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Mexico's Deteriorating Oil Outlook: Implications and Energy Options for the Future

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A. KEY ISSUES

1. Oil Output Decline Accelerates

Mexico's crude oil production, which reached a peak of 3,455,000 barrels per day (b/d) at the end of 2003, has now fallen consistently below 3,000,000 b/d since October 2007, with government estimates suggesting it could fall as low as 2,140,000 b/d a decade from now.

Output in 2007 averaged 3,082,000 b/d, 5.4 percent below the 2006 average of 3,256,000 b/d, reflecting continued decline at the supergiant Cantarell oil field in Campeche Bay. Cantarell declined sharply in 2007, with output from the field in early 2008 standing 900,000 b/d lower than its peak level of 2,140,000 b/d achieved in December 2003. Cantarell now accounts for only 43 percent of Mexico's crude oil production, compared to 63 percent four years ago.

The decline has been partly offset by significant increases at other offshore oil fields in Campeche Bay. Official figures show production from the heavy oil Ku-Maloob-Zaap complex has increased by about 200,000 b/d over the past four years, while output from the Offshore Light Crude project has also jumped by roughly 200,000 b/d.

Going forward, Pemex's expectations for Cantarell are not good. Presentations by top officials at state-owned Petroleos Mexicanos (Pemex) show production from the field falling to 1,000,000 b/d in 2010; 600,000 b/d in 2013; 450,000 b/d in 2015; and 399,000 b/d in 2017. (These figures have been confirmed by a public information request). All signs are that Pemex does not have other fields capable of offsetting these future declines, especially as Ku-Maloob-Zaap is expected to start declining in 2009 or 2010, and the Offshore Light Crude project is also believed to be close to its maximum potential.

Estimates of crude oil output and exports in Mexico's federal budget for 2008 are unrealistic. The budget optimistically establishes a 3,200,000 b/d goal for output and 1,700,000 b/d for exports this year. Also, Pemex has set its own institutional goal of maintaining output at close to 3,000,000 b/d going forward.

Mexico's crude oil output could drop to 2,140,000 b/d in 2016, the Energy Ministry's *Crude Oil Prospectus 2007-2016* warns. This "low" or worst-case scenario would be the result of limited investment and the postponement of deepwater development.

The prospectus also portrays a best-case scenario, in which oil-industry reform would allow for major investment in exploration and rapid development of new discoveries. Under that scenario, Mexico's output would average 3,260,000 b/d over the 10-year period, rising to 3,400,000 b/d in 2016.

Unlike other recent planning documents drawn up by the Felipe Calderón government, the *Crude Oil Prospectus* does not present an intermediate or "base" scenario. The government's National Infrastructure Program, on the other hand, predicts that crude oil output in the year 2012 will be 2,400,000 b/d under a worst-case or "inertial" scenario, 2,500,000 b/d under a base scenario and 3,200,000 b/d under a best-case scenario.

Although these documents are not ambitious, they are more realistic than those presented in 2001 by the Vicente Fox government, which aimed for between 3,800,000 and 4,000,000 b/d of crude oil output by 2007.

Energy Ministry officials have said that Mexican fields with easy access to low-cost oil have a short future, in an apparent reference to Cantarell, and that Pemex does not have the operational and technological capacity to develop prospective resources in deep water.

Mexican crude oil output (barrels per day)

1997	3,022,000
1998	3,070,000
1999	2,906,000
2000	3,012,000
2001	3,127,000
2002	3,177,000
2003	3,371,000
2004	3,383,000
2005	3,333,000
2006	3,256,000
2007	3,082,000
2008	2,957,000*

**January*

2. SOME IMPLICATIONS OF OUTPUT DECLINE

Exports of crude oil will decline in line with, and probably even faster than, the decline in output. Crude exports averaged 1,686,000 b/d in 2007, down 6 percent from 2006, and they seem certain to fall further over the next few years, mirroring Cantarell's deteriorating prospects. Public finances remain highly dependent on oil export revenues. The *Crude Oil Prospectus* foresees that Mexico will begin to import crude oil by 2011, although it will remain a net exporter. By 2013, imports, basically of light oil, are estimated to reach 191,000 b/d, with exports, of heavy oil, at 959,000 b/d, under the "low" scenario.

