Understanding the Challenges to Mexico’s Oil & Gas Future

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July 2019
Mexico is an essential piece of the North American petroleum production platform. The energy reform measures implemented in Mexico over the last few years, also known as the New Energy Model, offer considerable potential to lift oil and gas production, increase employment and deliver technological advances, and additional revenues for Mexico’s federal, state, and local governments. The New Energy Model has brought new investment into Mexico’s petroleum provinces, and today 107 licenses have been awarded for investment to 73 companies. There has been significant investment in seismic surveys and commitments for new wells. This expanded activity in the petroleum sector, entirely from private investment, has led to new discoveries.

Mexico’s new president, Andrés Manuel López Obrador (often referred to as AMLO), has expressed skepticism towards the energy reforms of the previous administration and has halted most initiatives to bring new private capital into the development of Mexico’s oil and gas resources. Although Mexico has not had a full public debate on all aspects of AMLO’s criticism of the New Energy Model, this EPRINC assessment demonstrates that without massive new commitments of capital for petroleum development, Mexico’s oil and gas future is grim.

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Background

Mexico is one of the ten largest oil producers in the world, and the fourth largest in the Western Hemisphere behind the United States, Canada, and Brazil. The oil sector is crucial to the Mexican economy as oil revenues generate over 10% of the country’s export earnings. However, Mexico is a large but declining net crude exporter and is a net importer of refined petroleum products. Its most important trading partner is the United States, which is the destination for most of its crude oil exports and the source of most of its refined product imports. In 2017, Mexico had a net oil export of barely 400,000 barrels per day (b/d), down from a high of 1.78 million b/d in 2004.

Commercial production of crude oil in Mexico began in 1905, reaching a high of 3.4 million b/d in 2004, Figure 1. Onshore production peaked at 1.3 million b/d in 1980 and is now down to 330 thousand b/d (kb/d). Offshore production began in 1979 and now accounts for 83% of Mexico’s crude oil output, mostly from shallow water (water depths of less than 600 feet) fields in the Bay of Campeche. Mexico’s oil output has been steadily declining for the last 15 years reaching a low of 1.71 million b/d in December of 2018, a determined overall decline rate of 5% per year.

Figure 1
Mexico Crude Oil Production (million b/d)

Source: EIA; INEGI

To date, a total of 465 oil fields have been discovered, of which 130 correspond to offshore. The country’s top 50 oil fields by size (recoverable oil) account for 81% of total discoveries estimated at 54 billion barrels; of these, 34 billion are located offshore. A handful of ten fields currently account for nearly two-thirds of all domestic production. They are all offshore fields and are all on the decline except for Ayatsil and Onel. They include four of the 18 giant fields, those with discovered reserves equal or greater than 500 million barrels, discovered in Mexico through 2016.
Table 1 summarizes important attributes of these top ten producing oil fields as of December 2018. They all produce light oils (> 25 ° API) with exception of Ayatsil which produces a heavy (11 ° API) oil. An interesting characteristic of most Mexican oil fields is that they have little gas, that is, they contain oils that are highly gas-undersaturated. The saturation pressure of the super giant Akal field is 1,000 psi below its original reservoir pressure. As a result, fields with gas caps are few if any. This characteristic is reflected in the low gas-oil ratios (GOR) shown in the Table. They average about 300 standard cubic feet of gas per barrel (scf/b), excluding the two outliers: Ayatsil and Xux that produce heavy and volatile oils, respectively. GOR values for oils with API gravities in the range of 25-40 degrees are normally above 800 standard cubic feet per barrel (scf/b). This characteristic is important in that reservoirs with low GORs contain less natural energy which translates into lower recovery factors. This is discussed later in the section on ‘Mature Fields’.

