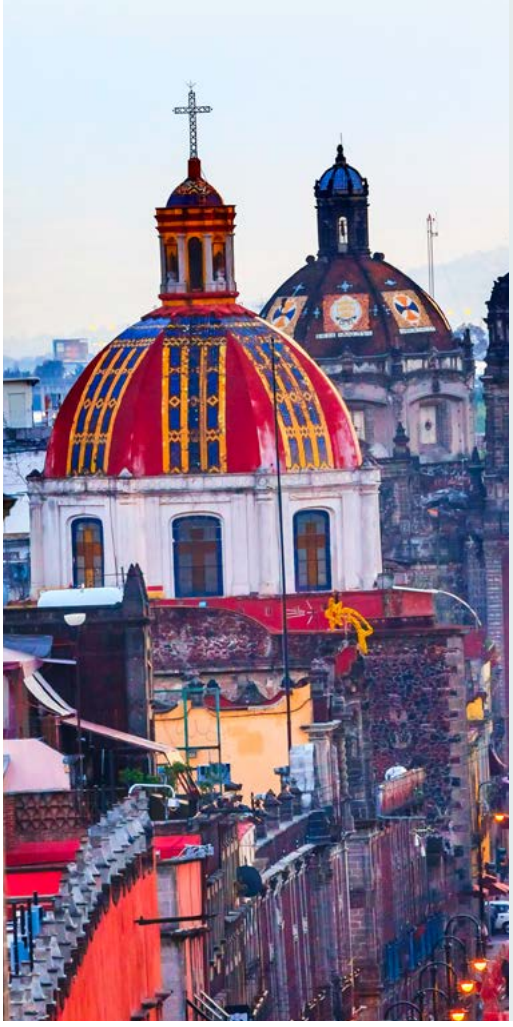
White Paper

Merchant Economics in Mexico: Party On?

By Pat Milligan and Dinesh Madan, ICF



Shareables

- 2016 DA spark spreads in Mexico of $15+/MWh and a residual capacity price of $175/MW–day makes merchant gas look attractive.
- However, ICF sees a sharp correction in spark spreads and capacity coming as 10+ GW of new CC comes online by 2020.
- The long–term depends on retirement activity and RPS buildout; locational advantages may become increasingly important for plant economics.

Executive Summary

2016 was a good year to be merchant in Mexico. Even as exchange rates with the USD slid to record lows (from 17.2 on 1/1/2016 to 20.7 on 12/30/16), all–hours average spark spreads in the day–ahead market were in the range of US ~$15/MWh or higher in most of the country[1]. Further, in late February the capacity balance market cleared an unexpectedly high $175/MW–day for uncontracted capacity in 2016, reversing course after releasing an estimate in December that prices could be zero. Taken together, a merchant combined cycle could have made as much as $150–200/kW in 2016[2]. Can these premium merchant conditions last?

[1] 7,000 Btu/kWh cutoff. Distributed nodes in the SIN considered. Zonal gas prices estimated from previous VPN tariffs.

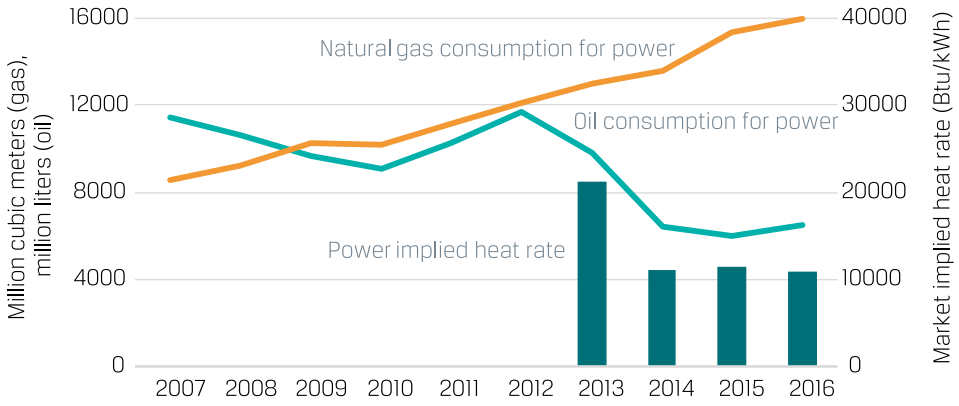
[2] 8000 run hours at $15/MWh spark spread + $175/MW–day at full availability = $184/kW–yr

A truly open market – if that is what Mexico wants to be – would suggest not. In this paper, we provide an analysis of key factors and trends that can help in assessing this outlook. In particular, we see four system trends driving price over time.

1. Near–term: Oil Continues to be Marginal in Many Hours

The fraction of oil burned for power still correlates heavily with market implied heat rate (IHR)[3] as shown below, indicating that oil is often price–setting. This is reflective of current conditions, which saw energy prices in the USD $40–60/MWh range and estimated implied market heat rates around the 11,000–13,000 Btu/kWh range at major load zones in 2016. Mexico has intended to cut out oil–fired generation in the near–future, but low current prices and other factors (including less gas infrastructure than ideal) led to a pause and even reversal in oil–fired dispatch and generation.