Pemex's contribution to government finances could potentially fall significantly as output and exports decline. However, this did not occur in 2007, thanks to rising crude oil export prices, which have jumped from roughly $20 per barrel in 2002 to $80 per barrel recently. Pemex's 2007 pre-tax revenues stood at a record $101.6 billion (bn),* up 2.8 percent from 2006, with oil exports accounting for $37.9bn. The finance ministry took a total of $80.8bn in revenues from Pemex in 2007, an amount equivalent to 35.4 percent of all government revenues. This figure is 1.7 percent lower than in 2006, when Pemex provided 37.1 percent of government revenues.

Falling oil output, at a time of fast-rising gasoline imports, has led to concern regarding government revenues and Mexico's energy security. Mexico used to consider itself self-sufficient in energy, but now it will likely have to resort to greater fuel imports to guarantee future availability of gasoline and other fuels. Today, Mexico imports almost 40 percent of its gasoline, 40 percent of its coal (mainly for the coal-fired Petacalco plant on the Pacific coast), 25 percent of its liquefied petroleum gas, and 20 percent of its natural gas.

3. OIL RESERVES POTENTIAL

Mexico's proven oil reserves have declined steadily since 1982, reflecting intensive exploitation of oil fields and a lack of investment in exploration. Investment to search for new oil reserves

* All figures in U.S. dollars.

was deemed almost unnecessary from 1980 to 2000, given the size of Mexico's reserves, but is now considered critical. Nevertheless, over 80 percent of Pemex's budget for exploration and production is still funneled into production.

Mexico has been overexploiting its oil fields, reaching output levels that are no longer sustainable in the absence of major new discoveries and an adequate level of oil reserves replacement. The industry has prospered for decades on the basis of intensive exploitation of giant oil fields. Such exploitation began with the Poza Rica field in the 1950s and 60s, then the Cárdenas, Bermúdez, and Jujo-Tecominoacán complexes in Tabasco in the late 1970s and 80s, then the offshore Abkatún-Pol-Chuc complex in Campeche Bay in the 90s and, most recently, Cantarell and Ku-Maloob-Zaap. Today's problem is that there are no major discoveries to take the place of Cantarell and Ku-Maloob-Zaap a few years from now. Cantarell is already declining and Ku-Maloob-Zaap will begin to decline within two or three years.

Estimating oil reserves in Mexico has long been a controversial issue. Official reserves figures have fallen sharply over the past decade, partly owing to the implementation of international standards in calculating them. Proven oil reserves stand at 11.8bn barrels, equivalent to about 9.6 years of production at current rates. However, total "3P reserves" (proven, probable, and possible)[†] amount to 45bn barrels.

As Mexico has recently looked towards the deepwater Gulf of Mexico, there has been much speculation about "prospective resources": non-proven volumes of oil identified through geoscientific studies in areas where no drilling has taken place. Mexico is believed to have 53.8bn barrels of "prospective resources," of which 29.5bn lie in deep water, with another 20bn in shallow water and on land. Lack of expertise, available rigs, and an appropriate legal framework has been holding back Pemex's efforts to make headway in deepwater exploration. In the meantime, some attempts are being made to develop mature fields on land and improve recovery rates by using better technology on offshore fields.

[†] Proven, probable and possible reserves are discovered by drilling, with a probability of recovery of 90, 50, and 10 percent respectively.

Most observers believe Mexico still has major reserves to be discovered, but exploration results have been very poor. Some figures show Mexico having reserves potential throughout 750,000 square kilometers ($km^{2)}$ of the Gulf of Mexico while others say there is 1,200,000km^2 of unexplored territory. In any case, only 25 percent of the first figure has been explored. That 25 percent, however, includes the onshore and shallow-water sedimentary basins that make up Mexico's main oil-bearing regions. In other words, practically no oil has been found in the most accessible areas in recent years.

4. National Infrastructure Program

The Calderón government has outlined some general energy policy goals as part of its National Development Plan. The plan's main policy goal is to "ensure reliable, quality supply, at competitive prices, of energy inputs demanded by consumers." It also calls for a "review of the legal framework (…) to strengthen Pemex and promote greater competition."

President Felipe Calderón has also outlined his government's National Infrastructure Program, which includes foreseeable investments of $75bn in exploration and production, $27bn in refining and $6.5bn on gas and petrochemicals by Pemex during his 2007-12 term. Another $27bn is slated to go to the state-run electricity industry.

