis.

Given the drop in international oil prices that began in the second half of 2015, together with increased pressure on national public finances, Mexico's hydrocarbon fiscal policy has tended to favour tax revenues over the development of the oil industry.

In Mexico, up to 2014, the framework for oil revenue was the Federal Act on Duties (LFD) which had, as part of its

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'... MEXICO'S HYDROCARBON FISCAL POLICY HAS TENDED TO FAVOUR TAX REVENUES OVER THE DEVELOPMENT OF THE OIL INDUSTRY.'

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scope, the permits (*asignaciones* in Spanish) from *Petróleos Mexicanos* (PEMEX), which were treated under the model of Shared Profit. From 2015 onward, the Hydrocarbon Revenue Act (LISH) has applied, whereby both allocations from PEMEX, as well as Exploration and Extraction Contracts (CEE) (which include licences, shared production, and shared profit), are considered.

Hydrocarbon taxes in Mexico depend both on generic aspects and on specific aspects defined at the level of each contract. At a *generic* level there are five elements affecting the government take. These are the:

- land and surface occupation fee,
- contract fee for the exploration and extraction phase,
- tax on exploration and extraction of hydrocarbons,
- contract royalties,
- income tax.

At the level of each contract, some *specific* aspects have appeared in Mexico, to date. These are:

- permits: compensation as a percentage of operating income,
- shared production in a CEE: compensation as a percentage of operating income and an adjustment mechanism based on profitability,
- licence in a CEE: compensation as a percentage of revenue and an adjustment mechanism based on

an R factor that depends on the production levels.

The LISH has allowed the Mexican state to maintain stability in its public finances, since in both the LFD and the LISH, the government take from the exploitation of oil fields in PEMEX's shallow waters is around 93 per cent. (It should be pointed out that most of PEMEX's production is derived from such fields.) The table overleaf shows the details using the fiscal conditions for hydrocarbons that will apply in 2019, an estimated cost of OPEX + CAPEX of 12 USD/BOE, and a price per barrel of USD35.

Given that, either under the LFD or the LISH, PEMEX would pay on average 93 per cent government take from its shallow-water permits, PEMEX has a strong incentive to migrate its fields to CEE (Exploration and Extraction Contracts) from the current permits, and partner with third parties (a process known as 'farmout', a special type of joint venture) thus allowing for a better fiscal regime for the national oil company. (Note: maintaining the same assumptions as in the table overleaf and using the parameters of Round 1.2 on a cost recovery limit of 60 per cent, the government take for a project in shallow waters in the CEE mode would be approximately 85.1 per cent.)

The recent experience of the Mexican state with the Trion farmout is an example of the type of new businesses being developed in Mexico in partnership with the national oil company. We can expect many more investment opportunities with PEMEX, where the private party is the operator and financier of the project and PEMEX has a non-working interest and is 'carried' for the project. Certainly, the

Comparison of the estimated take by the Mexican state derived from shallow-water permits (units per boe)

ACT	LFD 2014	ACT	LISH 2015
Limit of cost recovery	USD6.5/boe	Limit of cost recovery 12.5%	USD4.4/boe
DSHFE 10.0%	USD3.5	7.5% duty on hydrocarbon	USD2.6
DFICT 0.65%	USD0.2		
DFF 0.003%	USD0.0		
Operating income 71.5%	USD24.8	Duties on shared profit 65%	USD18.20
DOSEH DRSEEH 0.03%	USD17.7 USD0.0	Oil activity tax (USD/km ²)	USD0.0
Cash flow before income tax	USD1.5	Cash flow before income tax	USD2.2
ISR	n/a	ISR 30.0%	USD0.7
Free cash flow	USD1.5	Free cash flow	USD1.5
Government take	93.3%	Government take	93.4%

Notes: DSHFE: Oil tax for the stabilization fund; DFICT: Duty for the scientific and technology research fund; DFF: Duty for oil control; DOESH: Ordinary duty on hydrocarbons extraction; DRSEEH: Duty for the regulation and supervision of exploration and exploitation of hydrocarbons; ISR: Income tax

above de facto policy would allow the Mexican state to maintain a presence and develop key PEMEX projects, reduce liquidity pressure on federal public finances, and obtain additional resources not included in the budget via collection of bonuses.

As regards the taxation on hydrocarbons for private stakeholders, it seems that public policy seeks to achieve two conflicting objectives simultaneously: the maximization of the country’s economic development via the competitive development of the oil sector and the maximization of government take.

It is important to recall that the Mexican tax system was originally based on a paradigm of high oil prices; this has led to the regime needing to adapt to the new, lower price, conditions. Therefore to achieve a breakthrough in the implementation of the bidding rounds for oil resources, the federal government has had to become amenable to the market’s wishes and adjust the terms and conditions to

make them more competitive. Three years into Mexico’s Energy Reform there have been four calls and one farmout, with three more being under implementation.

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‘... THE FEDERAL GOVERNMENT HAS HAD TO BECOME AMENABLE TO THE MARKET’S WISHES AND ADJUST THE TERMS AND CONDITIONS ...’

During the first three calls the principal challenges were, among others: the size of the exploration blocks, the adjustment mechanisms and returns to be expected, and the bidding processes that encouraged overbidding (leading to the so-called ‘winners’ curse’) that could make the development of the oil fields unviable.

As regards the size of the blocks, SENER nearly doubled the average surface area of exploration blocks in shallow waters from 302 km² in Round 1 to 594 km² in Round 2. Also, it is noticeable that even the smallest

exploration block of Round 2 is almost four times larger than a comparable block in Round 1. This is very important because it increases the probability of discovering commercial reserves.

During 2017, SENER presented the revised Five-Year Plan for tenders for exploration and extraction of hydrocarbons from 2015 to 2019, in which it was announced that the government was seeking a new strategy to revitalize the oil bidding rounds. The new strategy is based on three central elements: standardization of contractual areas by geography, the nomination of contractual areas by private entities to be tendered by the Mexican state, and a continuous process of granting licences to be a certified oil operator.

In a market that is undergoing reshaping, the standardization of the size of areas contributes to the simplification of processes. In fact, thanks to the standardization of the areas, any company that is interested in exploring a particular area can nominate it for tendering to the Mexican government. To do this, a technical study is required to support the recommendation. This step will help areas that are perceived by the market as having the greatest resource potential to be tendered in a timely manner by the Mexican state.

Aspects of Mexico’s hydrocarbon policy

Through the oil rounds we have been able to identify the evolution and definition of the government’s fiscal and economic hydrocarbon public policy.

Model contract: After several rounds it seems that the Mexican state has identified an economic model contract with which it feels comfortable.

- Deepwater: Licence contracts with minimum and maximum compensation, with an adjustment



mechanism based on profitability and the use of a signing bonus.

- Shallow water: Production sharing contracts with minimal payment and windfall adjustment mechanism.
- Onshore: Licence contracts with minimal payment and windfall adjustment mechanism.

The question remains whether the state will announce the use of signing bonuses in the future for Round 2.2 and 2.3.

It seems that the model of the production sharing contract has been chosen for shallow-water areas because the state has more information on reservoirs and can exert more control, while in deepwater and onshore areas they have chosen the licence contract, as it is more efficient for supervision and monitoring.

Let us remember that the institutional framework of the Mexican state on hydrocarbons is in the process of evolution and maturation, so that fixing a production sharing agreement for all oil contracts would be unfeasible. The authorities do not have the human resources needed to supervise and monitor production contracts, mainly because of concerns related to the administrative and accounting reviews of the deductibles needed to estimate the profit oil.

Maximum compensation: Since Round 1.2, the Ministry of Finance announced, in advance of the submission of financial bids, that a minimal compensation was required by the state for each field type, it did not require a maximum compensation. This made the assumption that in an efficient market, companies would know how much to bid. However, in Round 1.3, in order to develop national oil companies, the state encouraged participating companies which had neither knowledge nor previous experience in the sector to overbid; this in turn threatens the development

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‘... THE STATE ENCOURAGED PARTICIPATING COMPANIES WHICH HAD NEITHER KNOWLEDGE NOR PREVIOUS EXPERIENCE IN THE SECTOR TO OVERBID...’

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of the fields that they won. Therefore, starting with Call 1.4, the state has established parameters of maximum compensation that should help resolve the problem of overbidding (the ‘winners’ curse’).

Bonuses: While the signing bonus is an instrument that the law allows to be used in licences, it was not until the deepwater farmout that the Mexican state had considered using it. This makes sense under the logic that the bonus somehow mitigates uncertainty and shortens the time that the state needs to wait to earn income from deepwater projects that take more than eight years to produce the first barrel of oil.

Note that the signing bonus, apart from adding liquidity to the Mexican state, is an efficient element for avoiding speculative deals – such as those which occurred in Round 1.3 where there was no efficient system of incentives/penalties to prevent these.

It would be a positive benefit for the state to use the bonus on onshore licences as a self-selection mechanism for bidders. Only bidders with the highest reputation and experience would have the financial backing to meet high signing bonuses.

It is relevant for Mexico to consider the above, since the higher the level of geological risk, the less likely it is that private companies will bid high levels of bonuses without affecting their bids as far as the percentages of profit and cost oil are concerned.

Taking into account all of the above for fields with high geological risk and long development periods, if the Mexican

state chooses to use bonds, it seems more appropriate to use a system that combines a low signing bonus and a high production bonus. However, it is important to stress that bonds are highly regressive, so they are not recommended from an economic and tax optimization standpoint.

Issues affecting Mexico’s policy

In the future, the state still has several challenges to overcome to achieve the consolidation of private industry operators in supporting PEMEX to develop the country’s reserves. In bidding rounds to date, the authorities have favoured a scheme that seeks to attract companies with high experience and high financial support (apart from in Round 1.3). However, the development of shale in the USA has enabled us to understand that it is only possible to seize this type of opportunity by incorporating independent operating companies and juniors, which are not included in Mexico.

Unconventional resources

For the development of shale resources in Mexico, it is critical that the Mexican state recognizes the quality of the unconventional shale resource and therefore takes into account its particular characteristics and implications in the design of its fiscal, contractual, and financial system. Notwithstanding the peculiar characteristics of shale, there seems to be an attachment to the old fiscal regime paradigm in Mexico that does not distinguish between conventional and non-conventional reservoirs (see the Chicontepec tax treatment under the LISH). Secondary bills on fiscal matters only seem concerned with the differences between oil, and associated and unassociated gas, rather than with different treatments based on the type of reservoir of origin (such as conventional or unconventional reservoirs).

While unconventional resources such as shale have several differences *vis-à-vis* conventional fields, such as those mentioned above, the three most distinctive economic aspects are:

- 1 The productivity of shale wells follows an asymptotic pattern, so a greater economic contribution is recorded during the first two to three years. The later well performance thus becomes irrelevant in economic terms.
- 2 Limited economies of scale due to the continuous investment required to maintain production levels.
- 3 Diminishing marginal returns associated with drilling additional wells.

The above three points imply the need to recognize that the tax system is equally important, if not more so, than the contractual model for the successful development of shale. For this, it would be commendable to develop a third generation licence containing elements such as investment uplift – migration from a vision of windfall via quantity and price

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‘... THE TAX SYSTEM IS EQUALLY IMPORTANT, IF NOT MORE SO, THAN THE CONTRACTUAL MODEL FOR THE SUCCESSFUL DEVELOPMENT OF SHALE.’

to one just in quantity – and a move from specific formation tenders to tenders where the entire geologic column is tendered, to generate an upside to the investors and greater sizes of tendered areas.

Conclusion

Today, following the technological revolution of shale, we live with an oil industry where the market behaves under the paradigm that oil is not as scarce as in the past. Therefore, in this environment, the price of oil is set more by demand than by the supply of the commodity, implying lower prices and margins and thus affecting the disposable income for government take. In such a context, it is critical that state expectations regarding oil revenue adjust and that new players,

able to significantly increase the tax base, can develop and contribute to economic development.

In short, while it is true that the economic model of the contracts developed by Mexico is highly sophisticated and encompasses international best practice, the market environment has undergone a structural change in pricing and technology. Given the drop in international oil prices and increased pressure on national public finances, fiscal policy in Mexico’s oil sector has tended to favour the maximization of tax revenues from PEMEX over optimizing the development of the oil industry. A lower government take to enable the development of the oil industry would contribute to the development of enabling industries (such as construction and services) that would maximize GDP and generate both greater economic benefit and government take at the aggregate level. The latter is especially relevant for the development of onshore projects.



Upstream contracts: has Mexico adopted international best practice for optimal risk sharing in E&P contracts?

Elisabeth Eljuri

Each time there is a new oil opening in a hydrocarbon-rich jurisdiction the dilemma is clear: how much can the state offer to investors to make it attractive, achieve alignment between the state and the investors, and yet not give industry too much? States do not want to feel they have given away more than they had to, but the regulatory regime, including the upstream contracts (‘Upstream Contracts’), cannot stand in the way of full development and commercial success either. In this article, the reference to ‘investor’ includes both an individual

company seeking to enter into an Upstream Contract as well as a group of investors that will enter into such contract together.

Mexico’s Energy Reform of 2013 has opened the door to private investment in exploration and production (E&P) and for that purpose a wide spectrum of contracts was adopted. The variety of contracts that are being used could only be intended to provide the best balance of conditions for the different areas being offered, considering their unique geological profiles and various levels of information and

maturity in the E&P process.

It has long been known that alignment between the interests of the state and the investors throughout the life of the contract is what ensures the longevity of Upstream Contracts. It is in the best interest of the Mexican state, and even more important for the Mexican administration, to avoid future perceptions of unfair imbalances in favour of private operators. There may be some times, due to windfall profits made by investors after price hikes, or occasionally due to savings thanks to



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'IT IS IN THE BEST INTEREST OF THE MEXICAN STATE ... TO AVOID FUTURE PERCEPTIONS OF UNFAIR IMBALANCES IN FAVOUR OF PRIVATE OPERATORS.'
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new technologies over time, when there is a temptation to attack those contracts and initiate a reverse reform or re-nationalization process. This should be prevented at all costs.

That exposure to realpolitik is what this article seeks to address, by reminding the Mexican authorities of the industry's best practices ('Best Practices') that can be followed to ensure both a long-term successful partnership between the state and its investors and, more importantly, the stability and success of the Mexican Energy Reform.