EXHIBIT 1. HISTORICAL GAS AND OIL CONSUMPTION FOR POWER AND RECENT HISTORICAL MARKET HEAT RATES



Source: ICF

We expect significant oil burn to continue for the next 1–2 years as oil prices remain depressed and before new gas combined cycle (CC) available capacity ramps up fully.

2. Large planned CC buildout to 2020

Over 10 GW of combined cycles are either under construction or have cleared RFPs and should be online in the next 3–4 years. Many of these builds are using GE H–class or Mitsubishi National J–class turbines, with base block heat rates as low as 6,400–6,600 Btu/KWh. This buildout outstrips even the Secretaria de Energía's (SENER) relatively–aggressive demand growth forecasts (averaging about 3.7% nationally, compared to the last 10–year average growth of about 2.3% annually) of an additional approximately ~5 GW in coincident peak to 2020,

[3] Market implied heat rate is the power price divided by gas price, often expressed in Btu/kWh. This gives a rough indication of the heat rate of the marginal unit if that marginal unit is gas, and also gives a sense of energy margins available for gas units (the difference between the unit heat rate and the market IHR).

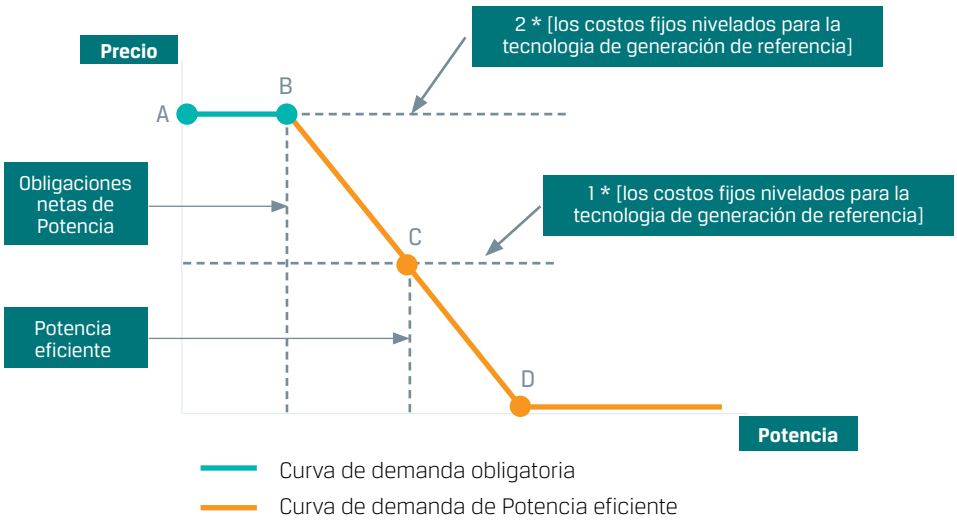
and will push reserve margins up from the low 20% range currently to near 30% or higher, absent retirements. The residual capacity market, which draws the line for zero price somewhere near 28–29%, will likely be wiped out.

EXHIBIT 2. MEXICO'S CAPACITY BALANCE MARKET

CENACE (Centro Nacional de Control de Energía) operates a backwards–looking capacity balance market annually to mop up extra capacity in the market and send capacity reserve signals. Generators are given capacity credit as measured during 100 critical hours during the year. A vertical line at that capacity level is then drawn against a demand curve, which takes the following parameters:

- B: Minimum reserves (~13% RM for the SIN)
  - = 2x net CONE for reference CT
- C: "Efficient" reserves (~21% RM for the SIN)
  - = 1x net CONE for reference CT
- D: Zero point defined by straight line continuation from points B to C

The resulting price is credited to generators and charged to LSEs by load – so net position for each market participant is the critical factor.



Source: Diario Oficial de la Federación, http://www.dof.gob.mx/nota_detalle.php?codigo=5453483&fecha=22/09/2016

Stacking up units, in 2016, there were about 32 GW of nuclear, coal, geothermal and combined cycle capacity; below the average demand of roughly 36 GW. Even including the existing renewables, there is significant demand that must be met by older combustion turbines and oil/gas steam. But by 2020, nuclear/coal/CC resources will total about 42 GW, and should equal or exceed the average load

(perhaps 40–42 GW), plus renewable penetration will also be higher. Therefore, much of the older oil-burning fleet owned by the Comisión Federal de Electricidad (CFE) could largely being pushed out of the dispatch stack. For several years the system will be heavily oversupplied on the rapid gas CC buildout, placing downward pressure on heat rates.

3. Price pressure in the 2020s: Will the CFE be willing to retire 25% or more of its fleet?

Whether one assumes rising and recovering $4+/MMbtu Henry Hub pricing or low and falling sub-$3/MMBtu forward prices to 2020, our modeling shows that given the CC buildout, 8–12 GW of older oil/gas steam units, generally CFE-owned, will be uneconomical by 2020 and should retire.