As already mentioned, a basis scenario puts crude oil output at 2,500,000 b/d in 2012. An "inertial" scenario would bring output down further, to 2,400,000 b/d in 2012, while a best-case scenario would place it at 3,200,000 b/d. For natural gas production, the basis scenario is 5.0bn cubic feet per day (ft^3/day) in 2012, the inertial scenario is 4.7bn ft^3/day, and the best-case scenario is 7.0bn ft^3/day. In late 2007 and early 2008, output stood at close to 6.4bn ft^3/day. However, after rising steadily for the past three years, natural gas production has plateaued and seems unlikely to rise further.

In refining, crude oil throughput is expected to remain basically flat from now until 2012, at 1,400,000 b/d, according to the program's estimates. However, a best-case scenario would have work beginning on a new refinery during the Calderón government. The refinery would

be completed eight or ten years from now. Should that occur, throughput would be somewhere between 1,800,000 and 2,100,000 b/d in 2015 or 2017.

5. PEMEX'S CAPEX IS INCREASING

Government discourse suggests that Pemex will not have difficulty securing future investment. Capital expenditures (capex) at Pemex will increase 35 percent in 2008 to $19.7bn, up from $14.5bn in 2007 and $13.8bn in 2006, according to presentations made by company officials.

The increase in 2008 is largely due to a tax reform bill passed at the end of 2007 that reduces Pemex's tax burden by about $2.8bn. Pemex will also have some windfall tax revenues to spend this year. Some $16.8bn of this year's capex will go to exploration and production in an attempt to keep up faltering crude oil output.

Company officials say that to maintain crude output at 3,000,000 b/d, Pemex must exploit new fields in deep water, shallow water, and on land. However, it is not clear that, even with more investment, total output can remain stable or increase.

Pemex aims to drill 1,000 wells annually in Chicontepec, a vast onshore region full of tiny oil fields, at a cost of between $10.5bn and $14.5bn during the Calderón administration (2007-12). However, past exploitation of Chicontepec has been notoriously unsuccessful because pressure in the fields falls quickly after initial drilling. It remains to be seen whether this problem can be overcome with new technologies. Over the same period, Pemex also hopes to invest over $11bn in the supergiant Cantarell oil field, at least $6.5bn in Ku-Maloob-Zaap, and $5.5bn on the Light Offshore Crude project. All of these projects are in shallow waters in the Campeche Bay area.

Plans are for Pemex's capex to increase to $22bn annually from 2009 onwards. The company expects to spend as much as $130bn over the 2007-12 period. It is uncertain, however, that international banks will be ready to keep funding Pemex's capex requirements as keenly as they have in the past. Pemex is a highly indebted company with total liabilities amounting to $111.4bn, of which $46.1bn are commitments to its workers and pensioned staff.

Also, company general director Jesús Reyes-Heroles has expressed concern about Pemex's lack of managerial and administrative ability to spend the money well and to develop projects, in apparent reference to the fact that some Pemex projects in the recent past have not been well executed. Indeed, serious accountability questions can be raised about how well Pemex spends its vast budgets on exploration and production.

In Mexico, all investment in the oil and gas industry is administered by one single company, which contracts out all the work. As capex increases, so does the size of the contracts being awarded to companies doing integrated oilfield services, such as Schlumberger, Hailliburton, Repsol, ICA Fluor, Cobra, Precision Drilling, Petrobras, and others. Under Mexico's restrictive legal framework, these companies cannot share in production or profits under concessions or risk contracts, but rather carry out service contracts and get paid on a unit-price basis.

It would no doubt be more efficient to have a deregulated industry that would allow many players to invest, administer, and risk their own capital, and this would also most likely increase total investment. In the near future, however, Pemex is likely to remain the only investor, but it may have trouble financing its investments due to its high indebtedness.

Required Upstream Investments 2007-2012

Project	Estimated Cost
Cantarell	$11.0–14.5bn
Chicontepec	$10.5–14.5bn
Ku-Maloob-Zaap	$6.5–9.0bn
Light Offshore Crude	$5.5–7.5bn
Burgos Basin	$7.5–10.5bn

6. Plans to Move into Deep Water

The Calderón government has decided to prioritize the exploration of deepwater fields and, particularly, the exploitation of crossborder oil fields in the deepwater Perdido Fold Belt on the U.S.–Mexico maritime boundary, where international oil companies are already working in fields such as Great White, Trident, Baha and Hammerhead on the U.S. side. Seismic studies carried out by Pemex show that crossborder fields in Perdido are likely to exist.