All investments come with some degree of risk, both for the investor and for the state, and there is usually a positive correlation between this and an investment's potential return (see *Leadership Handbook of Management and Administration*, James Berkley, Baker Books, 2008).

However, energy projects are quite unique, for multiple reasons as explained by Thomas Wälde and George Ndi, in the article 'Stabilizing International Investment Commitments: International Law Versus Contract Interpretation' (*Texas International Law Journal*, 1996, 31, 216–20). The most relevant issues are explained below.

- *First*, energy projects are unique in comparison to many other types of projects; they involve transactions between investors and host states over technically challenging activities and are both capital intensive and of lengthy duration.
- *Second*, energy investments are not only long-term fixed investments but are also 'quasi-irreversible'. It has been stated that investors cannot, in the short term, 'pack up and leave'

or, when in negotiations with host officials, convincingly threaten to do so – at least not without incurring great cost.

- *Third*, long-term Upstream Contracts in the energy sector usually involve contracts that include flat royalty and tax rates; these agreements are not always designed to accommodate significant operational changes, such as elevated commodity prices or evolving economic, political, or social conditions.

In our view, based on its long-standing democratic history, it is unlikely that Mexico would be driven by mere political motivations to attack any investments made, as the country has a long tradition of free trade and investment. However, Mexico could be tempted to question whether the Energy Reform was truly successful if the model failed to achieve what the state sought with this reform (factors such as: increased production, wealth for its people, security of energy supply at affordable process, development of an indigenous upstream industry beyond the national oil company *Petróleos Mexicanos*, known as PEMEX, among others).

In no order of hierarchy, some aspects of the industry's Best Practices that the Mexican authorities have, at least partially, tried to observe are:

- 1 Bid selection criteria (which precede the signing of the Upstream Contract).
- 2 An attractive contract duration and objective renewal provision.
- 3 Sufficient exploration opportunities.
- 4 Adequate performance guarantees.
- 5 Balanced state control over operations.
- 6 Proper allocation of environmental liability and adequate abandonment security.
- 7 Appropriate relinquishment terms.

- 8 Reasonable restrictions on change of control and assignments.
- 9 *Force majeure* terms: how to deal with Acts of State.
- 10 International arbitration and waiver of sovereign immunity.

This article seeks to comment on how Mexico has adopted each such Best Practices within its new regulatory and contractual framework. To be as specific as possible, we will comment on Mexico's Round 1 contracts. This round was recently completed and included four separate calls to bid Licences and Production Sharing Contracts, and one deepwater Licence as part of the PEMEX farmout (a special type of joint venture) initiative.

1 Bid selection criteria (which precede the signing of the Upstream Contract)

Mexico has adopted a two-stage bidding process that has, so far, avoided the adverse impact on government take imposed by front-end loaded regimes that are not very attractive.

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'FORTUNATELY, MEXICO HAS STAYED AWAY FROM REQUIRING SIGNIFICANT BID BONUSES UP FRONT.'
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For example, significant bid bonuses for contract awards have not been required, except as noted below for farmouts. The bid selection of Round 1 has, up to now, included bidding an over-royalty to the state, a production sharing percentage (in cases of Production Sharing Contracts), and additional work programme commitments. Mexico has used a well thought out combination of these criteria.

Fortunately, Mexico has stayed away from requiring significant bid bonuses up front. Other than the tie-breaking bonus (for bids that have identical

over-royalty bids), overall the cash bonus component has been minimal.

As an exception to the foregoing, with the more recent farmout bid rounds that started with Trion in December 2016, more significant upfront cash is now required from investors for both a tie-breaking bonus and as part of an agreement to carry PEMEX (which was the case of Trion), or in order to receive an award altogether (such as in the case of Ogarrio and Cárdenas-Mora announced in May 2017).

2 An attractive contract duration and objective renewal provision

Mexico has adopted a relatively acceptable contract duration, although it is on the lower side of best international practices, as investors aim at long-term Upstream Contracts (somewhere between 25 and 35 years), with strong renewal clauses. Investors are willing to take the exploratory risk but will also want to reap the benefits of the opportunity for as long as possible. No automatic renewal clauses have been included in the Mexican contracts. There are of course renewal provisions, but they are not triggered automatically.

In our view, the renewal clause should be almost automatic, if not completely automatic, provided the investor is up-to-date with its obligations under the Upstream Contract, including any fiscal contributions. A renewal clause that gives the state discretion in granting such renewal is unattractive and exposes the investors to potential corruption and other unacceptable risks.

Moreover, the renewal clause should not give the state the right to renegotiate the terms of the contract, or to request additional bonuses, for example.

These duration and renewal-related aspects represent an opportunity for improvement in future bid rounds.

3 Sufficient exploration opportunities

The selection of areas for bidding rounds, as well as their shape and extension, has been decided by the Energy Secretariat (SENER) after somewhat limited consultation with the industry.

Investors want to have adequate exploration opportunities and not have the acreage limited by depth, for instance. Also, investors prefer to retain some potential for area expansion in cases where the expansion is justified, because full development of a discovery would not be possible otherwise. Whether such preferences can be incorporated in the design of areas on offer is something that SENER and the National Hydrocarbons Commission (or Comisión Nacional de Hidrocarburos, CNH) could consider in the preparation of future bidding rounds.

The Mexican contracts contain references to best practices for the unitization of reservoirs located in adjacent contract blocks. A clear regulatory framework is still pending and will be critical to the success of any blocks that require unitization with neighbouring areas. However, the details of such a unitization regime exceed the scope of this article.

4 Adequate performance guarantees

The state, once having selected the investor, will want such an investor to honour its bid and its contract obligations. The state has given exclusivity in a specific acreage to such an investor, to the detriment of other investors that may have expressed interest. Therefore, compliance with the minimum work programme or commitment by such an investor is critical, as is compliance with long-term obligations all the way to abandonment toward the end of the life of the project. (For abandonment security, see point 6 below.)

The bidding rules of the various bids of Mexico’s Round 1 included at least four types of guarantees:

- (a) a bid bond;
- (b) a letter of credit to guarantee performance of the minimum work programme;
- (c) a parent company guarantee or equivalent to guarantee all obligations under the Upstream Contract;
- (d) a trust to guarantee abandonment obligations.

Some of the winners of the bidding process realized, after being awarded blocks, that they were not able to fulfil their commitments and preferred to exercise their option to allow foreclosure on the bid bond, rather than sign the Upstream Contracts; this allowed the second-placed bidder to take their place as winner.

States can request a myriad of guarantees but the Mexican authorities have so far been reasonable by requiring the most common ones. On the main guarantees requested, we offer the following comments:

- (a) as to financial security guaranteeing the minimum work commitment (such as bonds or letters of credit), we note that letters of credit are very expensive and in some cases, not all, they could be substituted with surety bonds at a much lower cost to the investors;
- (b) in respect of the parent company guarantee for the Upstream Contract obligations, including environmental liabilities, we note that there has been an

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‘STATES CAN REQUEST A MYRIAD OF GUARANTEES BUT THE MEXICAN AUTHORITIES HAVE SO FAR BEEN REASONABLE BY REQUIRING THE MOST COMMON ONES.’



improvement in the more recent deepwater bid, allowing the guarantee to be capped under certain circumstances. Not all bids included this option but we welcome the improvement. In short, uncapped guarantees by the ultimate parent company, as currently required in the Mexican contracts (with the exception of the deepwater bid round), may seem unacceptable to larger companies, due to the exposure it represents.

Overall, the key factor is to avoid making these guarantees so onerous that they then make the Upstream Contract unattractive.

(See also our comments below on international arbitration. All guarantees should be subject to a neutral and independent forum which ideally would be the same as the one provided in the Upstream Contract.)

5 Balanced state control over operations

Depending on the Upstream Contract in question, the state will want to preserve a greater degree of control over operations by the investors. The key is that such control cannot be excessive since that would basically prevent the investor from applying its international oil and gas expertise in full. The state has invited such investors in order to benefit not only from their capital investment but also from their expertise, including the use of advanced technologies.

The new contracts include provisions that give CNH the ultimate say over many investment and operating decisions. This is a suboptimal administration practice. Unless a development or operating approach proposed by an operator is bound to materially and objectively affect the ultimate recovery of the resources in a negative way, operators should be free to make their own technical and

financial choices. The Best Practice for the following up of development and operations by the state implies an alignment of interests with the operator, so that the operators are free to choose the best approaches based on their own best judgment.

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‘THE NEW CONTRACTS INCLUDE PROVISIONS THAT GIVE CNH THE ULTIMATE SAY OVER MANY INVESTMENT AND OPERATING DECISIONS.’

6 Proper allocation of environmental liability and adequate abandonment security

In areas where there have been prior activities, environmental baselines are required so that any pre-existing environmental damage (prior to entering into the Upstream Contract) should be borne by the state or the predecessor operator of that acreage. Such pre-existing damage should not be inherited by the new investor group. That is a basic, but very critical, principle applied in this industry.

The contract should have clear rules on how to allocate such pre-existing liability – for example, a requirement for baseline studies, notices, and presumptions of liability. Some of these rules have been included in the new Mexican contracts. However, there has been a major deterioration between the rule contained in the first farmout, Trion (where pre-existing damages are born by the predecessor operator) and the more recent farmout opportunities being offered (Ogarrio and Cárdenas-Mora). For these, in the first drafts made available at least, there has been an attempt to impose pre-existing liabilities on all investors and PEMEX, on a pro rata basis. This is quite unprecedented and should be urgently changed.

On a related subject, security

requested from the investor for abandonment obligations should be reasonable, but sufficient for the state to ensure that the investor will honour any remediation and abandonment obligations that may arise, even after the Upstream Contract has ended. All of this should be clearly regulated in the contract; typically security is either in the form of an abandonment trust, or some other form of guarantee. Contract provisions in Mexico’s Round 1 require a trust with a Mexican bank. In our view, some of the details could be improved – allowing international banks, for instance, would be a welcome change.

7 Appropriate relinquishment terms

The Mexican Round 1 contracts have included rules relating to when operators can terminate their obligations with no further liability. Clearly, prior to completion of the minimum work commitment, there is an exposure because investors have committed to such works or investments. But after such work is completed, the Upstream Contract allows an investor to depart by withdrawing or relinquishing (all being subject to proper notice to the state and any surviving obligations such as abandonment). No contractual penalties apply since the investor is free to leave and the state would retain the acreage in full (including the reserves on the ground). Thereafter, the state can, for instance, re-award such acreage to another investor or its national oil company.

8 Reasonable restrictions on change of control and assignments

Mexico should make an effort to allow a secondary market to be developed and to continue over time. This is critical to the success of the Energy Reform. Such flexibility is not entirely clear at this stage, as the rules for such assignments have only been recently

adopted by CNH and will need to be tested; any such requests for changes of operatorship or control will still need to be approved by the contract administrator (CNH).

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‘MEXICO SHOULD MAKE AN EFFORT TO ALLOW A SECONDARY MARKET TO BE DEVELOPED AND TO CONTINUE OVER TIME.’

Upstream Contracts should allow investors to effect assignments or changes of control in their group without significant red tape. Typically, the state will want to approve any assignments or changes of control that effectively mean that a third-party investor will come into a block. However, the process should be clear and, provided certain operational, technical, and financial conditions are met, such an assignment or change of control should be allowed.

The early adoption and publication of objective requirements for future assignments should, in theory, provide legal security and assurances that the CNH will not impose excessive conditions in order to approve a future change in ownership. Over time, the new assignment rules, published by CNH on 30 January 2017, will be tested and an assessment will be possible.

9 Force majeure terms: how to deal with Acts of State

The Mexican Round 1 contracts include *force majeure* clauses. As is common in this industry, there may be circumstances outside the control of an operator that could prevent the continued development, or the operations, of an asset; the *force majeure* nature of such circumstances could be in dispute, or their presence could extend over time.

As for any long-term project, energy projects are significantly exposed to unexpected events that qualify as *force majeure*. The Upstream Contract

should have clear rules and deal with matters such as when it is reasonable for the investor to be released of its obligations if a case of *force majeure* continues for a long period of time. Moreover, the state should not be able to take away a contract simply because an investor is in extended *force majeure* (because that would be confiscatory). The state should work together with the investor to solve it. Examples of such an event are: a boundary dispute with a neighbouring country, war, or a lack of permitting that is not the investor’s fault.

When PEMEX is involved in an Upstream Contract, it cannot be allowed to allege *force majeure* in relation to an Act of State (due to the shareholding relationship between the state and PEMEX). Hence, Acts of State can usually only be alleged as a form of *force majeure* by private investors. However, this specific exclusion is not present in the farmout contracts offered in Mexico to date.

The application of *force majeure* as and when required in the future, by the appearance of unforeseen events, will test the capacity of the state to accommodate the underlying principle to the realities of this industry. It is not uncommon to see third parties trying to block operations with social or environmental arguments and operators consequently invoking *force majeure* in those circumstances.

10 International arbitration and waiver of sovereign immunity

Lastly, one of the top three qualities of an Upstream Contract, from an investor’s perspective, is whether such a contract has a neutral and independent forum in which disputes between the state and the investor can be solved. This means an international arbitration clause, selecting both international rules of arbitration as well as a neutral city for the arbitration (outside the host state).

This is not entirely the case with Mexico’s Round 1 contracts. Unfortunately, Articles 20 and 21 of the Hydrocarbons Law have created a mandatory split in the jurisdictional choice. Even though the Licences and Production Sharing Contract of Round 1 contains an international arbitration clause, any disputes related to cases of administrative rescission of such contracts are subject to the Federal Courts of Mexico. Therefore, there is a carve out of disputes that need to be referred to the Mexican courts and they will not be covered by the arbitration provisions of the contract. This has created significant heartburn in the industry and ideally it should be changed over time. Many procedural details are included in the dispute resolution provisions to mitigate this risk, and to attempt to preserve the right to due process and arbitration as much as possible.

Moreover, the Upstream Contract should also include a full waiver of sovereign immunity by the state. Otherwise, the enforceability of such arbitration awards becomes illusory and grants very limited value to the investor. This is also an area with ample room for improvement in Mexico, at least from the perspective of a foreign investor.