SENER and other planning agencies have largely agreed with this assessment. In the 2016 Programa de Desarrollo del Sistema Eléctrico Nacional (PRODESEN) report, SENER projected 10.2 GW of retirements by 2020. However, it is not apparent that anything much has been planned or scheduled to this point, and SENER is not the one making the actual decision.

Retiring so many plants in a relatively short time will not be easy. Leaving possible political and operational difficulties aside, there are potential technical challenges: the transmission infrastructure in Mexico is relatively less developed than other open North American markets, and many of the CC builds are located in the north of the country while many oil/gas units are located in the relatively-more congested south and central areas. There is currently no clear market mechanism related to sub-regional capacity requirements (i.e. capacity subzones) – capacity anywhere in the entire Sistema Interconnectado Nacional (SIN) is treated equally in the balancing capacity market, and the long-term auction cut locational benefits after the first year's clearance.

While these plants will likely stop dispatching regardless, their retirement will help capacity pricing recover in the early 2020s after expected lows in the next few years (due to expected CC overbuild).

4. Long-term: what will RPS push look like?

Mexico has a target of 35% non-fossil generation by 2024, vs current production at about 24%, implying a need for an additional 50–60 TWh from clean sources. That would suggest additional wind and solar capacity in the 15–20 GW range, absent further significant geothermal or hydro expansion (small amounts of which have cleared in the second long-term auction, but large amounts seem unlikely). Therefore, the established pace of about 2.5–3 GW of new renewable capacity per long-term auction is likely to be sustained through 2024.

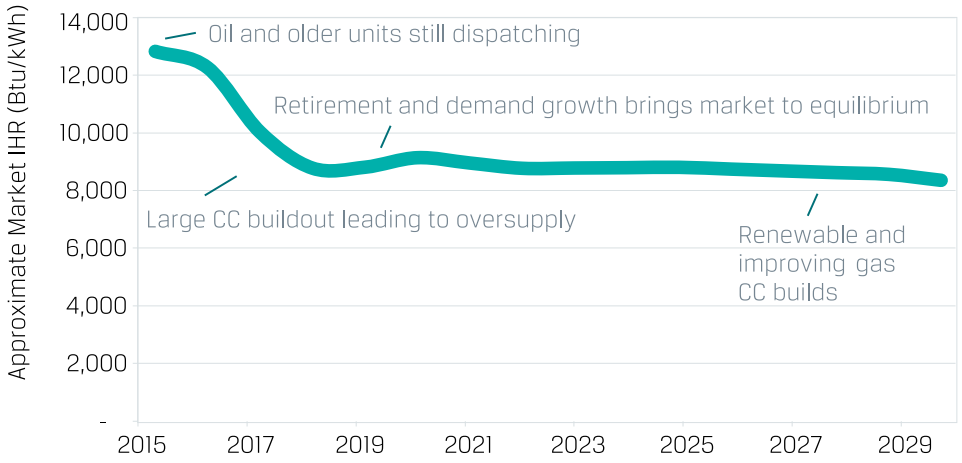
One additional aspect of this is the locational consideration. Solar has been the favorite technology thus far, and the best solar resources are located in the northern parts of the country, which generally coincides with most of the current gas capacity and pipeline build. This could exacerbate what has historically been

north–south congestion on the network. Over 2015 (CFE reported costs) and 2016 (day–ahead market), prices in the North and Northeast transmission regions have generally averaged about USD $3/MWh lower prices than the Central/East/West transmission regions. Increasing low–cost gas imports from Texas may exacerbate the trend. SENER is planning large transmission projects across the country, and particularly in the northern regions; completing these will become increasingly important to managing congestion.

A view on pricing

These four drivers manifest in distinct price trends over the next decade. As gas becomes the marginal fuel, market heat rate trends are the most useful way to visualize the evolution of the market. While there will continue to be zonal price separation and other locational trends, we see general hub market heat rates evolving as shown in Exhibit 3 below: a pronounced decline in the near term with significant CC buildout underway, a slight tightening with retirements and demand growth, and then a gradual decline in the long term as the system continues to add renewables and becomes more efficient.

EXHIBIT 3. PROJECTED EVOLUTION OF MARKET HEAT RATES



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About the Authors

Patrick Milligan is an associate with ICF's Commercial Energy division with experience modeling supply and demand in wholesale power, generator asset valuation and financial projection in a variety of markets in the United States, Mexico and Canada.

Dinesh Madan is a Technical Director in ICF's Energy Advisory Group. He joined ICF in 2005 and has been extensively involved in the areas of energy market modeling, wholesale power market assessment, asset valuation and financial modeling, restructuring and litigation support including contract evaluation and risk assessment. Mr. Madan is an expert in US electricity markets, with a special focus on ERCOT and CAISO and market design and issues affecting wholesale and retail power markets.

For more information, contact:

Shanthi Muthiah
shanthi.muthiah@icf.com +1.703.934.3881

Dinesh Madan
dinesh.madan@icf.com +1.703.713.8846

Pat Milligan
pat.milligan@icf.com +1.703.225.5856

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