Pemex estimates, speculatively, that there are over 29bn barrels of as yet unproven oil reserves in Mexico's part of the deepwater Gulf of Mexico. So far, Pemex has practically no relevant experience in deep water, having only contracted the drilling of four deepwater wells in waters of up to 1,000m in southeastern Mexico. Results from the wells were inconclusive. Moving into deepwater—especially into Perdido, where water depths are roughly 2,500–3,000m (8,200–10,000ft)—will require joint ventures with international oil companies and a better tax deal for Pemex. Developing Mexico's deepwater area in the Gulf of Mexico goes beyond the capacity of any single oil company working on its own.

Mexico has no deepwater oil production at this time, nor is it likely to have any before the middle of next decade, as deepwater projects generally require about eight or nine years to mature. However, the government's position is that Mexico must make major progress in deepwater projects now if it aspires to maintain oil output and government revenues in the long term, given that existing proven oil reserves, onshore and in shallow waters, are expected to last only nine years.

Joint ventures are needed, but decisions, probably including constitutional amendments, will have to be made by the president and by Congress. For now, it continues to be taboo in Mexico to think of sharing output or the revenues from oil sales with foreign companies. Some people in government believe this can be done without constitutional amendments by increasing exploration though service contracts with third parties, but such contracts may well lead to legal controversy, in the same way that other Pemex contracts (the so-called "multiple services contracts") allowing private companies to develop natural gas fields, have been challenged by lawmakers and have gone to court. Given very high exploration and development costs, Pemex will also require a much lower tax rate in order to exploit deepwater fields profitably.

It has been argued in Mexico, even by Calderón administration officials, that cross-border fields could be exploited unilaterally within a few years by international oil companies already working on the U.S. side of the boundary, once a ten-year moratorium expires in 2010 on drilling within 2.5 miles of either side of the border. Drilling on the U.S. side would depressurize fields

and allow companies to pull out Mexican oil, officials say. However, it would be politically insensitive for either government to allow this to happen. Diplomacy is required to find solutions for joint development of the fields. Inexplicably, no such diplomacy has been undertaken.

For now, Pemex has proven its will to move into the floating rig market by awarding three major contracts for new, deepwater semisubmersible rigs with operating water depth capacity of up to 3,000m (10,000ft). The three contracts, each worth close to $1bn covering construction of the vessels to be rented for a five-year drilling term, have been assigned to Mexican, British, and Norwegian companies which will be building their units in Korea, Russia, and Singapore.

The deepwater issue is being hyped in Mexico and needs to be kept in perspective. In the U.S. Gulf, deepwater fields provide little more than 1,000,000 b/d of crude oil production despite almost thirty years of intense investment and development. Mexico cannot realistically expect to achieve better results or to find a supergiant deepwater field to substitute for Cantarell.

The Calderón government has been promoting energy reform efforts that appear to have two major objectives. One is to find ways of exploiting cross-border oil fields under proposed alliances between Pemex and international oil companies. The other is to reduce (or at least stem the growth of) the nation's gasoline imports by allowing direct private investment in refining.

7. GASOLINE IMPORTS TO REMAIN STRONG

Mexico is expected to continue to be a major importer of gasoline, as demand outstrips domestic production. The nation will go on importing close to 40 percent of its gasoline over the next decade, according to the Energy Ministry's Prospectus on Petroleum Products.

Demand for gasoline has been rising steadily in recent years, from 635,900 b/d in 2004 to 754,700 b/d in 2007. Indeed, gasoline imports jumped from 94,900 b/d in 2004 to 307,000 b/d in 2007, due in part to recent problems at Mexican refineries. By 2016, demand will increase to over 1,000,000 b/d, according to the prospectus. The number of cars on Mexican roads is expected to jump by 80 percent—from 19,400 last year to 35,500 in 2016—though fuel efficiency is also expected to increase markedly.