Conclusion

The foregoing is by no means an exhaustive review of how successful the new Mexican Upstream Contracts have been in reflecting international Best Practices. However, in our view, it does include the key terms that investors wish to see in such contracts in order to ensure long-term success for both the Mexican state and the investor. We trust that this article provides an educated view on areas for potential improvement in the Mexican contracts, with the objective of ensuring the attractiveness of those private investments that will underpin the success of the Energy Reform.





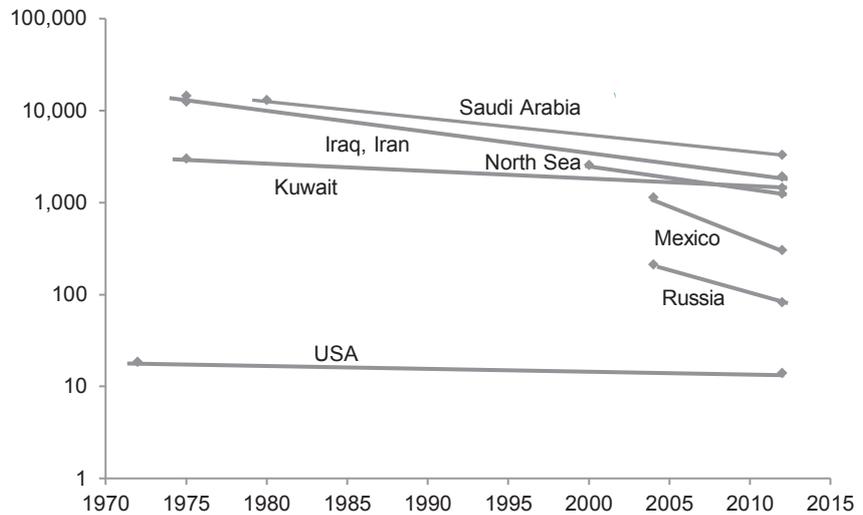
Mature oil fields need tax incentives: the Mexican case

Rafael Sandra and Ivan Sandra

Mature oil fields, sometimes referred to as 'brown' fields, are essentially fields that have past their peak production potential and are on the decline. According to a recent IHS report ('Mature Fields Hold Big Expansion Opportunity', Joel Parshall, *JPT*, October 2012), about two-thirds of the world's crude oil production comes from mature fields, a consequence of reserves depletion. In the case of Mexico the corresponding estimate is also close to the worldwide average, or higher. Continuing to add reserves is the only way to maintain and increase production, and the only two ways of replacing them are *exploration* and *improved/enhanced oil recovery or IOR/EOR*.

- *Exploration* finds new reserves which often take years to put on stream.
- *IOR/EOR* has the potential to generate fresh reserves by complementing the natural energy of the resources already discovered and extending field production for years.

Today, the development of a new field would generally include IOR (gas or water injection) from start-up, to maintain the pressure of the reservoir. Historically, EOR would come later on to recover an additional 10–20 per cent of the remaining oil in place. This is the technology associated with the exploitation of mature fields.



Crude oil production: major producing countries (barrels a day per producing well)

Sources: EIA; O&GJ.

Unfortunately, EOR does not seem to attract a similar level of interest as exploration in many countries. To put this into perspective: the global contribution of exploration has been about 10 billion barrels (Bbo) of new oil reserves per year over the last five years, whilst an increase of just 1 per cent per year in the recovery factor from EOR could bring 80 Bbo of fresh reserves per year. However, only a fraction of the potential of EOR is being realized.

Production from several major oil producing countries, including Mexico, is on the decline (see figure above).

Six countries (the USA, Venezuela, Canada, China, Trinidad, and Indonesia) already have broad field experience with EOR (see table below) while others (India, Saudi Arabia, Oman, Malaysia, to name a few) are just beginning the cycle. Today, less than 3 per cent of world crude oil production comes from EOR – the USA has the highest EOR production, about 12 per cent of its domestic production. Mexico is one of the largest oil producers but has had very limited field experience with EOR – barely one project (CO₂ in Sitio Grande field) so far. However, its recent reforms give

Active field EOR projects worldwide

Thermal	No. of projects	Miscible gases	No. of projects	Chemical	No. of projects	Biological	No. of projects
Steam	145	CO ₂	133	Polymers	24	Microbial	3
Combustion	15	Hydrocarbon	37	Surfactants	3	Nitrates	2
Hot water	2	Acid gas	1				
Total	162	Total	171	Total	27	Total	5

Notes: A total of 365 projects across: Argentina (1), Brazil (8), Canada (39), China (36), Colombia (2), Egypt (1), Germany (9), India (3), Indonesia (2), Mexico (1), Netherlands (1), Norway (2), UK (1), Trinidad (11), USA (200), and Venezuela (48). Source: 'Worldwide EOR Surveys', *Oil and Gas Journal*, Vol. 112.5, 5 May 2014.

strategic importance to developing mature fields.

It is often said that the primary reason why EOR has not been the preferred investment choice of the international oil industry is because the economics of finding new reserves (notwithstanding access challenges), when compared with generating fresh reserves from existing fields, have always favoured the former. However, global finding and development (F&D) costs for new reserves have been on the increase, doubling from USD11 per barrel in the 1990s to about USD22 today (see 'A Look at Key E&P Metrics', Enercom Inc., *Oil & Gas Financial Journal*, July 2015; EIA-28 Financial Reporting System). The high-end values refer to deepwater US Gulf of Mexico. On the other hand, CAPEX requirements for implementing EOR are in the range of USD3–15 per barrel of fresh reserves.

From a technological point of view, there are three main types of EOR and each has its poster child (see table on the previous page):

- *Thermal* EOR uses steam as its most popular technology;
- *Miscible* EOR alternates between CO₂ and natural gas as the preferred injection fluid, depending on availability;
- *Chemical* EOR which principally utilizes surfactants.

Polymers are generally used as viscosity buffers in water injection projects. Today, steam and miscible gases together account for 86 per cent of all active EOR projects, while interest in chemical EOR is at its lowest point – only three surfactant projects are now active in the USA compared with more than 200 in the mid 1980s (see 'Worldwide EOR Surveys', *Oil & Gas Journal*, Vol. 112.5, 5 May 2014). Acceptance of chemical EOR methodologies quickly fell off because

of an inexplicable mix of successes and failures, some even in the same field. The process was not fully understood at that time. We have surpassed that stage and now have a better hold on the DNA of the reservoirs. Nonetheless, industry still remains reticent about the experience. Biological EOR is still in an early stage of field development, and the small number of active projects are mostly pilot scale.

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'THE MAIN OBJECTIVE OF EOR IS TO INCORPORATE FRESH RESERVES FROM KNOWN RESERVOIRS BY INCREASING THE RECOVERY FACTOR.'

In terms of costs, advanced waterfloods (AWFs) using nitrates, low salinity water, and cyclic surfactants are the lowest, while CO₂ and steam injection are the highest. OPEX costs are very important in EOR projects, not only because of the cost of materials (such as CO₂ and chemicals) but also due to the fact that projects are applied to marginal fields already nearing their economic limit. These facts are key determinants that need to be addressed in specialized contractual agreements proper to EOR and mature fields, so companies/investors can start to consider making EOR part of their portfolios.

The main objective of EOR is to incorporate fresh reserves from known reservoirs by increasing the recovery factor. Historically, recovery factors have been low across mature fields, with an estimated worldwide average of 22–25 per cent. The North Sea has an average recovery factor nearing 50 per cent, while the US average is 40 per cent. In contrast, Mexico's average recovery factor is a low 18 per cent. The North Sea has achieved its high recovery efficiency because of two advances:

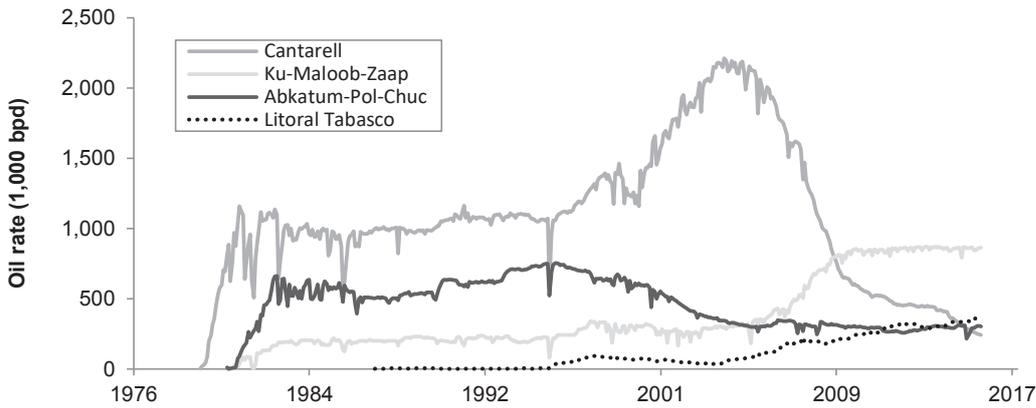
- (a) intensive efforts in IOR methods such as: re-injection of stranded gas and waterflooding, both from the *onset* of the development of the fields, and
- (b) the support of well thought-out tax incentives as a consequence of the relatively high-cost nature of the operating environment.

There are few EOR projects in the North Sea; they are limited to two large miscible natural gas projects and a recently started low salinity AWF project. These are also the only full-field EOR projects in offshore fields anywhere in the world. Offshore EOR presents complex, expensive logistics.

The opportunity for Mexico

Mexico is a major oil producing and exporting country. Large-scale production started in the early 1900s, peaked at 3.4 million b/d in 2004, and subsequently declined at a higher than normal rate of 9 per cent per year. By the end of 2016, production had dropped to a little over 2 million barrels a day (mb/d) and exports to 1.1 mb/d, with about half going to the USA. Mexico's production is rapidly approaching a critical juncture. In an effort to brake its decline trend, the country made some sweeping reforms in 2013 that led both to the opening of its oil and gas industry to private oil companies and to partnering opportunities for *Petróleos Mexicanos* (PEMEX). The declared focus is on boosting offshore exploration and revitalizing Mexico's numerous mature offshore and onshore fields, in particular those with original oil-in-place (OOIP) greater than 400 Bbo.

A recent report prepared by the National Hydrocarbons Commission (or *Comisión Nacional de Hidrocarburos*, CNH) (*The Future of Oil Production in Mexico: IOR-EOR*, CNH, 2012) states that Mexico has some 700 oil fields containing 250 Bbo of OOIP, of which



Production profiles – Mexico’s offshore fields

44 Bbo had been produced by the end of 2016. This gives a low recovery factor, nearing 18 per cent. Mexico has been successfully injecting water in several of its fields since as far back as 1951 (Poza Rica) (see ‘EOR Projects in Mexico: Challenges and Opportunities’, Fernando Rodriguez de la Garza, V Congreso Anual Conjunto de Asociaciones del Sector Energético, Mexico, 21–22 June 2013). However, only 11 other fields have benefited from water injection, among the largest: San Andres (1961), Tamaulipas-Constitucion (1968), Sitio Grande (1977), and Abkatun (1991). Regarding gas injection for pressure maintenance, two world-class nitrogen projects take the stage: Cantarell (2000) and Ku-Maloob-Zaap (2008). The latter is currently the largest producing oil field in the country (see figure above). Mexico’s single EOR project has been miscible CO₂ injection in the Sitio Grande field (2006).

Mexico has several giant oil fields with high quality reservoirs – see the columns of OOIP and reservoir quality index (RQI) in the table overleaf. Inexplicably, the application of IOR/EOR has been limited to only a few fields and this is evident in the overall recovery factor. A case in point is the giant Panuco field (see ‘Panuco Block – Executive Summary’, PEMEX, June 2011) within the Poza Rica cluster. This

heavy oil (11–13°API) field has an OOIP of 6.8 Bbo with a good RQI of 4; more than 1,600 wells have been drilled and production peaked at 291,000 b/d in 1924. The recovery factor is 10 per cent. This field should have been a top candidate for huff-and-puff steam injection (an EOR technique in use since the 1940s in Venezuela and the USA). Nonetheless, it was left to a slow death as production declined slowly, to below 2,000 b/d by 2012.

The CNH report considers 101 fields with a total OOIP of 140 Bbo as the most suitable for the application of

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‘INEXPLICABLY, THE APPLICATION OF IOR/EOR HAS BEEN LIMITED TO ONLY A FEW FIELDS AND THIS IS EVIDENT IN THE OVERALL RECOVERY FACTOR.’

EOR. These fields are grouped in nine clusters (see table overleaf) and had produced 35 Bbo through 2012. The recovery factor for this select group is 25 per cent. This table provides a quick look at vital field metrics such as size (OOIP), recovery factor, peak production, oil gravity, and RQI (see ‘New Reservoir-Quality Index Forecasts Well-Productivity Worldwide’, Rafael Sandra and Donald Goddard, *Oil & Gas Journal*, Vol. 114.12, 5 December 2016), together with fresh reserves

expected to be obtained via EOR. Most likely, these are the fields scheduled to be licensed or farmed out during the course of this and coming years.

The report further postulates that EOR can recover an additional 10 Bbo of oil, which will generate a production potential of 1 mb/d, and it also provides a breakdown of the genres of EOR that they consider will be most applicable for the different fields. In synthesis, miscible gases (CO₂ and hydrocarbon gases) are the dominant choice for all the fields. Additionally, *in situ* combustion and alkaline/surfactant/polymer (ASP) slugs pushed along by water injection are secondary choices for the Cinco Presidentes fields. The expected volumes of EOR oil to be recovered for each field are shown in the table overleaf. Cantarell and KMZ together account for half (52 per cent) of the 11 Bbo of EOR oil; two-thirds of the expected EOR potential would come from heavy oil in offshore fields – both very high-cost settings. Moreover, neither natural gas nor CO₂ is readily available in the volumes required, which would incur additional costs.