### Table 1

**Top Ten Oil Producing Fields, 2018**

<table>
<thead>
<tr>
<th>Field</th>
<th>Discovery year</th>
<th>Reservoir Depth, meters</th>
<th>EUR mb</th>
<th>°API Peak Production Dec. 2018</th>
<th>1000 b/d</th>
<th>Dec. 2018 Production 1000 b/d</th>
<th>GOR, Orig. scf/b</th>
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<td>Maloob</td>
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<td>3,541</td>
<td>2,500</td>
<td>14-25</td>
<td>460</td>
<td>2018</td>
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<td>1990</td>
<td>3,647</td>
<td>1,800</td>
<td>14-25</td>
<td>328</td>
<td>2017</td>
<td>299</td>
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<td>Ku</td>
<td>1980</td>
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<td>25</td>
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</table>

Notes: EUR is discovered reserves; mb, million barrels; GOR, gas/oil ratio  
Source: Comision Nacional de Hidrocarburos

Pemex broke ground in deepwater Gulf of Mexico in 2007 and has since drilled 25 exploration wells in water depths varying from 600 to 9,500 feet. Ten of the wells proved gas and three wells (Exploratus, Trion, and Maximino) proved oil. Deepwater is critical to Mexico’s future production growth; it accounts for more than half of Mexico’s prospective oil resources estimated at about 30 billion barrels.

Hydrocarbons (oil & gas) are dispersed among ten sedimentary basins in Mexico (Figure 2). About 89% of all the oil discovered so far - 54 billion barrels - lies in the southern Sureste super basin (a conglomerate of four sub-basins) which extends into the Bay of Campeche. The remaining six billion barrels of oil discovered is in the northern Tampico-Misantla-Veracruz super basin. The Deepwater Gulf of Mexico (GoM) basin – the country’s tenth basin – is just in an early stage of exploration. In fact, over 90% of Mexico’s portion of the Gulf of Mexico remains unexplored and is the foremost focus of the 2014 Energy Reform. Figure 3 highlights the locations of Mexico’s 19 giant and 72 world-class oil fields discovered to date; together these account for 95% of all the oil discovered.
Let’s look at the history of Mexico’s giant fields. Giant fields are the foundation of the oil industry. So far, 19 giant oil fields have been discovered; Akal (Cantarell) ranks #1 with an outsized volume of 15 billion barrels of recoverable reserves, followed by Ku with 3 billion, Maloob and Abkatun with 2.5 billion each...to Zama (0.6 billion), Cardenas and San Andres with 0.5 billion each. Together these giants account for 70% of all discoveries. Except for Zama, which was discovered in 2017, no giant fields had been discovered since the early 1980’s and this void has taken its toll on Mexico’s output, triggering its steep decline since 2004. Zama not only is the first discovery by the private sector under the new Energy Reform but, perhaps more importantly, has provided new insights for exploration in Mexico’s deepwater GoM. It is a clean Upper Miocene sandstone reservoir with the same rich oil-prone source rock as the U.S. GOM: 5% total organic content (TOC), hydrocarbon index (HI) of 600, and 200 meters thick. It has all the markings of a true high-impact discovery. Until now, naturally fractured carbonate reservoirs of Cretaceous and Jurassic age account for almost 97% of Mexico’s oil production while Tertiary sandstones are the predominant gas reservoirs.
Exploration and Production (E&P)

Through 2017, Mexico had produced a total of 44 million barrels of crude and condensates, or 81% of all its discoveries to date. Its remaining reserves are officially stated at 6.4 billion barrels as of January 1, 2019 which, at current production rates of roughly 660 million barrels a year (or 1.8 mb/d), will theoretically be depleted in ten years. Simultaneously, Mexico’s oil reserves have also been on a continual decline, from 20 billion barrels in 2000 to 6.4 billion barrels in 2019, an average drop of 715 million barrels each year. Reserves are the basis of production and as such discovering new reserves must be the country’s main goal. First, finding new reserves is an endeavor of high geologic uncertainty; following a discovery, the process of developing the new field is characteristically slow. Typically, it requires 4-5 years to complete the cycle from drilling a successful exploratory well to reaching the field’s full production potential. Add another 2-3 years of comprehensive data valuation prior to selecting the location of the exploratory well.