Mexico hopes to cope with part of rising demand by upgrading its refineries and possibly building a new one. If that happens, the Energy Ministry predicts that gasoline imports will drop to 253,000 b/d in 2016, but it is not yet clear when work will begin on these projects.

Reconfiguration and construction of refineries could potentially add 480,000 b/d of new distillation capacity by 2016. The Energy Ministry maintains that gasoline imports could fall slightly over the next two years if the Minatitlán refinery upgrade is completed. However, there are reports of delays on that project due to controversies with contractors. In recent years, refinery upgrades have been postponed several times, and upgrades at the Cadereyta and Madero refineries (now completed) and at Minatitlán (still ongoing) have been mired in controversy and legal battles between Pemex and its contractors, leading to doubts about Pemex's ability to carry out new refining projects.

Reconfiguration of Pemex's other three refineries—Tula, Salamanca, and Salina Cruz, which are expected to come online early in the next decade—should hold imports steady at close to 320,000 b/d from 2012 to 2016. Plans are in place to install delayed coking plants in all six of Mexico's refineries. Currently, only two of them—Cadereyta and Madero—have such plants fully installed.

An additional refinery would increase capacity and reduce exports significantly, but such a project is not expected to be completed before 2015, and construction will depend on investment being available. For now, there are no concrete plans to build a new refinery, as the upgrades of the existing refineries are the first priority. Calderón's reform, if successful, would lead to legal changes allowing Pemex to join up with an international company to build a refinery in Mexico. As a precedent, Shell and Pemex have had a successful joint venture at the Deer Park refinery in Houston, Texas.

Over the past decade, processing capacity at Mexico's refineries has risen only marginally, from 1,520,000 b/d to 1,540,000 b/d. However, gasoline quality has improved, as reflected in an increase of isomerization and alkylation capacity from 30,400 b/d to 127,500 b/d over that period. Refineries must meet the challenge not only of rising demand, but also of profitability, processing of heavier crude oil, and production of cleaner, low-sulphur fuels.

Pemex will need to invest between $7bn and $9bn to upgrade three of its refineries, at Salamanca, Tula, and Salina Cruz, between 2007 and 2012. Another major expenditure to add plants to produce clean fuels at all six of Pemex's refineries will require between $3.8bn and $5.2bn. A grassroots refinery for processing 300,000 b/d of heavy crude would cost between $7bn and $9bn. That cost would double if the decision were to build a 600,000 b/d refinery.

The obsolescence of a large part of Pemex's pipeline infrastructure and gasoline storage terminals is also a major issue. Mexico's gasoline imports are brought in entirely through the Atlantic port of Tuxpan, where existing infrastructure is aging and insufficient. Gasoline imports are often taken to Mexico City by tanker truck, which is much more expensive than by pipeline. Current infrastructure is insufficient to handle increasing gasoline imports, increasing the risk of supply shortages.

Mexico's legal framework has restricted investment in refining and related infrastructure, which are activities reserved to Pemex. The company's refining division has consistently recorded losses over the years. There has been recent talk of opening up refining and related business—such as oil-product distribution, storage, and pipelines—to direct private investment, which potentially could be part of a reform.

Mexican Gasoline Imports (b/d)

2004	94,900
2005	169,800
2006	204,700
2007	301,800
2008	283,900
2009	271,300
2010	292,500
2011	323,500
2012	323,100
2013	313,400
2014	304,600
2015	212,700
2016	253,000

Source: Energy Ministry prospectus.

8. Major Electricity Investments Are Planned

The Mexican government plans to promote public- and private-sector investments of $34.2bn in electricity over the next five years, according to the National Infrastructure Program. These investments break down as follows: $14.5bn in generation, $8.5bn in transmission, $7.3bn in distribution, $3.7bn in maintenance, and $0.2bn in other activities.

In turn, the ten-year *Electricity Industry Prospectus* published by the Energy Ministry says Mexico will require $63bn in investments to meet its public-service electricity infrastructure needs between 2007 and 2016. New generating capacity of 22,153 megawatts (MW) for public use will be needed over the period, accounting for 43.4 percent of the investments, while 19.5 percent will go to transmission projects, 24.2 percent to distribution, 11.8 percent to maintenance, and 1.1 percent to other investments.