Most of Mexico’s mainstay oil fields are ageing (see graphs of production profiles above and on page 35) and fast becoming economically marginal. Increasing outputs from the KMZ and

Attributes of major oil fields – Mexico

Fields ¹	Peak production (1000 b/d, year)	Production 2012 (1000 b/d)	Cumulative production (Bbo, 2011)	API gravity	Formation lithology	Depth ² (ft)	Net Thickness (ft)	Permeability (mD)	Porosity (%)	RQI ³	OOIP (Bbo)	RF ⁴ (%)	Expected EOR (Bbo)
Cantarell (10)	2,192 (2004)	454	14.0	12–25	Carbonate	115 + 8,423	500	>1,000	10	17	35	40	2.3
Ku-Maloob-Zaap (23)	855 (2012)	855	3.4	12–25	Carbonate	330 + 9,400	1,000	>1,000	10	25	37	9	3.4
Abkatum-Poi-Chuc (12)	755 (1995)	266	5.4	28	Carbonate	112 + 9,850	750	>1,000	10	19	15	36	1.0
Litoral Tabasco (16)	367 (2015)	319	0.3	39	Carbonate	80 + 10,700	500	150	8	1.5	7.6	4	0.8
Samaria-Luna (8)	653 (1979)	205	3.2	30	Carbonate	0 + 13,120	575	100	6	0.7	10	32	0.7
Bellota-Jujo (5)	440 (1986)	130	3.0	27–38	Carbonate	0 + 16,000	800	100	5	1.2	6.6	45	0.5
Macuspana-Muspac(4)	409 (1979)	75	1.0	35	Carbonate	0 + 10,000	500	75	8	0.8	3.0	33	0.2
Poza Rica (17)	217 (1970)	68	4.0	32	Carbonate	0 + 7,625	575	100	11	1.6	22	18	1.8
Cinco Presidentes (6)	166 (1972)	96	0.9	35	Sandstone	0 + 9,760	200	200	20	2.0	3.6	25	0.3
Totals (101)		2,518	35								140	25	11

Notes:

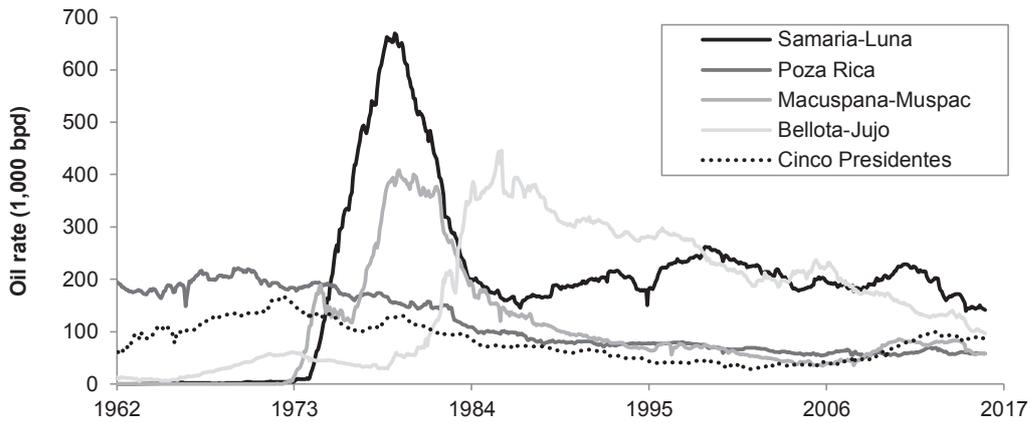
1 Parentheses indicate the number of active fields in the cluster. Reservoir characteristics correspond to the most representative field.

2 Depth = water depth + reservoir depth below the seabed.

3 Reservoir quality index (RQI) is a measure of reservoir quality that collates five static geo-parameters: permeability, porosity, net pay, pore pressure gradient, and heterogeneity into a single number (index). As a guideline, Ghawar's RQI is 9. See Rafael Sandrea and Donald Goddard, 'New Reservoir-Quality Index Forecasts Worldwide', *Oil & Gas Journal*, Vol. 114.12, 5 December 2016.

4 Recovery factor (RF) = cumulative production / OOIP.

Sources: National Commission on Hydrocarbons (CNH); PEMEX Annual Reports; other reports.



Production profiles – Mexico’s onshore fields

Litoral Tabasco clusters are the result of new field discoveries. EOR is the last resort for prolonging the life of these existing valuable assets and for recovering as much as possible of the large quantities of remaining oil in the ground. This is Mexico’s challenge. However, to achieve this lofty EOR goal of 10 Bbo would require huge investments, in the order of USD150–200 billion, and this would call for very attractive incentives to shift investors onto this new track.

In addition to the previously mentioned EOR technologies, we would like to

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‘MOST OF MEXICO’S MAINSTAY OIL FIELDS ARE AGEING AND FAST BECOMING ECONOMICALLY MARGINAL.’

highlight three new field-proven technologies that could have a major impact on Mexico:

- (a) *Down-hole steam generators* that extend the steam injection process to heavy oils well beyond the current depth limit of around 2,500 feet and allow steam to be injected in laterals as long as 10,000 feet (see www.eSteamoil.com).
- (b) *Portable on-site nitrate generators*

using air as input drastically reduce the cost of this chemical. Nitrate-AWF generates *in situ* surfactants that add 10-plus recovery efficiency points to standard water floods (see ‘Advanced Nitrate-Based Technology for Sulfide Control and Improved Oil Recovery’, D. M. Dennis and D. O. Hitzman, SPE 106154, Society of Petroleum Engineers, 2007).

- (c) *Huff-and-puff surfactants* that primarily complement ongoing water injection projects post water breakthrough. This process has been effective in both light and heavy oil reservoirs, including those with oil as low as 11°API (see ‘Cyclic Surfactant AWF’, www.newport-energy.com).

Final remarks

EOR CAPEX is now very competitive with exploration F&D costs. Worldwide, there are more than 1,500 world-class oil fields – those with 100 million barrels or more of reserves – and thousands of smaller fields that are prime EOR candidates. A recent paper (‘Approach Screens Reservoir Candidates for EOR’, Rafael Sandra and Darshill Dharod, *Oil & Gas Journal*, Vol. 114.4, 4 April 2016) provides a template-style

methodology for screening these potential reservoir candidates for EOR. EOR is no longer an end-of-life recourse. Field experience in the North Sea has shown that early implementation of IOR/EOR produces higher recovery efficiencies.

The stage is all set for EOR to make an impact on future global supplies of crude oil, and Mexico has a great opportunity to make it work on a large scale. For investors, it requires significant CAPEX over the long term, with payouts that are characteristically drawn out for five to eight years. So how can the producing countries jump start this effort? The obvious pathway is tax incentives and contracts that specifically address the development of mature fields. Additional regulations and incentives that consider decommissioning costs/liabilities also need to be considered.

The best example of the successful effects of tax incentives is the current shale gas/tight oil revolution which has extended the gas reserves of the USA to 100 years and boosted oil production by 5 mb/d. Tax incentives were put in place in the early 1980s and the results are astounding.



Implementation of Mexico's downstream and midstream reform

Adrián Lajous

In December 2013 Mexico launched an ambitious and wide-ranging reform programme (the Reforma Energética) aimed at transforming its energy sector. By the early 2020s, the position of the oil and gas industry should therefore be dramatically different from that which prevailed until recently. The state monopoly under which it operated for 75 years is coming to an end.

Competition is being introduced in final product markets and private investment is searching for opportunities across the industry. In some areas, substantial capital flows have made their imprint. New players are entering under new rules of the game. Government is learning to intervene indirectly through independent regulatory bodies subject to market-based rules – even if at times it is tempted to revert to its traditional role. Petróleos Mexicanos (PEMEX), the incumbent, has been further weakened by a combination of low prices, severe financial restrictions, and institutional decay. Under these conditions the state oil company has not been able to play the constructive role it had been assigned in the implementation of the reform.

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'PEMEX NEVER PREPARED ITSELF ... FOR THE INEVITABLE SHIFT FROM LOW-COST SHALLOW-WATER OIL PRODUCTION TO HIGH-COST DEEPWATER EXPLORATION ...'

The timing of reform could not have been worse. Mexico had allowed PEMEX to deteriorate for too long, depleting its natural, human, and institutional resources. The state oil company is highly indebted, overtaxed, and subject to secular underinvestment. Middle management is deeply averse to change. Production in the first quarter of 2017 had declined by

1.4 million barrels a day (mb/d) from its 2004 peak. PEMEX never prepared itself, either technically or financially, for the inevitable shift from low-cost shallow-water oil production to high-cost deepwater exploration and unconventional resource development. For many years it has been allowed to operate its refineries at the lower limits of the fourth quartile among its peers. During the first three years of the current administration PEMEX was further weakened by gross mismanagement, forgoing many opportunities offered by the Mexican Energy Reform. It is also unprepared for the challenges that a competitive environment will raise.

The enabling laws of the Energy Reform Bill were published shortly before oil prices collapsed and very low prices prevailed for longer than expected. The global oil industry had to rigorously enforce capital discipline and limit expenditure. This affected competition in bidding for access to Mexican upstream assets and delayed the build-up of initial work programmes. PEMEX budgets were abruptly slashed after a slow initial adjustment, generating a severe liquidity crisis. Under these circumstances the state oil company assumed a passive role in the implementation of the Energy Reform and, at times, resisted or managed to defer specific initiatives.

Natural gas

The reform and transformation of Mexico's midstream and downstream natural gas industry is advancing successfully. However, in the upstream, the production of natural gas has declined at an accelerating rate. This is explained by the maturity of the reserve endowment and a dramatic fall in rig

count following the oil price collapse. The growth of the country's natural gas demand and of imports has required a significant expansion of the Mexican gas transport system, of its interconnections with US pipelines at the border, and from these to the south and west Texas hubs. More gas was needed to accommodate the prospective growth of industrial demand and, more importantly, the demand from the power sector, which has based its capacity expansion on a combination of gas-burning, combined-cycle (CCGT) sets and, to a lesser extent, renewable resource generation. Additional pipeline infrastructure will be built over the next two years; most of this is now under construction, thus fulfilling the first five-year (2015–19) capacity expansion programme. This will allow the evacuation of Permian gas to north-western Mexico and eventually to central Mexico, and also augment the supply from south Texas.

This new infrastructure, developed by private investors, has been accompanied by the liberalization of domestic natural gas markets and the imminent introduction of market pricing. This process will be rolled out gradually by the Comisión Reguladora de Energía (CRE) during the second half of 2017, beginning with the north of the country and followed by central Mexico. Asymmetric regulation will reduce the incumbent's market share and PEMEX has relinquished its natural gas transport infrastructure to an independent system operator (CENAGAS), which is now its owner and operator. It will also have to release 70 per cent of its current contracts over a period of four years and buyers can easily opt out from existing contractual arrangements. Lastly, the results of the 2016–17 open season for transport and



border crossing interconnection capacity have been made public.

Gross total production of natural gas reached its peak in 2009, when PEMEX extracted 6.5 billion cubic feet a day (bcf/d). Since then it has steadily declined to 4.3 bcf/d (in the first quarter of 2017) a drop of 2.2 bcf/d. Practically all of this fall can be attributed to the reduction in non-associated gas production from mature legacy basins, which peaked in 2007. By the first quarter of this year, production from these fields had contracted by more than 60 per cent. Field-by-field analysis shows that total output from producing fields will continue to fall during the rest of this decade, at least. What is under discussion today is the decline rate in this period.

Mexican natural gas imports grew rapidly from 2014 to 2016, increasing by approximately 2 bcf/d. Previously, they had expanded substantially in 2011 and 2012, but had faced serious bottlenecks in the north-south trunkline to central Mexico and overland flows had to be supplemented with LNG. Pipeline imports from the USA are now dominant, representing 88 per cent of total natural gas imports in 2016. They will further displace LNG over the next two years. In 2016, pipeline imports reached 3.8 bcf/d, while outflow from LNG regas facilities averaged 0.5 bcf/d. A conservative estimate of 2020 imports from the USA is 6 bcf/d, based on an average yearly growth of 0.5 bcf/d and the elimination of Mexico's LNG imports. This volume is comparable to the expected US LNG export capacity in 2020. (At that point, five US LNG liquefaction facilities are expected to be onstream, with a capacity of approximately 9 bcf/d, but actual offtake could be significantly less.)

PEMEX sales of domestic production to third parties have contracted at a rapid pace, increasing the need for imports.

In the first quarter of 2017, after covering its own-use requirements, PEMEX dry gas sales from its own production dropped to less than 1 bcf/d. This volume will tend to fall at a significant rate up to 2020, further reducing the company's share in the domestic market. However, precise volumes are difficult to forecast given the current economic uncertainty affecting Mexico. Imports would be negatively impacted by lower economic growth and a slowdown in electricity and industrial demand. On the other hand, delays in Mexican upstream projects and a greater than expected natural gas production decline would further strengthen natural gas import demand.

In the short and midterm there is little that Mexico can do to reduce its natural gas import dependence and supply vulnerability. Possible measures are costly and have a limited effect. In the longer term, domestic production could expand substantially with the development of both the Chicontepec basin and the shale resources from the extension of the Eagle Ford formation into Mexico, as well as from other plays in the Burgos and Sabinas basins. Their development, however, will require substantial capital, the adoption of best practice techniques, critical managerial skills, credible environmental stewardship in ecologically fragile areas, appropriate regulatory and fiscal regimes, and time. These projects could, optimistically, mature in the second half of the 2020s and the early 2030s.

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'IN THE SHORT AND MIDTERM THERE IS LITTLE THAT MEXICO CAN DO TO REDUCE ITS NATURAL GAS IMPORT DEPENDENCE AND SUPPLY VULNERABILITY.'

Four key measures have been implemented in the midstream and

downstream natural gas industry and a fifth one will begin shortly. These are:

- (a) the October 2015 transfer of ownership and control of PEMEX legacy high-pressure transport infrastructure to a different operator (CENAGAS);
- (b) the allocation of gas transport capacity to PEMEX and the CFE (Comisión Federal de Electricidad) for their own consumption of natural gas;
- (c) the first phase of a four year gas release programme by which PEMEX relinquishes up to 70 per cent of contracted natural gas volumes;
- (d) the launching, in May 2017, of an initial open season for firm transport capacity that assigned excess capacity in the CENAGAS integrated pipeline system and in selected import entry pipelines; and
- (e) the adoption, in the second half of 2017, of market prices in areas where effective competition prevails.