The process is also very technology- and capital-intensive, requiring a capex of roughly U.S.$10-15 per barrel of reserves discovered. This is equivalent to an investment of about U.S.$2-3 billion for finding and developing a new 200-million-barrel field, which would generate a production capacity of 95,000 b/d. And finally, the process requires exceptional exploration prowess to minimize the huge exploration risk. The success ratio of exploratory wells is one in ten. Over the last 18 years (2000-2017) Pemex has drilled 967 exploratory wells and discovered 5 billion barrels of oil reserves. Meanwhile, it produced over 15 billion barrels of oil during the same period – more than three times the reserves discovered. This is unsustainable and the primary cause of the steep production decline.
Figure 4 demonstrates the oil reserves discovered and the number of exploratory wells drilled yearly since 2000. During the period 2000 through 2016, discoveries averaged 323 million barrels per year versus production of 912 million barrels per year. The high volume (1,184 million barrels) of discoveries in 2005 corresponds mainly to four new fields (Kayab, Kach, Lem and Pit) that are still under appraisal. Likewise, the discoveries in 2012, 2013, and 2014 correspond largely to three deepwater fields: Trion (270 million barrels), Maximino (370), and Exploratus (212), respectively, that are also under appraisal. Just these examples sum two billion barrels of idle reserves of the five billion barrels discovered from 2000-2016. Deducting these idle reserves from the five billion barrels discovered would further degrade the production/discovery ratio to five from an already high three. Idle reserves are delayed undeveloped reserves and there are many more during the period analyzed.

![Exploratory Wells Drilled and Oil Discoveries, 2000-2017 (million barrels of oil)](image)

Source: Comision Nacional de Hidrocarburos

It is interesting to note that from 2007 to 2009 there was a short wave of discoveries averaging about 750 million barrels per year. Figure 4 shows that production decline noticeably abated during the subsequent years, 2009-2013. This highlights the interaction of these two important parameters, production and reserves. After 2013, however, production decline reverted to its previous rate of about 5% per year as some of the new reserves of the 2007-2009 years were still under development. In the period 2015-2017, a total of 81 exploratory wells were drilled. Pemex drilled 69 wells and the private sector 12 (one in 2016 and 11 in 2017). Discoveries in 2017 totaled a high of 1,400 million barrels, of which 1,200 million (Zama, Hokchi, Amoca, Mitzon, and Tecoali fields) were contributed by the new private sector. Quite an umph! Pemex also had a good year, discovering Nobilis, a deepwater oil field.
To summarize the results of exploration and oil production activities through 2017, Figure 5 provides a quick look at Mexico’s history of oil production and consumption since 2006. As of 2017, net exports are about to fade as production continues falling, and despite a decreasing trend in consumption since 2012 as natural gas slowly replaces oil in the power generation sector. Mexico produces an additional 360,000 b/d of NGLs, liquids produced from its natural gas production. NGLs are generally used as inputs for petrochemical plants and blended into vehicle fuel.

**Figure 5**
Mexico Oil Production & Consumption (million b/d)

Source: Comision Nacional de Hidrocarburos

*Mature Fields – IOR/EOR*

Mature oil fields are fields that have passed their peak production potential and are on the decline. As we have seen, Mexico’s oil production is in steep decline, about 5% per year, and essentially all its 456 fields are also on the decline. Even its most prolific field and one of the largest in the world, Akal (Cantarell), has been declining since 2004 at an alarming rate of 25% per year; Akal was producing 2 million b/d in 2004 and is now at just 45,000 b/d. The recent Energy Reform has a declared focus on “boosting offshore exploration and revitalizing Mexico’s numerous mature offshore and onshore fields, those with original oil-in-place (OOIP) greater than 400 billion barrels”. This refers to the top 80 or so fields, half of which are offshore.

While exploration discovers new reserves, 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. Both improved oil recovery (IOR), gas or water injection, and enhanced oil recovery (EOR), the injection of steam, miscible gases and chemicals, could recover an additional 10-15% of the oil-in-place. This is the classic technology associated with the exploitation of mature fields. The average recovery factor for most Mexican fields is about 20%, leaving behind a huge 80% of the resources already discovered. An additional recovery factor of 10-15% would certainly be welcome.