The goal of the infrastructure program is to increase effective generating capacity from 56,000 MW currently to between 65,000 and 68,000 MW in 2012, according to the program, which borrows heavily from the annual planning done by the nation's dominant, state-owned utility, the Federal Electricity Commission (CFE), though it also considers minor investments to be made by private companies and by Luz y Fuerza del Centro, a smaller and notoriously inefficient state-owned utility that distributes power in and around Mexico City.

The program also aims at increasing transmission and distribution lines by at least 14,000km (8,750mi) over the five-year period and providing public service to 97.5 percent of the population, which implies achieving greater coverage in rural areas of Mexico.

A specific goal of the infrastructure program is to put Mexico among the forty best evaluated nations in the World Economic Forum's electricity supply quality index. The index, which measures fluctuations in voltage, gives Mexico a rating of 4.1, slightly better than Argentina, with 4.0, and China, with 3.9, but well below the United States, with 6.3, Spain, with 6.0, Chile, with 5.6, and even Brazil, with 5.0.

The infrastructure program also points out that Mexico's per capita electricity consumption is well below that of developed nations, at 1,804 kilowatt hours (kWh) per inhabitant per year. This compares to 13,338 kWh in the United States; 7,391 kWh in Korea; and 5,974 kWh in Spain.

A key challenge for Mexico will be to reduce losses in the distribution of electricity as a percentage of power generated. The global standard is for losses to average 10 to 12 percent of power generated, though many nations achieve between 4 and 9 percent. Mexico's losses stand at 16 percent, a ranking similar to that of Brazil (16.8 percent) and Argentina (15.4 percent).

9. High Reserve Margin and Diversification

Although Mexico's electricity planning is aggressive going forward, it has also arguably been too aggressive in the recent past in terms of adding new generating capacity, leading to a situation in which Mexico now has an ample reserve margin (that is, ample idle capacity at hours of peak demand).

The high reserve margin is the result of growth in capacity having outstripped the demand for electricity since 2001. Low economic growth has slowed the demand for electricity and also the need for new generating capacity in the short term, meaning that most of the aforementioned future investments in public-sector generating capacity will not be required in the immediate future, but rather from 2011 on. As a result, the CFE will be tendering few new generation capacity additions over the next two to three years. No new power stations will be completed in 2008, and only two will do so in 2009. Electricity consumption is expected to grow at 4.8 percent annually over the next decade, based on the government's macroeconomic forecasting for the Mexican economy as a whole, which predicts Mexican GDP will grow at an average annual rate of 3.8 percent.

The high reserve margin is partly the result of a large number of gas-fired power stations having been built and operated by private companies (independent power producers, IPPs)

over the past decade. The IPPs deliver electricity to the CFE for public service, but, because of constitutional restrictions, cannot sell electricity directly to end users.

The reserve margin is now considered to be more than sufficient to avoid contingencies and ensure reliability in power supply. The *Electricity Industry Prospectus* says that the operating reserve margin was 24.5 percent of total capacity in 2007 and will remain high for the next two years, before falling to 6 percent in 2011, a level that is considered adequate and which authorities hope will be maintained thereafter.

It can also be argued that high reserve margins, while expensive to maintain, have been very useful in meeting contingencies. Last year, when bomb blasts on Pemex pipelines knocked out a number of gas-fired power generators for several days, hydropower was able to take their place. Then, in November, when climatic conditions and a landslide wreaked havoc on Mexico's most important hydropower dam complex on the southern Grijalva River, perhaps causing long-term damage, oil- and gas-fired plants were able to substitute for lost capacity. Even so, reserve margins are currently much higher than needed even to deal with such contingencies.

Faced with excessive dependence on gas-fired plants, the CFE is planning a more diversified approach to power generation. In the medium term, it will tender a major coal-fired complex on the Pacific coast, two large new hydropower dams, several windpower and geothermal projects, a solar generation project, a repowering of its older oil-fired plants, and two transmission lines linking Baja California to the national grid.

Gas will remain important, and the CFE has been promoting LNG regasification projects to diversify gas supplies. The country's first regasification terminal at Altamira, owned by Shell-Total-Mitsui on the Atlantic coast, has been operating for over a year and brings in LNG from Nigeria, Qatar, Egypt, and Trinidad. The CFE is promoting two more LNG terminals on the Pacific coast, at Ensenada (to start up in 2008) and at Manzanillo (to start up in 2011). However, it seems virtually certain that there will be no more LNG available on the market, particularly on the Pacific coast, to justify the building of more LNG terminals in the future. Also, the CFE has

been experiencing recent problems in buying coal in a tight market for its 2,100 MW Petacalco power station on the Pacific coast.