These efforts build on work carried out in previous reforms, some of which was partially successful. In 1995, private investment was permitted in gas transport and distribution pipelines and netback prices began to be set monthly, through spot-related formulas linked to Henry Hub prices.

By July 2016 the CRE had granted 60 natural gas marketing permits to companies that will import gas from the USA and this number has continued to grow. Affiliates of all the large-scale gas consumers are included in this list. With firm capacity transport contracts, the regulator can now begin to free natural gas prices. On 1 July 2017 a regime of natural gas market pricing and firm transport contracts should be in place in northern and central Mexico. It is doubtful that price deregulation will extend, in the short term, to the south-east of the country because of

limited competition in that region. The regulator will continue to set the prices of first-hand PEMEX sales in this region through spot-related formulas linked to Henry Hub. In all cases, the pricing transition should be relatively smooth, as the deemed size of the adjustment to market prices is not large.

Oil products

The success of natural gas reform has not been matched by developments in the midstream and downstream sectors of the refining industry. Little private investment has been allocated to their activities, market liberalization is advancing more slowly, and there are a number of major issues that must be resolved for key objectives to be achieved within the proposed time frame. Policy makers and regulators were unaware of the much greater complexity involved in liberalizing the larger, multi-product, and multi-market refining and marketing industry. Prior to this reform, CRE was exclusively involved with natural gas and had only recently expanded its scope to LPG. This explains why both their experience and knowledge of the oil products markets were limited. Under these circumstances, the design of a competitive oil liquids market advanced at a slower pace and has not been fully worked out. Also, the natural gas supply crisis of 2013 had given this fuel greater priority, while the upstream concentrated the attention of government.

Having spent a large part of their political capital in congressional and trade union negotiations, on exploration and production issues, and in natural gas, government authorities did not engage in a detailed legislative discussion of refining and marketing and preferred to address outstanding issues through the regulatory process. One example of this was the treatment that was given to the existing liquids

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'PEMEX REFINERY OUTPUT HAS CONTRACTED SIGNIFICANTLY IN THE LAST THREE YEARS, AUGMENTING OIL PRODUCT IMPORT DEMAND.'

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infrastructure, where the incumbent was allowed to maintain ownership and control through PEMEX Logística, a wholly owned subsidiary. More importantly, the pressing need for private investment in upgrading refineries was excluded from the agenda. The PEMEX trade union and left-wing opposition in Congress adamantly objected to any form of privatization of existing assets.

PEMEX refinery output has contracted significantly in the last three years, augmenting oil product import demand. Infrastructure constraints, mainly the result of secular under-investment, have increased supply costs as pipeline transport capacity was supplemented with higher-cost trucking of oil products. Limited storage and terminal capacity have dangerously reduced product inventory in key regions and increased transport requirements. The supply of imports has modified traditional transport patterns while rapid urbanization has forced, in some instances, the reallocation of terminals; long-haul oil products trucks are affecting road traffic, increasing safety risks; in addition, the massive theft of oil products, particularly gasoline and diesel, has created a significant black market, which raises difficult problems for liberalization. As the market opens to competition, the guaranteeing of product fungibility in the logistical system will be particularly challenging.

The most severe deterioration of PEMEX's performance has occurred in its refineries. In the second half of 2016, capacity utilization hardly exceeded 50 per cent. Many factors combine to explain this disastrous outcome, the

most direct one being the reduction of refining operating and capital expenditures – the result of draconian budget cuts in 2015 and 2016. However, it must be stressed that refining activities have been mismanaged over a long period, due to the compounding effects of rapid managerial decay in combination with budget cuts. The PEMEX refining division has consistently incurred significant losses over the last 25 years. In 2015, the most recent year for which financial results can be disaggregated, net losses surpassed the threshold of USD7 billion.

Market liberalization without the privatization of existing assets raised difficult issues that have restricted private investment in the Mexican refining industry. This political decision is at the heart of a major design flaw in the reform; it has been particularly costly in the short term given the capital and operating expenditure constraints faced by PEMEX. Changes in the upstream allowed greater flexibility through farmouts – a special form of joint venturing. In the case of natural gas, the expansion of the pipeline system was carried out with private investment, while legacy gas pipelines were fully transferred to an independent system operator. The CFE played a key role in financing new infrastructure by acquiring long-term firm capacity in pipeline projects.

These types of options were not initially contemplated in the refining reform programme, which lacks a range of strong and credible promoting agents as alternatives to the incumbent. Given the nature of the oil products market structure, large-scale, long-term buyers were unavailable or unwilling to assume the risks involved in developing infrastructure under the new regulatory framework before it was fully developed and actually tested. Assurances of the timely adoption of market prices were also needed. However, these could



only come about after PEMEX had assigned capacity in its logistical infrastructure through open seasons, or when new capacity had actually been built by private parties. These sequencing issues led to a vicious circle which is being resolved piecemeal, and no major projects have been built. This is delaying the effective entry of competitors, but they will eventually emerge when a certain momentum has built up.

The process of partnering in PEMEX refineries confronts what appear to be insurmountable obstacles. Private investment falters before the particular labour relations and practices, trade union power, and the vested interests of union leadership in refinery operation, maintenance, and transport. Excessively high head counts erode workplace discipline, while enormous unfunded labour liabilities require a major capital injection. Other liabilities, including environmental ones, are difficult to identify and quantify. The integrity of ageing and improperly maintained installations is difficult and costly to ascertain. There is much to be learned from the recent catastrophic explosion in the PEMEX/Mexichem joint venture. Under these conditions, the lack of interest and response by private investors is easily understood.

Private investment in all segments of refining and marketing is being promoted. However, although many projects have been put forward, only a very limited amount of investment has actually flowed so far. PEMEX investment has not materialized, due to severe capital constraints and an allocation of scarce resources that has unequivocally favoured the upstream. A significant number of transportation and distribution permits have been granted in all available modes. However, most remain unused due to logistical infrastructure constraints. Storage, service station, and marketing permits have also been awarded.

Regulation, at times incomplete, has been supportive. Third-party access, open season terms and conditions for PEMEX excess capacity, and market-based tariff principles have been offered to new entrants. New service station operating and ownership patterns are being promoted; these should improve efficiency and quality of service, competing with the PEMEX franchise. Notwithstanding the progress that has been made, new players need greater certainty with respect to important details of unresolved issues and the actual adoption of market prices.

PEMEX continues to pursue some form of joint venturing in its refineries. It has apparently structured a project for the provision of hydrogen to its Tula refinery. Its partner would build a new plant and operate the existing one. Other ancillary services might follow suit in this and other refineries. More importantly, PEMEX hopes to find a partner that will help it complete the construction of a USD2.2 billion delayed coker, also in the Tula refinery, and operate this plant. Other process plants are being considered in this and in other refineries. The probability of actually implementing major joint venture projects is, for now, very low. In these projects, PEMEX has to assume practically all the risks involved; this will turn out to be costly and the partner will capture most of the uplift.

The transition from the regulated oil products price regime to market pricing has been full of pitfalls, technical mistakes, destabilizing political interventions, and poor communication with consumers. These tended to increase as the process gained in complexity and fatal deadlines closed in. The Mexican government gave ample evidence that it should not be involved in determining producer and retail prices. Currently, first-hand sale and maximum retail gasoline and diesel prices are set for 83 inland and seven

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‘THE SPEED AND TIMING OF THE INTRODUCTION OF MARKET PRICES WAS DETERMINED BY THE ELECTORAL CALENDAR.’

border regions. Product quality varies among them and quality differences are reflected in the price. From late May to December 2017, market prices will be introduced in five stages throughout the country. They will follow closely the PEMEX open season schedule for oil product pipelines, terminalling, and storage. Results of the first open season bidding process for two border state logistical systems – Baja California and Sonora – were published on 2 May and prices should be freed in this area before the end of that month. The results of a second PEMEX open season are set for 25 May and will cover the remaining four border states, including the Monterrey metropolitan area, which makes it of particular interest, as market prices should prevail by 15 June in this economically important region.

The speed and timing of the introduction of market prices was determined by the electoral calendar. Government authorities wanted to finish the process at least six months before the presidential elections (to be held in July 2018), with the deadline being brought forward to the second half of 2017 from 1 January 2018. The deadline was originally set for 2018, before the end of the current government in December of that year. However, it was brought forward so as to be in a better position to manage any potential price disruption associated with liberalization and to promote midstream investment. Concern with price volatility before the elections, the frequency of price changes, and regional price differentials could all be disturbing to consumers. Domestic prices at the pump will fluctuate due to changes in

external reference prices, exchange rates, and transitional issues as competition is introduced. However, the public will continue to believe for some time that price determination is the responsibility of government.

Ambitious reform programmes like those reviewed here will necessarily

face both foreseeable and unanticipated problems, delays, and consequences that will require pragmatic solutions. Flexibility will be required to correct the course in a timely manner. Most of the problems that have been raised will be resolved. However, one of these will require a more radical redefinition: there is an

imperative need to dramatically improve the operational efficiency of the PEMEX refineries and attract substantial private investment to upgrade them. The prerequisites of such an effort are well known by PEMEX. It is the business model itself that must be changed.



The puzzle of liberalizing a centralized electricity system for a decentralized technologies future

Rolando Fuentes

Since the 1990s, most OECD countries have implemented electricity reforms that transformed vertically integrated monopolies into vertically unbundled providers that compete in segments (such as generation) where competition is possible. In this model, generators submit a supply schedule of prices for generation and receive the market clearing price. Today many economies are moving in the same direction, and Mexico is one of them.

Since the turn of the millennium, one major policy concern has been the meeting of climate change targets, for which decarbonizing the power sector is key. One way of doing this is by raising the share of renewable energy sources in electricity generation. In line with this concern, Mexico promulgated the Renewable and Energy Transition Financing Law and the General Law of Climate Change that mandates 35 per cent of power must come from renewable sources by 2024 (see *Prospectiva de Energía Renovables 2016–2030*, edited by Secretaría de Energía, SENER, Mexico City, 2016).

Combining liberalization and renewables promotion policies will prove to be a challenge. Not only are there fundamental contradictions between them but, more importantly,

new distributed energy resources (which include solar PV, batteries, and demand response tools) will rapidly change the business and regulatory landscape. Thanks to new technologies, a significant portion of future end-use electricity consumption could be supplied and managed by relatively small-scale, distributed resources. For consumers, the range of alternatives available to manage their electricity supply expand as new technologies allow them not only to buy their power, but produce it, sell it, shift it, reduce it, or even eliminate it.

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‘COMBINING LIBERALIZATION AND RENEWABLES PROMOTION POLICIES WILL PROVE TO BE A CHALLENGE.’

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These changes will, in all probability, reduce the reliance on the central grid, which ultimately would change the way electricity is purchased, transported, and consumed, and therefore regulated. The standard model for restructuring the electricity industry, described in *Electricity Market Reform: An International Perspective* (Fereidoon P. Sioshansi and Wolfgang Pfaffenberger, Elsevier, 2006) and by many others, arguably needs to be

revisited to efficiently embrace new technologies and avoid unnecessary transition costs. This would also imply radical changes to the way in which utilities, like the Comisión Federal de Electricidad (CFE or Federal Power Commission), realizes business and operational models.

The objective of this article is to identify structural inconsistencies that could eventually hinder the success of electricity reform, not only in Mexico, but in other countries pursuing similar agendas. Liberalizing a centralized electricity system today with the prospect of near-future penetration of decentralized technologies raises the question of whether newcomers can leapfrog the standard reform process and, if so, how.

Our reflections suggest three propositions:

- 1 Market liberalization and renewable penetration are ultimately incompatible.
- 2 The new focus of business and regulations will be downstream, but the future of retail is uncertain.
- 3 New regulations need to create markets for services that are latent, to avoid permanent transition costs.

These are discussed in the following sections.



1 The paradox between liberalization and renewables

Market liberalization and renewables promotion policies are ultimately irreconcilable. Previous research with other KAPSARC colleagues – see *The Renewable Energy Policy Paradox* (Jorge Blazquez, Carlo Andrea Bollino, Rolando Fuentes, and Nora Nezzamuddin, KAPSARC, 2016) – shows that there is an incompatibility between electricity liberalization and renewables policy regardless of the country, location, or type of renewable technology. The promotion of renewables in liberalized power markets creates a paradox, in that successful penetration of renewables could fall victim to its own success. High market penetration of renewables leads to depressed and more volatile electricity prices. This interplay results in any future deployment of renewable energy necessarily being more costly and less scalable. The corollary suggests that penetration of renewables capacity has limits.

This paradox applies only to liberalized markets and not to centrally planned systems. So far, the implementation of the Mexican Energy Reform in electricity (or Reforma Eléctrica) has largely been centred on auctions. The objective of these auctions is to reduce uncertainty in relation to new investments, by guaranteeing long-term

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‘HIGH MARKET PENETRATION OF RENEWABLES LEADS TO DEPRESSED AND MORE VOLATILE ELECTRICITY PRICES.’

demand while influencing technology choices in the direction of clean technologies. These auctions are instrumental to achieving the target of 35 per cent of clean energy by 2024.

The table below illustrates the first long term auction of capacity and clean energy certificates. The price range observed in the Mexican auction is quite low (22.85–67.11 USD/MWh) compared to any auction in the relevant power markets in Latin America (see *First Long Term Auction Special Report*, Galo Energy Consulting, 2016).

However, auctions are hybrid solutions, not the outcome of liberalized markets. One of the main competitive decisions for firms in liberalized electricity markets is the decision on timing and the size of their investment. Locking in prices, volumes, and the moment of investment in a bilateral agreement with the government is not a market outcome. This arrangement is an expensive option for the government as well, because it locks in technologies and prevents them from benefiting from the technological progress that would inevitably occur over long periods of time.

Whereas penetration of distributed technologies would undoubtedly help in achieving the 35 per cent target, an uncoordinated uptake could turn out to be challenging with respect to energy policy. As put forward in ‘Prosumage of Solar Electricity: Pros, Cons, and the System Perspective’ (Wolf-Peter Schill, Alexander Zerrahn, and Friedrich Kunz, *Economics of Energy & Environmental Policy*, vol. 6 (1), 2017), meeting a renewable energy expansion target is easier to achieve with central support schemes oriented at grid feed-in, rather than with a potentially uncontrolled PV expansion.