A recent report prepared by the National Commission on Hydrocarbons (CNH, 2012)
examines 101 mature fields with a total oil-in-place (OOIP) of 140 billion barrels, considered the most suitable for applying EOR. These are Mexico’s main-stay oil fields that are aging and fast becoming economically marginal – example Akal, Abkatun, and many others. Most likely, these are the fields scheduled to be licensed or farmed-out during the coming years. The report postulates an additional recovery of 10 billion barrels of fresh reserves via EOR. This is Mexico’s challenge. However, to achieve this lofty EOR goal would require huge investments, in the order of U.S.$150-200 billion, and this would call for very attractive incentives to shift investors onto this new track. EOR projects are characteristically very slow on implementation, many requiring pilots before moving on to full scale development.

Since 1951, Mexico has implemented only 10 water injection projects (IOR). Four of the projects – in the Poza Rica, San Andres, Tamaulipas, and Sitio Grande fields – have produced bonus oil volumes between 144 and 390 million barrels, according to the CNH report. Regarding gas injection (IOR), two world-class nitrogen projects take the stage: Cantarell (2000) and Ku-Maloob-Zaap (2008). Repressuring these reservoirs provided a huge jump in production as shown in Figure 1. Mexico’s single EOR project has been miscible CO2 injection in the Sitio Grande field (2006); it is still under evaluation.

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 big scale. For investors, it requires significant capex over the long term, with payouts that are characteristically drawn-out for 5-8 years. Tax incentives are typically used worldwide to kick-start EOR activities.

**Oil Production Outlook**

From what we have seen so far, Mexico’s oil reserves and production have reached a critical impasse, to the extent that reserves would be exhausted in 10 years if the past/present situation continues. Mexico anticipated this approaching dilemma years ago and in 2008 enacted reforms to permit Pemex to create incentive-based service contracts with foreign oil companies to increase production in mature onshore oil fields. The contracts were awarded on a fee per barrel produced basis. The foreign firms had no ownership rights over any oil they produce, but they were expected to provide Mexican fields with technological improvements.

The first three service contracts under the new framework were awarded in August 2011, targeting small mature fields in Tabasco State: Magallanes, Santuario and Carrizo. The contracts were awarded to Schlumberger and Petrofac. A second licensing round focusing on mature fields in the northern region was held in 2012. The six areas on offer included the onshore fields: Altamira, Panuco, San Andres, and Tierra Blanca, and the offshore fields Arenque and Atun. The fields were awarded to Petrofac, Schlumberger, Cheiron and Monclova-Pirineos. A third round, held in July 2013, focused on the Chicotepec area located in the Tampico-Misantla basin. The Chicotepec contracts were awarded to Halliburton, Baker Hughes, and Diavaz, a Mexican service company. They were fundamentally geared towards de-risking the area, that is investigating different methodologies for a more efficient, commercial development.

The nine fields associated with the first and second licensing rounds were, in general, very mature fields producing less than 2,000 b/d the year the license was awarded. Most showed modest increases in production over the next two years, and thereafter have been declining. The two most successful cases were the San Andres and Ebano-Panuco fields. The San Andres field’s production increased from 1,700 b/d in 2012 to a high of 3,700 b/d in 2014 and has since been declining to a current level of 1,600 b/d. The Ebano-Panuco’s joint production increased from 6,600 b/d in 2012 to a high of 3,700 b/d in 2014 and has since been declining to 6,150 b/d today. It has been conjectured that the main interest of the participants in those early service contracts was the possibility of exploring for deeper or nearby new reserves. One operator, Petrofac, did find new reserves in one of the fields.

In December 2013, Mexico’s Congress approved a broad-spectrum energy sector reform that “opened its energy sector to international
operators that can provide financial and technological expertise to exploit its 35-70 billion barrels of prospective oil and gas resources in the Deepwater Gulf, and its potentially huge shale deposits.” The early service contracts were migrated over to these new, broader reforms.