10. Wind Power Is a Key Option

Given overdependence on gas, supply problems with coal and LNG, damage to hydropower dams, and environmental drawbacks with oil, wind power would seem to offer a major opportunity for Mexico, which has only 83 MW of installed windpower capacity, despite having several regions with notoriously strong winds. The United States, China, Spain, and Germany all install 2,000 MW or more of windpower capacity annually. If Mexico could do the same, wind power could account for most of Mexico's future additional capacity requirements.

For now, private companies have committed to making investments of $3bn to build just under 2,000 MW of new windpower capacity over the next three years. The figure includes financing for a transmission line, to be owned and operated by the CFE, which will connect their projects to the national grid.

The Ministry of Energy has announced that formal agreements have been signed for thirteen windpower projects, all of which will be built at La Venta in the Isthmus of Tehuantepec in southern Mexico, and which have received permits from the Energy Regulatory Commission (CRE) in recent years. The obstacle to the development until now has been the lack of a transmission line. Constitutional restrictions prevent private companies from transmitting electricity in Mexico. These projects are in addition to the CFE's own plans to complete four 101.4 MW windpower projects over the next four years, thus providing another 406 MW of capacity.

An open season was called in March for windpower companies to reserve capacity on a firm basis on a major power transmission line to be built by the CFE, which will connect new windfarms to the national grid. The open season allows the CFE to determine how much capacity private developers are prepared to reserve. The CFE says it is prepared to build a 145km (91mi),

400 kilovolt (kV) transmission line, capable of transmitting up to 2,600 MW of electricity, to connect developers to the national grid.

B. RECOMMENDATIONS FOR THE FUTURE

Policy measures needed to put Mexico's energy industry, and particularly Pemex, on a sound, sustainable, long-term footing, are wide-ranging and extremely complex. There is no single solution or model that will necessarily give the best results. Moreover, there is no clear, shared, long-term vision among Mexicans about how to proceed. On the contrary, political obstacles to reform are formidable, vested interests opposed to reform are strong, and discussion tends to be superficial, revolving around different, often unclear interpretations of the concept and scope of "privatization." The whole idea of deregulating or selling parts of the energy industry to private investors remains a highly emotional issue among Mexicans, who still see the nationalization of the oil industry in 1938 as a key part of Mexican history and the Mexican identity. The idea of direct participation in the industry by foreign companies remains highly controversial. All of this makes it extremely difficult to move ahead with reform measures.

As a result, all political parties still consider amendments to the restrictive constitutional precepts on energy matters to be politically unviable. In essence, the constitution says that only the state can carry out all the essential activities of the oil and electricity industries. However, governments have, over the years, sought ways around the constitution in order to allow private companies to do oil services work for Pemex, generate electricity and store LNG for the CFE, and offer a wide range of other non-core activities in the energy industry in an attempt to make the industries more competitive.

In a previous policy paper (*Pemex: Problems and Policy Options*, February 2006 / Paper No. 4), it was suggested that change in Pemex could be based essentially on any one of three models:

MODEL No. 1. This would be an improved status quo, without constitutional amendments, in which the fiscal goals of the Mexican government would remain unchanged, while giving greater financial and administrative autonomy to Pemex and applying business (rather than political) criteria to its administration and operation.

MODEL No. 2. Pemex would continue to be a fully state-owned company, but with a full-blown opening to private investors through constitutional and legal changes that would allow Pemex to award concessions, risk contracts, profits-sharing, and/ or production-sharing contracts.

MODEL No. 3. Pemex would become a limited company with majority state participation or, alternatively, remain under state control, but with a majority of private capital. The composition of capital could be either 100 percent Mexican, public and private, or 50 percent or more of its capital could be private, either Mexican or foreign, and it would be financed on capital markets. Private companies could also associate with Pemex or amongst themselves in a deregulated industry.