2 The new focus of business and regulations will be downstream

For most of its existence, the profitable part of the electricity business has been upstream. It is now likely that the added value will come from downstream (see ‘Renewable Energy: A world turned upside down’, *Economist*, 25 February 2017). New technologies shift the attention from generation, which is the core of the standard reform model, towards the retail segment and beyond, for which the model is less adequate. Distributed technologies bring about three issues.

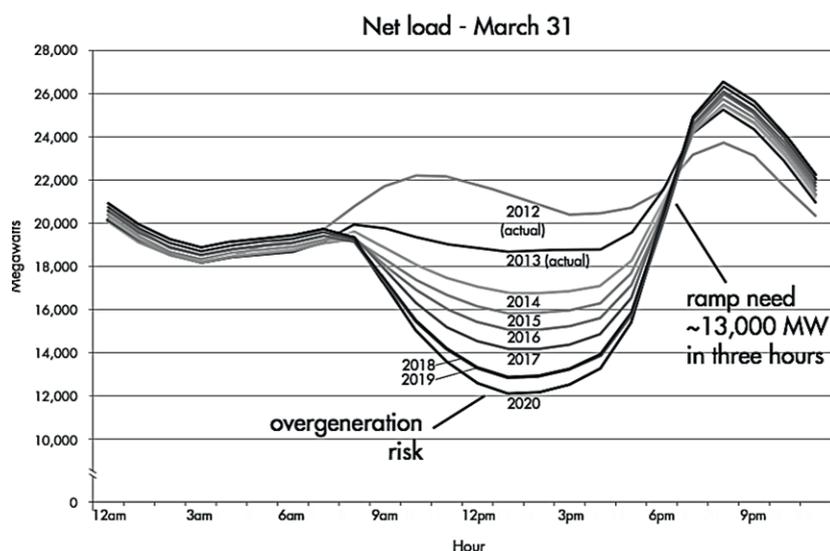
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‘NEW TECHNOLOGIES SHIFT THE ATTENTION FROM GENERATION ... TOWARDS THE RETAIL SEGMENT AND BEYOND ...’

The *first* is that due to the structure of the industry (where transmission and distribution remains a natural monopoly and baseload and peak times are almost pre-defined) competition in electricity markets ends up being limited to the mid-merit segment of demand. This segment is precisely the one most affected by the production

Results of first capacity and CEL auctions

	Capacity (MW)	Energy (MWh)	Clean Energy Certificates (CEL)*
CFE purchase bid	500	6,364,250	6,361,250
% assigned in winning bids	0%	84.42%	84.08
Total solar		4,018,859	3,996,890
Total wind		1,384,021	1,384,021
% solar		74%	74%
% wind		26%	26%

* One CEL is equivalent to 1 MWh.
 Source: Galo Energy.



California’s duck curve of load demand after PV penetration

Source: ‘Overgeneration from Solar Energy in California: A Field Guide to the Duck Chart’, Paul Denholm, Matthew O’Connell, Gregory Brinkman, and Jennie Jorgenson, National Renewable Energy Laboratory, Technical Report NREL/TP-6A20-65023, 2015.

profile of solar and creates the so-called duck curve of load demand. This is already happening in California (see figure above). The direct outcome is less demand at the core of the reform model and, indirectly, more mid-merit capacity that remains idle for longer periods of time.

The *second issue* is that the greater the deployment of distributed energy resources (DERs), the more the boundaries between transmission–distribution, distribution–commercialization, and generation get blurred, as these processes occur in the same place: the household. In the standard reform model, competitive price signals from generation and retail are distorted in the transmission and distribution segments, which remain as monopolies. This clouds the two-way price signals that should exist between generation and retail, and may explain why liberalization has had negligible or mixed efficiency impacts – some authors estimate gains of the order of 5 per cent of costs (see ‘The role of policy in energy transitions: lessons from the energy liberalization era’, Michael G. Pollitt, *Energy Policy* Vol. 50, 128–37, 2012). The penetration of

DERs does away with the need for information flow between retail and generation, but the final effect is unknown.

The *third issue* is that while new technologies increase the number of competitors (with the emergence of new service providers and aggregators), they also reduce the size of traditional retail markets. The deployment of DERs can hinder the viability of the retail business for the utility as households become more energy independent – see *Can Adoption of Rooftop Solar PV Panels Trigger a Utility Death Spiral? A Tale of Two Cities* (Iqbal Adjali, Patrick Bean, Rolando Fuentes, Steven O. Kimbrough, Mohammed Muaafa, and Frederic H. Murphy, KAPSARC, 2016) – but it may also increase the transparency of the complex cross-subsidies system that Mexico now has in the domestic market.

The interplay between the standard reform model and new technologies is uncertain. What we know is that:

- flexibility would be more highly rewarded,

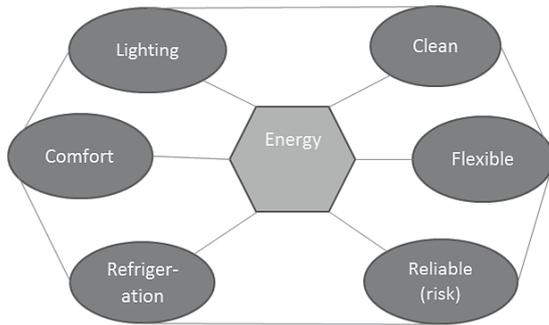
- there would be more traditional idle capacity and more self-generation,
- the retail part of the business needs to find other revenue streams.

3 New regulation needs to create markets for services latent now

The question then is how to update the reform model. There is still no clear answer to this question. Our proposition is to decouple market designs from technological features. Electricity market designs have been tailored, and then adapted, to meet the features of technologies. For example, the merit order dispatch designed in the 1990s, was based on fossil fuel technology’s cost structure, and combined-cycle gas turbine (CCGT) became the preferred option of new investors. Next, beginning in the 2000s, the entry of renewable energy technologies (mostly wind) forced the adaptation of the merit order dispatch in order to integrate incremental penetration of non-controllable zero marginal cost technologies. Now in the late-2010s, distributed energy resources enable power to flow in multiple directions at small scale and short distance. Since we can expect that technology will continuously improve, electricity markets will be in perpetual transition, provoking permanent adaptation costs.

Decoupling markets and regulations from technological features is possible if designs are based on the value they provide, not on inputs or processes. The price of electricity is usually based on the price of fuel, the timing, and the location of delivery. Markets could evolve and become more fragmented and base their services on the latent attributes of electricity. Attributes could either be desirable characteristics of power (like cleanliness or reliability), or the end use functions (such as cooling, lighting, or comfort).

The idea is that instead of redefining electricity markets every time a new



Electricity has multiple attributes

Source: Author.

technology disrupts the market, the energy (power only) component would be a by-product of the interaction of these peripheral markets. The advantage of this framework is that, optimistically, all cross subsidies could be eliminated and excess costs would be squeezed out as people would pay only for the services they want.

This is arguably a very futuristic vision, but it helps with the process of thinking critically about what the ultimate value of electricity services are. One of the great hidden values of the Mexican Energy Reform is that new institutional governance and new technologies ease the entrance of small and medium enterprises to the power markets. New business models around the world tend to be more bottom-up and small-scale, while highly IT-based. DERs can spur further innovation with respect to hardware and software development, as well as new business models.

Does the Mexican reform anticipate a technological turmoil?

The answer is not yet. The Regulatory Energy Commission (Comisión Reguladora de Energía or CRE) contemplates three stages for the

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'... NEW INSTITUTIONAL GOVERNANCE AND NEW TECHNOLOGIES EASE THE ENTRANCE OF SMALL AND MEDIUM ENTERPRISES TO THE POWER MARKETS.'

integration of distributed generation (which by 2015 was 0.22 per cent of total installed capacity and 0.07 per cent of electricity generation). The first two stages aim to give open access, upgrade the grid, and also contemplate net metering as a method of compensation. Given the lack of international experience in the subject, the commission leaves to the final, third, stage the development of a conceptual framework that would create an energy market at a distribution level for multilateral transactions. The matter might not be urgent given the low levels of penetration of these technologies. However, the problem is that, as with other technological disruptions (such as the iPod and UBER) they can occur at a very fast pace, and there is a danger that the new institutional framework would have been built for other types of technologies.

Probably one of the most well-known international experiences that is in the making is New York's Reforming the Energy Vision (REV), together with the approach being followed in California. As discussed in a paper 'Distributed Energy Resources: New Markets and New Products' (Richard Tabors, Michael Caramanis, Elli Ntakou, Geoffrey Parker, Marshall VanAlstyne, Paul Centolella, and Rick Hornby) read at the 50th Hawaii International Conference on System Sciences in 2017, New York plans to address this issue with a Distributed System Platform provider, an entity responsible for planning, grid operations, and market operations, where multiple products and services can be traded. California's approach has been oriented to giving 'aggregators' a bigger role so that they can deal on behalf of their representatives directly with CAISO (California Independent System Operator). This could be an option for Mexico to explore.

Final comments

Mexico has embarked upon a very ambitious energy reform that could have far reaching benefits for the energy sector and for its economy as a whole. Huge efforts have been made in building institutions and setting up the legal framework. Mexico has the benefit of being a latecomer in the electricity reform wave, which allows it to incorporate international best practice. However, failure to acknowledge macro trends in the power sector and structural contradictions may lead to friction between objectives, which may risk a stalemate.



Growing importance of US–Mexican energy trade

Lucian Pugliaresi

The formation and development of NAFTA

In 1992 the USA, Canada, and Mexico entered into the North American Free Trade Agreement (NAFTA). Its purpose was to expand trade among the three nations through the elimination of tariffs and other trade barriers. It was not fully implemented until 1994 following full ratification by all three trading partners, and it was signed into law by President Bill Clinton. NAFTA created the world’s largest single market, comprising 450 million people with an economic value of over USD20 trillion in joint gross domestic product. The three trading partners combined represent an economy that is greater than the economic output of the European Union (GDP figures taken from *CIA World Factbook*, 2016).

NAFTA has made substantial contributions to the development of shared and sophisticated supply chains between the USA and Mexico, as manufacturers integrate their production systems. The flow of intermediate inputs produced in the USA and exported to Mexico, and the return flow of finished products, have increased the importance of US–Mexican trade. These supply chain systems have brought about enormous efficiencies for US industries, but the Mexican production centres are also viewed (often incorrectly) as the central cause of employment losses in selected US manufacturing centres.

Independent research on NAFTA has concluded that the open trading system has been largely positive, but there have been important adjustment costs in all three countries. (*NAFTA Revisited: Achievements and Challenges*, Gary Clyde Hufbauer and Jeffrey J. Schott, Institute for International Economics, October 2005; *NAFTA’s Impact on North America: The First*

Decade, Sidney Weintraub (ed.), Center for Strategic and International Studies, 2004; and *Opening Markets, Creating Jobs: Estimated US Employment Effects of Trade with FTA Partners*, US Chamber of Commerce, 2010.) In the USA, manufacturing centres in the so-called rust belt saw populist resentment against globalization surface in the 2016 presidential election. This resentment was an important political force that helped bring Donald Trump to the presidency. More importantly, it has led the new administration to declare that the USA should either withdraw or renegotiate the existing trade terms in NAFTA. There has been little discussion of the growing role of energy trade between the USA and Mexico. When NAFTA was established, little attention was given to oil and gas trade with Mexico, as the petroleum sector was a monopoly dominated by the state Mexican oil company, *Petróleos Mexicanos* (PEMEX).

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‘THERE HAS BEEN LITTLE DISCUSSION OF THE GROWING ROLE OF ENERGY TRADE BETWEEN THE USA AND MEXICO.’

North American petroleum renaissance

Against the background of the Trump administration’s rethinking the economic value of NAFTA, the emergence of the North American petroleum renaissance and its reliance upon an integrated North American market stands out as an under-appreciated success story. This integrated North American energy market is poised for rapid growth, contributing to an increase in investment, employment, and energy abundance throughout the continent. The likely production growth in petroleum output offers both energy

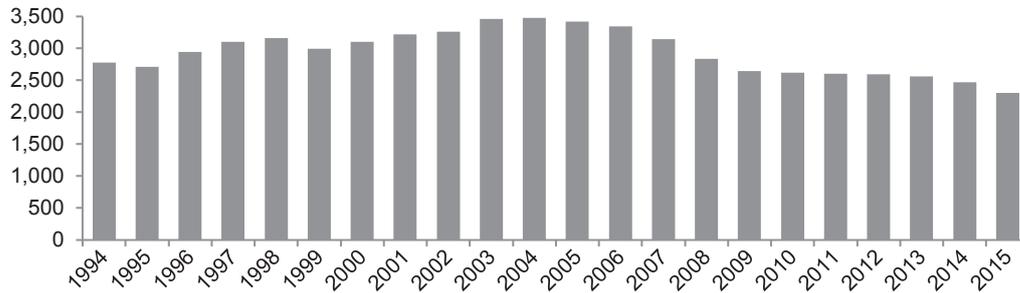
security and growing abundance in oil and gas supplies for consumers among all members of NAFTA.

A North American integrated energy market is especially important for the USA as it provides a growing market (in Mexico) for higher volumes of US natural gas production and refined products, as well as exports of advanced oil field services and equipment. As negotiations get started on the future of NAFTA, it is essential to have a full understanding of not just trade concerns in the manufacturing sector, but of the long-term economic and security stakes for the USA of sustaining and promoting full integration of the North American energy market.

This expansion in North American energy output took its lead from the US petroleum renaissance that saw domestic crude oil production rise from 5 million barrels/day (mb/d) in 2008 to over 9.5 mb/d by mid-2015. Although US production fell back by nearly 1 mb/d when oil prices collapsed in the second half of 2015, output is now rising with the recent gain in world oil prices. US natural gas production has followed a similar path growing from 45 billion cubic feet/day (bcf/d) in 1985 to nearly 75 bcf/d in 2015.

Each NAFTA partner is benefitting from the continent’s broad-based petroleum renaissance. In Canada, the Canadian Association of Petroleum Producers forecast oil sands production in Alberta to rise from 3.8 mb/d to 4.9 mb/d by 2030.