In Round Zero on August 13, 2014, CNH assigned Pemex a portfolio of 83% of the country’s proven and probable (2P) reserves oil and gas reserves. These assignments include 108 exploration areas and 336 production fields, an area of 184,000 sq. kms. In subsequent rounds through 2018, 75 licenses were granted to private parties for exploration and production, and 35 are production sharing contracts. Round One got under way on July 15, 2015 and Block 7, located in the shallow waters (166 m water depth) of the Gulf, was awarded to a consortium comprised by Talos Energy, Sierra Oil & Gas and Premier Oil. On February 20, 2017, CNH issued authorization for drilling a first well. Five months later, on July 11, 2017, Talos Energy, the operator, announced the discovery of a giant oil field with 600-plus million barrels of recoverable oil reserves – Zama – the first since the giant Caan field was discovered in the early 1980s. Also, in 2017, Hokchi Energy and ENI announced world-class discoveries in several offshore fields: Hokchi with 145 million barrels of reserves, and ENI’s three fields, Amoca, Mitzon and Tecoalli, which together contain 450-plus million barrels of oil reserves.

These early discoveries echo in big successes for the new Energy Reform. Production capacity of these new fields is estimated at 275,000 b/d (Zama 150 kb/d, Hokchi 35 kb/d), and ENI 90 kb/d), with full scale production scheduled for 2021/22 – a cycle of 7 years from bidding to reaching full capacity production. Pemex’s new, big onshore Ixachi field is also scheduled to go full production in 2022, a cycle of five years from discovery. These are normal cycle times (5-7 years) for the industry.

Recently (Jan. 2019) SENER/Pemex published its projections of Mexico’s oil production through the end of this administration. Production is expected to reach 2.45 million b/d by 2024 from the current level of 1.71 million b/d. Production increases are envisioned to come from exploration, implementation of IOR/EOR in mature fields, developing idle reserves, in-fill drilling and well repairs in existing fields, Figure 5. These projections also include the contribution of the new private sector.

Historical statistics show that Mexico’s known reserves are at a critical level, will be depleted in less than 10 years if the current/past operational situation continues, and need to be restocked as soon as possible. Our future scenario takes a more pragmatic approach: stop and reverse the decline in crude oil production through 2030. This is quite a challenge, both financially and geologically, since it would require doubling the average annual reserves discovery rate of the past 17 years. Maintaining current oil production of 1.7 million b/d through 2030 would entail discovering and developing new reserves and generating fresh reserves from IOR/EOR and other sources to a level of 620 million barrels each year.

In this scenario the current remaining reserves of 6.4 billion barrels would serve as a buffer for the inevitable yearly ups and down of the plan; hopefully they would remain intact or better at the end of the planning period. The E&P capex for this scenario is estimated to be U.S.$6-12 billion per year. The range reflects the different complexities of the areas being explored – onshore deep to deepwater offshore. As a reference, Pemex estimates a capex of U.S.$2.6 billion ($5.50 per barrel of oil equivalent (boe)) to develop Ixachi, its new large onshore condensate field. The exploration spend for Ixachi was an additional $2-3/boe. Pemex’s total upstream E&P capex was U.S.$8.6 billion in 2018.

The private sector has commitments to drill a total of 131 exploratory wells from 2015 through 2022, including 67 onshore, 33 in shallow water, and 31 in deepwater. These E&P companies are set to deliver on their production and capital targets, and have already made large investments, including the drilling of 19 exploratory wells as of the end of 2018, with results well above initial expectations and activities corresponding to Rouns II and III are yet to kick in. Production wise, Figure 6 shows the sector’s output estimate through 2031, with a peak of 327 kb/d in 2026, and thereafter declining since the Administration has announced that further lease auctions have been discontinued.
Figure 6
Oil Production Potential, Private Sector (kb/d)

Source: AMEXHI
Background

Mexico’s total energy consumption consists mostly of oil (56%), followed by natural gas (29%). Natural gas production has grown continuously, doubling from 3 billion cubic feet per day (bcfd) in 1980 to a peak of 6.34 bcfd in 2010 and has since been on the decline reaching 4.24 bcfd in 2017, Figure 7. For reference purposes, this current production rate is thermally equivalent to 700,000 b/d of oil. Reported production refers to marketed production. Some well-head production is flared when capture is not economically feasible. This occurs mostly in offshore operations; CNH estimates about 200 million cubic feet per day (MMcfd) of gas was flared in 2017.