These three options for the future of Pemex remain valid and can still be undertaken, though the outlook for positive change at Pemex does not look good at this time due to the turbulent and divisive political atmosphere that prevails, especially when key energy topics are up for discussion. While waiting for progress on possible legal reforms to improve Pemex's organization and performance, the following are some other general recommendations that would tend to move Mexico's energy industry in the right direction:

a. There is a need for rational exploitation of oil and gas deposits that does not deplete large oil fields over a short period. Achieving this would probably imply establishing a level of sustainable output at a lower level than has been achieved in the past. (However,

considerations related to public finances make it unlikely that a decision of this kind will be made).

b. Pemex needs to use new geoscientific and technological tools more intensively in its exploration efforts in order to discover new reservoirs and increase oil reserves. There are new technologies on the market that can help identify subsalt reservoirs, as well as geostatistical tools that can complement seismic studies and other geoscientific work already carried out by Pemex.

c. The creation of a national petroleum agency, similar to those operating in Norway and Brazil, would help Mexico's oil industry become more sustainable in the long term. The agency would have a team of specialists whose job would be to guarantee optimal exploitation of oil reserves. In parallel, it is imperative to establish a new law to ensure best industry practices and rational exploitation. The law would be implemented under the scrutiny of the oil agency.

d. Crude oil production and exports, as well as Pemex's bloated staffing, are probably unsustainable at current levels, unless unforeseeable successes in exploration occur. The company should, therefore, contemplate downsizing, possibly cutting staff from the current 140,000 to 90,000 workers, during the present government.

e. There is a need to reorient Pemex's budget, which overemphasizes oil production, in order to give greater weight to exploration for new oil reserves and greater priority to refining, pipelines, fuel storage, and maintenance of existing infrastructure, which have suffered from underinvestment over the past two decades. If Pemex's capex continues to increase as is foreseen, additional money could be assigned to exploration, refining, and maintenance, without reducing investment in oil production. Attention should also be given to developing transparent criteria for assigning Pemex's budget and for measuring the performance of contractors to make sure that investments are cost-effective.

f. The Mexican government should restructure Pemex's finances and take on Pemex's debt as sovereign debt. By improving Pemex's financial profile the stage could be set for a stock offering at some future time that would adequately capitalize the company.

g. In general, efforts should continue on reforms that would free Pemex from government bureaucracy and allow it to operate as a company rather than as part of the government bureaucracy and an instrument of public finances. In fiscal terms, further efforts are needed to expand the tax base and reduce the federal government's dependence on revenues from crude oil exports.

h. Major improvements in efficiency and competitiveness at the state-owned energy companies would require major changes in labor relations and a solution to pension-fund liabilities at the companies as a complement to the aforementioned reforms.

i. Efforts are required to reduce the demand for gasoline given that, under almost any scenario, demand is estimated to grow faster than Pemex's fuel production. It would be advisable to use smaller cars on the overcrowded roads of Mexico's biggest cities, reduce imports of second-hand cars, and improve public transport.

j. The CFE's budget should be oriented away from power generation and towards transmission, distribution, and maintenance in the medium term.

k. Wind power and other types of renewable energy should be promoted much more intensively as alternatives to oil-, gas-, and coal-fired power generation. Given the country's excess installed capacity, renewables could make up virtually all new capacity to be added over the next decade or so.

l. Energy consumption in buildings—particularly in new construction—should be regulated more strictly, given that many new houses are being built without applying any energy efficiency regulations. There is a great need for fuel savings and energy efficiency measures throughout the Mexican economy.

m. As far as is practical and politically possible, it would be useful to draw up a vision for the future and carry out an integral review of the legal framework pertaining to Mexico's energy industry, adapting the legal framework to the vision. Ideally, a large degree of consensus could be reached on the vision, thus setting the foundation for future political action.

BACKGROUND INFORMATION

This policy paper is based mainly on interpretation and analysis of government information and statistics that are available online.

The Calderón government's National Development Plan can be consulted at http://presidencia.gob.mx and the National Infrastructure Program is available at http://www.infraestructura.gob.mx

The Energy Ministry's prospectuses on crude oil, oil products, natural gas, and electricity are available at http://www.energia.gob.mx

The Federal Electricity Commission's ten-year Public Works and Infrastructure Program (POISE) can be consulted at http://www.cfe.gob.mx

Petroleos Mexicanos (Pemex) has a large number of presentations by company officials and statistical documents available at http://pemex.com

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