Energy reform and privatization in Mexico promises to halt the decline in crude oil production (see figure opposite above) in an oil province historically starved for investment by a government monopoly.



Trends in Mexican oil production (thousands of barrels/day)

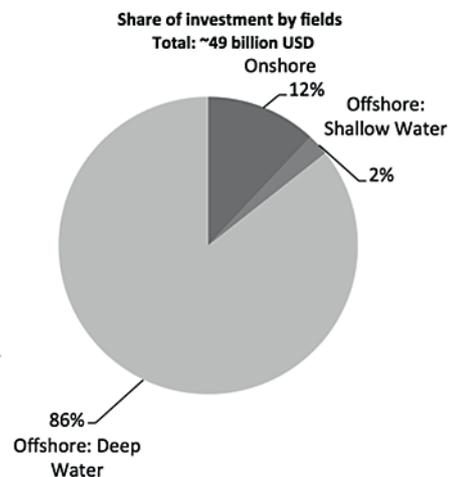
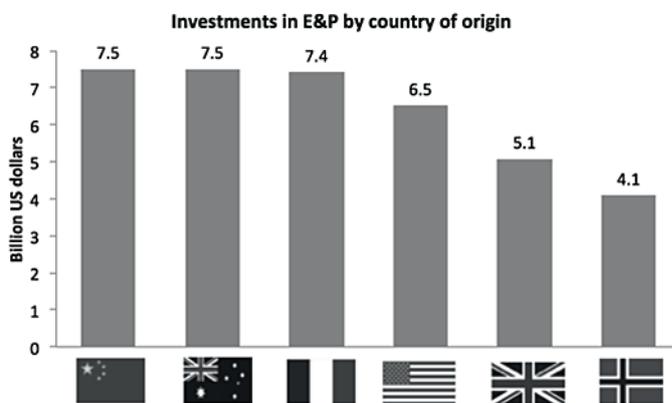
Sources: EIA, PEMEX.

In order to address declining production and insufficient investment in its oil and gas industry (and the energy sector generally), Mexico initiated an extensive reform programme (the Mexican Energy Reform or Reforma Energética) in 2013. Reforming the Mexican energy sector was politically challenging; it required the building of a broad political base of support, a change in the constitution, and populist resentment to foreign investment in the country’s oil and gas sector to be addressed. This reform programme ended the monopoly of PEMEX in the oil and gas sector and also opened up the electric power sector to foreign and domestic investors. In an oil market hindered

by lower oil prices and a general worldwide retrenchment in investment, Mexico’s reform programme has successfully brought in investment from international oil companies (IOCs) and new oil and gas entities worldwide. The figure below shows the diversity of worldwide investment that totals approximately USD49 billion for Mexico’s upstream sector alone. Forecasts by the International Energy Agency and the Mexican government expect this investment trend to halt the decline in crude oil production and push production to 3.4 mb/d by 2040, an increase of 1 mb/d over current levels.

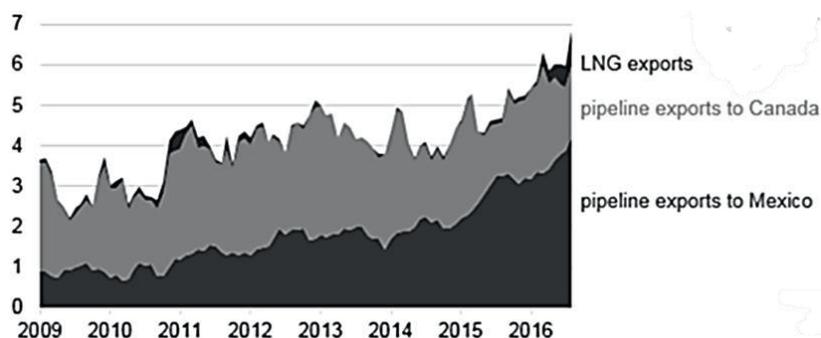
Reforms are also underway in the USA. The Trump administration is advocating

a deregulation agenda to promote domestic oil and gas production and making an aggressive effort to advance permits for new pipeline. These reforms offer an opportunity to increase production of US oil and gas supplies while at the same time providing additional low-cost transportation options for both Canadian oil sands and North Dakota crude oil for delivery to US refining centres. An open southern border for natural gas exports, combined with pipeline development and power generation in Mexico, is providing an important and growing market for US natural gas producers, pipeline developers, and equipment manufacturers. Open access, together with connections to worldwide



Investment in Mexico’s upstream oil and gas sector

Source: National Hydrocarbons Commission (Comisión Nacional de Hidrocarburos, CNH).



US natural gas exports, 2009–16 (bcf/d)

Source: EIA.

petroleum production and consumption centres outside North America, will offer additional opportunities for both efficiency and economic growth in a sector in which the USA has many comparative advantages.

A clear example is the rapid growth in US natural gas pipeline exports to Mexico, which represented more than half of all US gas exports in 2016. US export volumes have doubled since 2009 (see figure above) and in August 2016 the USA shipped 4.2 bcf/d of natural gas to Mexico via pipelines.

US-Mexican trade relationship

The US-Mexican trade relationship is essential for sustaining expansion of the US natural gas production platform. In 2015, Mexico’s energy ministry (SENER) announced a five-year plan to significantly expand the country’s natural gas pipeline network to accommodate higher levels of natural gas imports from the USA and contracts have been awarded for seven of the 12 pipeline projects. The largest and most expensive of the awarded projects is the Sur de Texas–Tuxpan pipeline, which aims to supply the Mexican states of Tamaulipas and Veracruz with natural gas from southern Texas via an underwater route through the Gulf of Mexico. The pipeline will extend nearly

500 miles and provide a total transport capacity of 2.6 bcf/d.

The rising supplies and low cost of US pipeline natural gas is helping Mexico meet its growing electricity demand with generation from new natural gas-fired plants. US natural gas exports to Mexico are expected to continue to grow in the short term, and SENER forecasts a widening gap between domestic production and demand through the end of the decade. Mexican imports of natural gas continue to outpace most projections. The prolific US natural gas supply base has kept US natural gas prices well below USD3 per million cubic feet (mcf). In the absence of the Mexican market, the current challenging pricing environment in the USA would quickly result in a substantial retrenchment in drilling and employment opportunities, an outcome that Mexican negotiators will surely raise with the USA.

The region’s integrated energy market

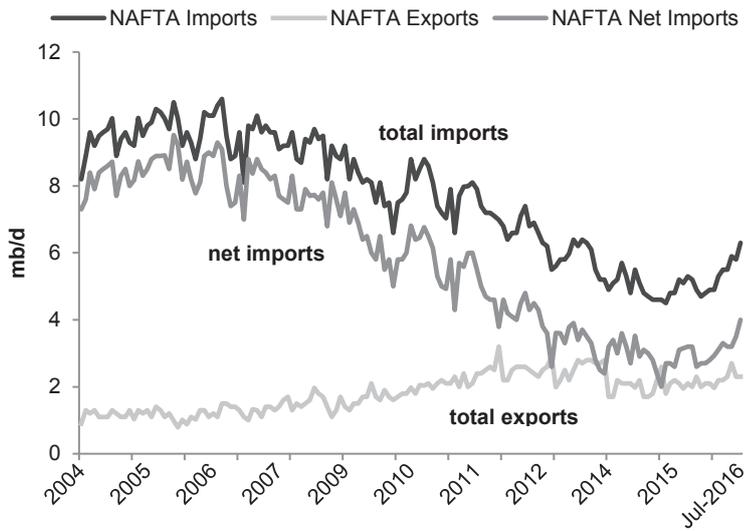
The NAFTA partners are already experiencing the benefits from enhanced energy security and resilience from this integrated production platform. At the recent *Energy 2017* petroleum conference in Mexico City, Deputy Secretary of Energy for Hydrocarbons for the Mexican Government Aldo Flores-Quiroga pointed out that integration is

well underway. When it comes to natural gas movements, the USA and Canada already have 42 cross-border interconnections, while the USA and Mexico have 13 interconnections. Refined products move across three cross-border pipeline connections in

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‘THE RISING SUPPLIES AND LOW COST OF US PIPELINE NATURAL GAS IS HELPING MEXICO MEET ITS GROWING ELECTRICITY DEMAND ...’

Canada and four in Mexico. Estimates by the US Energy Information Agency (EIA) show that North American petroleum consumption exceeds 22 mb/d, and well over three-quarters of this consumption is now sourced from NAFTA partners (see figure opposite), as net petroleum imports amounted to less than 4 mb/d. Government forecasts expect the combined US, Canadian, and Mexican markets to be a net crude oil exporter by the end of the decade. The economic and security benefits of rising production are a tribute to the value of an open and well-functioning trade system.

In 2016, the USA exported USD19 billion of energy products to Mexico ranging from bituminous coal to gasoline, diesel fuel, propane, and natural gas, among others. At the same time the USA imported USD9 billion of energy products from Mexico, nearly all of which was crude oil (see *Nafta, Trump and BATNA*, Kevin Book, Clear View Partners, Washington, DC, 26 January 2017). It is important to recall that this trade is taking place in close proximity, largely overland, with stable and secure allies, which makes it much more valuable to each trading partner than other international trade of this kind. It is also a highly dynamic market; just a few short years ago the USA was importing substantially larger volumes of Canadian natural gas, but this trend



NAFTA petroleum (crude oil and refined products) import balances

Source: EIA.

has now reversed as US supplies surge. The NAFTA trading partners have access to different resources and technology, making the market well suited to efficiency and production gains. For example, Mexico’s rising imports of refined petroleum products from the USA (mostly gasoline), limits requirements for costly investments in expensive refining capacity additions in Mexico. These resources have higher returns in other segments of the Mexican energy industry.

Concerns affecting future US–Mexican relations

Some commentators have raised concerns that the USA will now mimic Russian behaviour towards Ukraine by cutting off Mexico from US natural gas supplies to gain political and economic leverage (see *How Might a US–Mexico Trade Conflict Affect Trade in Natural Gas?*, Sam Walsh and Jason Bordoff, Columbia Center on Global Energy Policy, 22 February 2017). This sort of wild speculation is adding to existing anxiety in Mexico over the rise of American populism and is completely unsubstantiated even by the more nationalistic pronouncements within the Trump administration.

Participants in the NAFTA energy market should instead take solace in the knowledge that the value of the North American integrated energy market is well understood by many of the new appointees in the new US administration as:

- an economic boon to American consumers;
- an employment growth opportunity for US workers in the petroleum industry;
- (more importantly), a trade relationship that supports the North American petroleum production platform as a valuable strategic asset.

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‘... POLICY MAKERS SHOULD NOT LOSE SIGHT OF THE WIDESPREAD ECONOMIC AND SECURITY BENEFITS FROM THE INTEGRATED NORTH AMERICAN ENERGY MARKET.’

A more legitimate concern is that US trade negotiations with Mexico could spin out of control, playing into populist sentiment on both sides of the border. However, the inherent economic

and security interests of all three partners suggest that a more likely outcome is a sober and pragmatic approach from the political leadership on both sides of the border. One reason for this more optimistic outlook is that the national security community has put considerable effort into understanding how the North American energy surge and flows contribute to an improved strategic position for the USA and her allies. The appointments of former ExxonMobil CEO Rex Tillerson as Secretary of State and former Governor of Texas Rick Perry as Secretary of Energy bring broad experience in the energy sector to these important policy-making positions, together with a full understanding of the value of an integrated energy market for North America. The paramount task going forward is that as the USA addresses some of the ongoing concerns on NAFTA trade issues in the manufacturing centre, policy makers should not lose sight of the widespread economic and security benefits from the integrated North American energy market.

The reversal in Mexico’s petroleum and electricity markets involved enormous risks for its political leadership but is now paying off by delivering value for Mexico, Canada, and the USA. Sustaining the energy reform effort in Mexico remains a high priority not just for the future of Mexico, but also for its two main trading partners north of the border. The comparative cost structures and comparative advantages from this trade demonstrate that international trade can deliver sustained benefits in the form of rising economic growth, employment, and energy abundance.

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Mexico's hydrocarbon import dependence

Adrián Lajous

In the second half of 2015 Mexico became a net importer of hydrocarbons and in 2016 it incurred a USD6 billion oil trade deficit. The oil trade imbalance with the USA is striking. While having only run a significant deficit for the first time in 2015, the size of the deficit increased sharply to USD11.5 billion in 2016. This was the year in which Mexico's exports of crude and oil products covered just 43 per cent of its imports of oil products (mainly gasoline and diesel) and imports of natural gas from its northern neighbour increased sharply. In the current juncture, this high hydrocarbon import dependence makes Mexico particularly vulnerable, given the deteriorating bilateral relations between the USA and Mexico.

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 '... HIGH HYDROCARBON IMPORT
 DEPENDENCE MAKES MEXICO
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In 2016 Mexico's net liquids exports averaged 550 thousand barrels a day (kb/d). However it incurred a 175 kb/d deficit with the USA. This imbalance is due to the displacement of a growing volume of its crude oil exports to markets other than the USA and to the fact that most of its higher value oil product imports originate from the USA. In addition, net natural gas imports of 4.3 billion cubic feet a day (bcf/d), mostly from that country, added to this deficit. Net liquids exports tend to fall rapidly. In the first four months of 2017, they averaged 470 kb/d. The main causes of these deficits are structural in nature; they will be difficult to reverse during the remainder of the present decade and will probably grow larger. Several plausible scenarios that consider alternative crude oil, oil product, and natural gas prices, as well as diverse domestic production and

consumption profiles, all point in this direction.

Structural imbalances

The determinants of the current situation and the prospects of Mexico's hydrocarbon balance can be found in the decline of crude oil and natural gas production, as well as in the severe operating degradation of Petróleos Mexicanos (PEMEX) refineries, which have registered a significant fall in capacity utilization and the deterioration of high-value oil product yields. The increase in Mexico's natural gas demand, while its production continued to contract, also contributed to the trade deficit. These trends are long standing and have been reinforced by mismanagement during the first three years of the current government administration. Also, a prolonged period of low crude oil and natural gas prices (from mid 2014) triggered a financial crisis that severely affected the operations and overall performance of the state oil company, PEMEX.