Natural gas consumption, on the other hand, has almost doubled since 2000, reaching a high of 9.40 bcfd in 2015; it has since declined slightly to 9.16 bcfd in 2017. The power generation sector is by far the principal consumer accounting for a huge 62%, followed by the industrial sector with 20%, and Pemex with 16%. The remaining 2% includes residential use. Natural gas is increasingly replacing oil as feedstock for power generation.

Non-associated gas is gas produced from reservoirs that only contain natural gas, as opposed to gas found in association with oil, an important part of Mexico’s total gas production. As far back as 1980, non-associated gas production was near 1 bcfd or one-third of domestic production. Production remained around that same level through 1997; thereafter it started growing slowly, reaching a peak of 2.65 bcfd in 2007. At that time, it represented almost 45% of domestic production. Subsequently, it has been falling, returning to a level of 1 bcfd at the end of 2017; this is roughly 25% of current domestic production.

Figure 7
Natural Gas Production and Consumption (bcfd)
About seven hundred non-associated gas fields have been discovered to date containing 42 trillion cubic feet (tcf) of proven reserves; however, just 12% (84 fields) account for 93% of all discoveries. The Burgos (35%) and Veracruz (16%) basins together account for more than half of the discoveries, Sureste 33%, deepwater Gulf 8%, Tampico-Misantla 1%, Sabinas 2%, and the rest is dispersed in three small geologic provinces: Catemaco, Picashos and Chiapas. The 42 tcf of discovered reserves are equivalent thermally to about 7 billion barrels of oil or just 13% of Mexico's total oil discoveries of 54 billion barrels. Mexico apparently is very oil prone. In contrast to oil where carbonate reservoirs of Cretaceous and Jurassic age are the main reservoirs, Tertiary sandstones are the predominant reservoirs that account for 69% of all non-associated gas discoveries.

No giant gas fields have been discovered. There are only 19 world-class fields (defined as fields with 600 bcf or more of reserves) with a total of 25 tcf of reserves, which is more than half of all discoveries. Four of these major gas fields are located offshore: May (2.0 tcf), Labay (1.2 tcf), Lakach (0.9 tcf) and Piklis (0.8 tcf). The latter three fields were discovered in deep waters of the Gulf. Figure 8 shows the locations of the top 84 gas fields – those that have discovered 100 bcf and more of reserves – dispersed throughout the Republic. They account for 93% of all gas discovered.

**Figure 8**

**Major Gas Fields of Mexico**

Source: Comision Nacional de Hidrocarburos
Table 2 shows the top ten producing non-associated gas fields. They lie in three basins and together were producing 708 Million cubic feet per day (MMcfd) in December 2017; this represented 70% of the total non-associated gas production on that date. Overall, non-associated gas production accounts for a quarter of all gas production in 2017. The Burgos basin hosts six of the top ten fields including the top producing Nejo field. It also accounts for half of the top ten’s production, the rest is divided between the Sureste and Veracruz basins, each with two fields. Figure 9 shows the breakdown of associated and non-associated gas production. Both are declining significantly after peaking in 2010 and 2007, respectively.

<table>
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<tr>
<th>Field</th>
<th>Discovery Year</th>
<th>Basin</th>
<th>Depth m</th>
<th>OGIP bcf</th>
<th>Peak Production</th>
<th>December 2017 Production</th>
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<td>2000 50</td>
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<tr>
<td>Arcabuz</td>
<td>1968</td>
<td>Burgos</td>
<td>2,684</td>
<td>1,087</td>
<td>150</td>
<td>1998 39</td>
</tr>
<tr>
<td>Velero</td>
<td>1975</td>
<td>Burgos</td>
<td>2,100</td>
<td>915</td>
<td>126</td>
<td>2007 33</td>
</tr>
<tr>
<td>Sta. Anita</td>
<td>1958</td>
<td>Burgos</td>
<td>1,669</td>
<td>285</td>
<td>47</td>
<td>2010 26</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>708</td>
<td></td>
</tr>
</tbody>
</table>

Notes: * offshore fields. OGIP, original gas-in-place
Source: Comision Nacional de Hidrocarburos
Mexico had 21 tcf of remaining proven gas (associated and non-associated) reserves in 2000. These had dropped to one half as of January 1, 2017, a decline of 4% per year versus 5% for oil. Produced gas has totaled 31 tcf. At current production rates of 1.55 tcf per year, reserves would be depleted in six years. According to statistics from Mexico’s CNH, two-thirds of the reserves correspond to the southern Sureste basin. The remaining 3.3 tcf are divided among the Burgos (1.1 tcf), Tampico-Misantla-Veracruz (1.8 tcf), and Sabinas (0.03 tcf) basins; 0.36 tcf were recently discovered in the deep-water GoM.