Crude oil production actually reached its peak in 2004 and declined by more than 1.2 million barrels a day (mb/d), a 36 per cent cumulative reduction, over the following 12 years. In the last five years, dry gas production has fallen by 1.3 bcf/d, a 26 per cent decline. Detailed field-by-field analysis points to further yearly declines to 2020 and beyond. These trends have resulted in a sharp fall of exports and an increase of imports. Over the last five years, net liquids exports fell from 844 to 550 kb/d, a reduction of 35 per cent. At the same time net natural gas imports increased by 125 per cent.

PEMEX refineries have not improved their performance with respect to their peers since the company first

participated in a benchmarking survey carried out in 1993. Product yields have deteriorated and throughput diminished significantly since 2013. Budget cuts from 2015 to date have further eroded the production of automotive fuels. Increasing domestic demand for these fuels has augmented import requirements. In the second half of 2016, 68 per cent of gasoline sold in the domestic market was imported, as was 57 per cent of diesel consumption. Most of these products came from US Gulf Coast refineries, where the volume of export demand has helped sustain high capacity utilization. In 2016, the value of Mexican gasoline imports from the USA amounted to USD11.3 billion and the value of diesel imports was USD4 billion.

Dependence on natural gas imports is an even more serious source of concern. Although their value also amounted to USD4 billion, they accounted for 55 per cent of total domestic demand in 2016. It must be stressed that gas imports will continue to increase for at least four more years as production continues to decline, fuel oil is further substituted with natural gas, the gas transportation network expands, and more combined-cycle (CCGT) plants come on stream. Under these conditions Mexico's natural gas imports can only increase, putting the country at risk of exposure to external market conditions.

Awareness of the growing asymmetries that characterize Mexico's oil and gas trade balance, and of the structural changes that have brought them about, is still limited. Until recently, increasing dependence on imports was seen in the broader context of free trade and investment flows in North America, regulated by NAFTA. In the case of natural gas, the construction of a single



North American market was actively pursued. The Mexican Energy Reform (Reforma Energética) was seen as an important step forward in the regional economic integration of the energy sector, and it was expected that this would evolve following a pattern similar to that of other branches of Mexican industry. Imports of oil products from the USA were simply seen as a low-cost alternative to the record losses in PEMEX refineries.

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'AWARENESS OF THE GROWING ASYMMETRIES THAT CHARACTERIZE MEXICO'S OIL AND GAS TRADE BALANCE ... IS STILL LIMITED.'

This perspective has been threatened by the explicit protectionist and mercantilist views brutally expressed by President Trump, and also by his statements on the re-negotiation and possible denunciation of NAFTA, if US policy objectives are not accommodated. The uncertainty that this has caused is affecting both domestic and foreign investment, as well as the exchange rate of the Mexican peso. In addition, domestic inflationary pressures and the tightening of monetary policy have also contributed to lower expected economic growth rates.

The potential political and economic crisis associated with a deteriorating bilateral relationship between the USA and Mexico is a warning sign to Mexican policy makers. It is now absolutely clear that some of the basic assumptions under which they have operated for years must be reviewed. At this critical juncture, alternative strategies that reduce the level of oil industry vulnerability implied by such a high oil and gas import dependence need to be considered. The development of this industry will have to strike a better balance between economic and security of supply objectives.

Natural gas

Natural gas plays a central role in the Mexican energy matrix. Policy makers have come to realize more fully the nature of the country's triple dependence on natural gas.

- Natural gas contributes to more than 40 per cent of total commercial energy consumption (greater than the OECD average).
- It represents 60 per cent of electricity generation.
- Imports of natural gas rose to 55 per cent of total demand in 2016.

If PEMEX's own use of gas is excluded, close to 73 per cent of supply actually entering the market was imported in 2016. Under these circumstances an interruption in the flow of US exports to Mexico poses critical security of supply issues. This explains the growing concern with import dependence and with current uncertainties in USA–Mexico bilateral relations. It is clear that a politically or economically driven interruption of supplies has a very low probability of occurrence. However, the consequences of such an event are so devastating that serious consideration of these issues is now imperative.

Mexico can and should increase the production and domestic availability of natural gas. To achieve this it will have to incorporate in its project evaluations, and in the allocation of investment funds, security of supply criteria. There is a long list of possible initiatives and natural gas projects. Some of these appear in the PEMEX business plan, but private parties should develop others. The following are only mentioned for illustrative purposes.

1 PEMEX must advance more rapidly in stabilizing and optimizing gas production projects in shallow waters, end the massive gas flaring in this producing region, and reduce large volumes of fugitive methane emissions. In 2016 PEMEX flared

close to 500 million cubic feet a day (mcf/d) of natural gas, while re-injecting another 500 mcf/d in offshore reservoirs in Campeche and Tabasco which could be substituted with nitrogen.

- 2 The development of non-associated gas in deepwaters close to Coatzacoalcos. Five fields of significant size – Lakach, Piklis, Kunah, Nat, and Lalail – have been discovered, as well as a number of smaller satellite fields. Potential production from these fields is more than 1 bcf/d. PEMEX has invested more than USD1 billion in this area but this project has been deferred until further notice.
- 3 The Chicontepec basin holds important crude and natural gas resources. At the end of 2015 it accounted for 28 per cent of the country's proved and probable (2P) reserves of natural gas. PEMEX has failed to develop these resources. Now, with the changes brought about by the Mexican Energy Reform, it is possible to adopt new mechanisms and business structures that could solve, in a more fundamental way, both the technological problems and the reservoir and production management issues that have hampered the development of Chicontepec. If this initiative is successful, results could be reaped toward the middle of the 2020s by private investors.
- 4 The development of shale gas in the north of Mexico. The most conservative estimates of these potential resources assume technically recoverable volumes that are significantly greater than the estimated ultimately recoverable 2P gas reserves of Mexico. The Eagle Ford formation crosses the border with the USA between Nuevo Laredo and Eagle Pass in west Texas. The significant discoveries made by PEMEX in the Burgos and Sabinas

basins, have not led to a successful development programme, such as the one in the same play in south Texas. Mexico must now try to replicate the experience across the border. Such an effort could bear fruit in the second half of the 2020s or early 2030s.

These measures are costly and will take time to implement; they will thus have a limited effect in alleviating import dependence and supply vulnerability in the short term. However, in the longer term, domestic production could expand significantly. This will require substantial private capital, the adoption of best practice techniques, critical managerial skills, credible environmental stewardship in ecologically fragile areas, appropriate regulatory and fiscal regimes, and time.

Petroleum products

There is a fundamental strategic difference between natural gas and oil products imports: in the first case, Mexico has very limited alternatives to US imports, while in the case of products there are multiple options. In 2016, 88 per cent of gas imports flowed overland through cross-border pipelines and a growing proportion of LNG imports originated in the Sabine Pass liquefaction plant. LNG will soon be fully displaced by pipeline gas, making the USA the exclusive seller of gas to Mexico, underlining the regional character of this natural gas market.

In contrast oil products are traded in a global market. Prices in the main refining centres tend to converge due to active global price arbitrage. While the US Gulf coast and west coast refineries offer clear logistical advantages to Mexican markets, the costs of supply to Mexican ports from other refining centres are not substantially higher. Thus, the risk of a disruption of products imports, or of a substantial change in the conditions of

sale, could be accommodated by imports from other parts of the world.

When the value of oil products imports is compared to that of natural gas imports, the difference is very substantial. In 2016 the value of oil products imports was approximately USD20 billion, while that of natural gas was USD4 billion. PEMEX failed to use the substantial size of oil products imports from US refineries to support its heavy crude oil exports. This is something that it should attempt in the context of a new oil trade strategy.

More than ever, PEMEX is obliged to radically improve the operational and economic performance of its refineries. Their transformation would substantially reduce, although not eliminate, import requirements in the foreseeable future. For example, if it could return to the 2013 levels of throughput and automotive fuel yields, these refineries would have produced an additional 162 and 135 kb/d of gasoline and diesel, respectively. This would have reduced, in the second half of 2016, observed imports of gasoline by 29 per cent and of diesel by 61 per cent. (Even these levels of throughput and yields are particularly low when compared to the company’s peers.)

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‘MORE THAN EVER, PEMEX IS OBLIGED TO RADICALLY IMPROVE THE OPERATIONAL AND ECONOMIC PERFORMANCE OF ITS REFINERIES.’

It should be stressed that the inadequate performance of the PEMEX refineries is not so much a hardware issue but one that relates to their operating and maintenance standards. The problems of the PEMEX refineries have been over diagnosed. The causes of poor performance are well known and key corrective actions have been identified in great detail. The failure of a number of initiatives that have been carried out to improve performance is of a

managerial nature. The lack of a basic agreement among the main stakeholders on how and when key problems and issues should be addressed has been an insurmountable obstacle. It has not allowed the deployment of the necessary sustained effort. Any progress achieved tends to revert to a low-level equilibrium. Under these conditions, PEMEX refining and marketing activities will suffer severely from the disruptive effects of market liberalization. Management and government officials need to take advantage of the deepening crisis in this sector to constructively implement the necessary change programme and further energy reform.

Crude oil exports

Many factors can explain the behaviour of Mexican crude oil exports and their diversification over the last four years. These include:

- the fall of domestic production,
- contraction of the exportable surplus,
- changes in crude quality,
- lack of a clear definition of future crude streams available for export,
- changing price markers and price references,
- poor calibration of PEMEX price formulas under conditions of high volatility,
- failures in market analysis and in technical sales efforts,
- absence of linkages between crude exports and products imports.

A fuller comprehension of US and Canadian production, transport and pricing dynamics, as well as the expected changes in North American crude oil balances are also needed to explain the behaviour of Mexican crude oil export flows.

Mexican crude oil exports have been declining since 2004 due to falling production, which would have been even greater if domestic refineries had



not reduced their throughput. Both production and exports are still far from bottoming out. In the first quarter of 2017, PEMEX exported 1.1 mb/d of crude oil after having reached a yearly peak of 1.9 mb/d in 2004. Exports flowed mostly to the USA, concentrating in the Gulf coast, where Maya heavy crude found a home in large-scale, high conversion refineries with delayed cokers, in some cases specifically designed to run Maya. Olmeca, a high-yield lube crude, obtained premium prices in specialized refineries. Isthmus, a mid-grade, general-purpose crude, was mostly used domestically, leaving limited amounts for export.

As production volumes declined, crude oil quality also changed. Maya, originally produced from the super-giant Akal field, sustained stable specifications over a long period. It then became a blend of varying components. On the other hand Olmeca, a stream dominated by the Cárdenas field, also became a blend, affecting its lube properties. As the Maya blend tended to become heavier, a stream of very heavy crude was segregated and sold in Asia as Talam, starting in 2014 after a few test cargoes. These changes affected the attractiveness of Mexican crudes and their pricing.

In 2012, more than 75 per cent of Mexico's crude exports flowed to the USA. However, in 2013 and the first half of 2014 PEMEX diversified these exports away from US markets to Spain and East Asia. A very large Brent/WTI spread made diversification attractive. At the same time, PEMEX light crudes were displaced from US markets as domestic production rapidly expanded. Market conditions dramatically changed in the second half of 2014. As prices collapsed the Brent/WTI differential narrowed. Since then, crude oil prices have not been supportive of Mexico's geographical diversification. However, PEMEX continued to send increasing volumes to Europe (mainly

Spain) and Asia, while its exports to the USA contracted and lost market share. In 2016, only 49 per cent of total Mexican crude oil exports had a US destination, the lowest share since the mid 1970s, when the country re-entered international markets. It is difficult to understand the underlying objectives of this dramatic diversification and, more precisely, why this initiative was not reviewed and modified, given a fundamental change in market conditions.

The loss in market share of Maya crude oil in the US Gulf coast must be rigorously analysed and a detailed explanation of the changing market dynamics is required. Starting in the second half of 2014, Mexico's loss has been Canada's gain. From 2013 to 2016 Venezuela's market share was stable at 32 per cent, while Mexico's was reduced from 32 to 25 per cent. Other western hemisphere sources of heavy crude also lost part of their share. Surprisingly, Persian Gulf exporters registered significant gains.

Oil production trends in the USA and in Canada differed strikingly with respect to the direction followed by Mexican crudes. US production expanded from 5 mb/d in 2008 to 8.9 mb/d in 2016; practically all of this growth was of light crudes. Higher production volumes reduced net imports and allowed the rapid expansion of exports starting in 2015, after 40 years of prohibition. Almost all of Canadian crude exports, which increased from 1.9 mb/d in 2008 to 3.3 mb/d in 2016, went to US refineries. Two-thirds of last year's exports were of heavy crude, flowing mainly to the Midwest and, increasingly to the Gulf coast. US production displaced Mexican light crude and Canadian production is substituting Mexican heavy crude.

Canadian exports to the Gulf coast will intensify competition in that market. The recent expansion of pipeline capacity and the authorization of the Keystone

pipeline pose important risks to PEMEX. (They will allow landlocked crude without other pipeline outlets to flow to the Gulf.) As long as the crude oil from Alberta cannot reach other coastal export terminals, Canadian producers will adjust prices to the level that will allow the crude to flow to the Gulf. Their main limitations in placing marginal barrels are their high production cost.

Many other factors of a commercial nature help explain the behaviour of Mexican exports, as well as the diversification strategy that is being followed. With the recovery of prices and their relative stability it might be a good moment to rigorously evaluate the performance of the spot related pricing formulas that PEMEX has used since 1986. More generally, it must also appraise the price formation and contractual mechanisms that are central elements of the crude oil export strategy. The entry of new players in the Mexican upstream and the liberalization of product markets require fundamental adjustments, given the attrition of the current strategies.

Conclusion

A more diversified economic structure began to emerge in Mexico in 1994, based on higher manufacturing exports under NAFTA. The economic role of the oil industry has changed significantly in the last 15 years. Long-term trends will continue to modify this role, as well as ongoing energy reform. The next stage in Mexico's economic development should strengthen and multiply backward industrial linkages and increase its reliance on domestic markets. At the same time, non-oil sources of government revenues must be found to finance the much-needed provision of public goods. All of this will require fully liberalized final markets for oil products and natural gas and, eventually, the recovery of oil and gas production to reduce the country's hydrocarbon import dependence.



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