Figure 10 shows the non-associated gas discoveries during the period 2000 through 2017, an average of nearly 1 tcf per year. Three tall columns of discoveries highlight the graph. In 2003, two big fields were discovered: Nejo and Apertura; in 2008, Tsimin and Cauchy were the big discoveries, and Ixachi in 2017. Ixachi is a world-class gas field and, perhaps the biggest gas field discovered in Mexico. According to Pemex, it holds 2,800 bcf of recoverable gas and liquids — equivalent to 470 million barrels of oil. Full scale production of 80,000 b/d of liquids and 700 MMscfd of gas is scheduled for Ixachi in 2022.

During the 18-year period, 2000-2017, a total of 17 tcf of non-associated gas was discovered versus 12 tcf that were produced. Forty percent more gas was discovered than produced and, nevertheless, production continues to decline. This seems paradoxical. However, a closer look reveals that more than half of the discoveries remains idle, and the development of several others was significantly delayed. Just to name a few, three deep water fields (5 tcf) and Kunah (1.7 tcf) are...
still undeveloped; the big Tsimin field (2.6 tcf) started production seven years after discovery. So, production was not effectively replaced with new reserves thereby giving rise to the inevitable decline. No new gas reserves were discovered in 2015 and 2016.

**Figure 10**
*Gas Discoveries, 2000 – 2017 (bcf)*

![Gas Discoveries, 2000 – 2017 (bcf)](chart)

Source: Comision Nacional de Hidrocarburos

The northern region of Mexico will likely be the center of future reserves growth as it contains almost ten times as many potential natural gas reserves as the southern region. Mexico has one of the world’s largest shale gas resource bases, which could support increased levels of natural gas reserves and production. According to a 2013 EIA assessment of world shale gas resources, Mexico has an estimated 543 tcf of technically recoverable shale gas resources – the fourth largest of any country examined in the study. Most of its shale gas resources are in the northeast and east-central regions of the country. The Burgos basin accounts for two-thirds of Mexico’s technically recoverable shale gas resources. Burgos includes parts of the Eagle Ford shale play, which is considered Mexico’s most promising prospect and has been a prolific source of production in Texas. Mexico has taken preliminary steps to explore for and produce shale gas. Pemex produced its first shale gas in early 2011 from an exploratory well in northern Mexico. The current regulations regarding “no hydraulic fracturing” however, suspends any future activities in this area.

**Gas Production Outlook**

In 2001, as gas imports were beginning to grow, Pemex introduced the concept of Multiple Service Contracts (MSCs), opening the downstream natural gas sector to private operators as part of its strategy to increase non-associated gas production. The first bidding round for MSCs was launched in July 2003 targeting the Burgos basin, the biggest producer of non-associated gas. The five blocks awarded at the end of 2003 were: Reynosa-Monterrey, Cuervito, Mision, Fronterizo, and
Olmos. This model involved no incentives for any production increases and the bidding was based on discounts that set the maximum amount of money contractors can get paid for each work item.

A second round of MSCs was launched in 2005. Two blocks were awarded: Pandura-Anahuc and Pirineo, both in the neighboring Sabinas basin. A third round launched in 2007 also awarded two blocks: Nejo in the Burgos basin and Monclova in the Sabinas basin. As a result of these initiatives, Mexico’s gas production stabilized from 2011 through 2015, then returned to its previous high annual decline trend of 10 percent.

Recently (April 24, 2019) Pemex published its projections of Mexico’s gas production through the end of this administration. Production is expected to reach 6.93 MMcfd by the end of 2024 from its current level of 4.52 MMcfd. Production increases are envisioned to come mainly from accelerating the development of idle reserves and of new discoveries, increasing the recovery factor in mature oil fields, in-fill drilling and maintenance in existing fields. They propose a new service contract model that integrates exploration and production (CSIEE). Highlights include a fee per barrel or equivalent based on hydrocarbons produced; the operator is expected to provide all capex and opex.

Let’s look at our future gas production scenario. It is important to remember that Mexico’s produced gas comes mainly (75%) from gas associated with oil production and we assume this characteristic will remain the same; as such, most future gas reserves will simply come along with the newly discovered oil reserves. Essentially, the gas model depends on the success of the oil model which assumes maintaining oil production at 1.7 million b/d through 2030. Exploration efforts and spending will prioritize oil during this critical period. If non-associated gas shows up, like in the case of Ixachi, it is very welcome.
Mexico’s oil and gas reserves and production are at a critical crossroads. Oil reserves would be exhausted in ten years and gas reserves in six without massive new capital commitments. Of a total of 465 oil fields discovered, today a handful of ten currently account for nearly two-thirds of all domestic production; likewise, of the 700-plus gas fields discovered, ten account for almost half of all gas production. Oil production is declining at a high 5% per year and 75% of all gas production is associated with oil production. The remaining 25% comes from non-associated gas reservoirs which are also declining at 4% per year. In Mexico, 54 billion barrels of oil and 42 tcf (7 billion barrels equivalent of oil) of non-associated gas have been discovered so far. Of these 44 billion barrels of oil and 31 tcf of gas have been produced. Mexico is seemingly an oil prone country. The exception of course is its bountiful shale gas resources.

According to a recent (2013) EIA report, Mexico has an estimated 543 tcf of technically recoverable shale gas resources – the fourth largest in the world. This is equivalent to 90 billion barrels of oil or almost twice the oil reserves discovered to date. The Burgos basin accounts for two-thirds of Mexico’s shale gas resources. Burgos includes parts of the Eagle Ford shale play which has been a prolific source of production in Texas. Development currently is on hold following the ban on hydraulic fracturing.

Because of the urgency of the reserves/production issue, our future scenario takes a more pragmatic approach: stop and reverse the decline in crude oil production through 2030. This scenario is quite a challenge, both financially and geologically, since it would require doubling the average annual reserves discovery rate of the past 17 years. Maintaining current oil production of 1.7 million b/d through 2030 would entail discovering and developing new reserves and generating fresh reserves from IOR/EOR and other sources to a level of 620 million barrels each year. This would be equivalent to discovering ten giant oil fields the size of Zama. The E&P capex for this scenario is estimated to be U.S.$6-12 billion per year. Since 75% of gas production now comes from oil reservoirs, the two models are strongly interdependent.

The private sector has commitments to drill a total of 131 exploratory wells from 2015 through 2022, corresponding to Rounds I, II, and III. Production wise, the sector has provided (April 15th, 2019) a production guidance indicating a peak output of 327,000 b/d in 2026, thereafter declining as the Administration has announced that further lease auctions have been discontinued. During the period 2019-2024, the private sector will invest about U.S.$14 billion in exploration and development activities associated with the projects awarded to date. Investments close to U.S.$2 billion are projected for 2019, mostly in exploration activity, half in the Perdido area, and the other half in the Sureste and Veracruz basins. Total government take (taxes and royalties) from these projects are estimated at more than 90% of the estimated value of the oil and gas produced over the lifetime of the 25-year contracts. Additionally, construction of infrastructure will generate thousands of direct jobs and many more indirectly.

All told, the year 2017 essentially marks the start of field activities related to Mexico’s new Energy Reform and it was certainly a turning point for its oil and gas industry. Oil and gas discovered by Pemex and the private sector totaled a huge 1.87 billion barrels of new reserves which was nothing less than a spectacular year for Mexico.

“World Shale Gas and Shale Oil Resource Assessment”, EIA/ARI, June 2013


“External Engagements Update”, AMEXHI, April 30, 2019
“Advancement in Committed Wells – Five-year Plan”, PULSO Energetico.org., May 21, 2019