



**MEXICAN ELECTRICITY MARKET
OPERATION
YEAR 2023 AND 1H 2024**

TECHNICAL NOTE

September 2024

TABLE OF CONTENT

MEXICAN ELECTRICITY MARKET OPERATION	3
1. INTRODUCTION	3
2. ELECTRICITY CONSUMPTION	3
3. ELECTRICITY PRODUCTION	4
3.1. Installed Capacity.....	4
3.2. Electricity Generation.....	5
4. FUEL PRICES	9
5. SHORT TERM MARKET	9
5.1. LMPs in SIN Region	11
5.2. LMPs in the BC and BCS Regions	12
6. CAPACITY BALANCE MARKET	13
6.1. Capacity Price	13
6.2. 100 Critical Hours in the SIN	14
7. NEW GOVERNMENT	15
ENERGY MARKET INTELLIGENCE DIVISION	17
ABOUT GME	17

TABLE OF EXHIBITS

Exhibit 1: SEN' system net electricity consumption (2017 – 2023).....	4
Exhibit 2: SEN' system net weekly electricity consumption (2020 – 2024)	4
Exhibit 3: 2023 SEN' s system installed capacity (MW), Dec 2023.....	5
Exhibit 4: 2023 SEN' s system installed capacity (MW, %), Dec 2023.....	5
Exhibit 5: SEN' s system energy generation by type (2017-2023 table).....	6
Exhibit 6: SEN' s system energy generation by type (2017 -2023 chart).....	7
Exhibit 7: SEN's historical energy generation – Solar and Wind (in MW avg.)	7
Exhibit 8: Historical annual hydro generation (2017-2023)	8
Exhibit 9: Historical monthly hydro generation (2017-2024)	8
Exhibit 10: 2023-2024 Natural Gas prices (Henry Hub) [USD/MMBTU].	9
Exhibit 11: 2019 -2024 monthly LMPs at Queretaro node in the DAM [USD/MWh]	10
Exhibit 12: 2016 - 2024 Monthly LMPs	10
Exhibit 13: Monthly LMPs Queretaro Node	11
Exhibit 14: 2023 average LMPs heatmap for SIN, BCA, BCS [in USD/MWh].....	12
Exhibit 15: 2024 June and July LMPs heatmap for SIN, BCA, BCS [in USD/MWh].....	13
Exhibit 16: CBM 2016-2023 – Capacity Prices	14
Exhibit 17: CBM 2023 – 100 critical hours	14

MEXICAN ELECTRICITY MARKET OPERATION

YEAR 2023 AND 1H 2024

1. Introduction

This document presents a comprehensive analysis of the Mexican electricity market for 2023 and the first half of 2024, with a focus on both operational dynamics and key market developments. During this period, the electricity market was significantly impacted by the climatic effects of the El Niño phenomenon, which triggered severe heatwaves and droughts across the country. These conditions led to an unprecedented surge in electricity demand, particularly due to increased air conditioning usage, while simultaneously causing a decline in hydroelectric generation due to reduced water inflows to reservoirs. The combination of these factors, along with the unavailability of certain generation units, resulted in critically low generation reserves. This, in turn, posed challenges to the security of supply and drove electricity prices to exceptionally high levels.

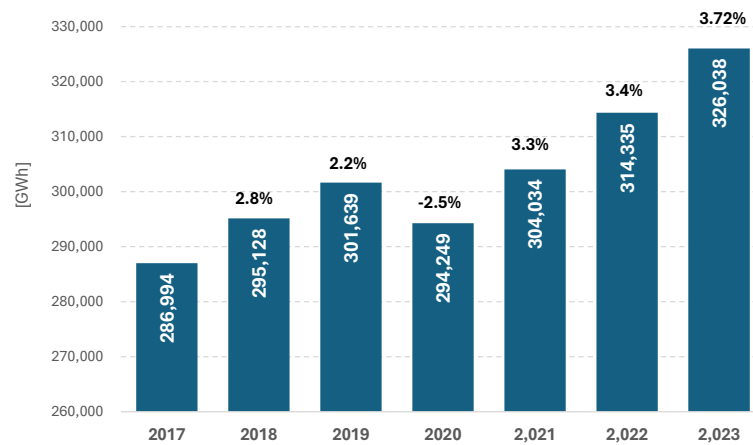
2. Electricity Consumption

In 2023, the National Electricity System (SEN) recorded an annual net electricity

consumption of 326 TWh, representing a 3.7% increase compared to 2022. This significant rise in demand was largely driven by the intense heatwaves that swept across Mexico during the latter half of the year. These extreme weather conditions led to a substantial increase in the use of air conditioning and cooling systems, particularly in residential and commercial sectors, which are highly sensitive to temperature fluctuations.

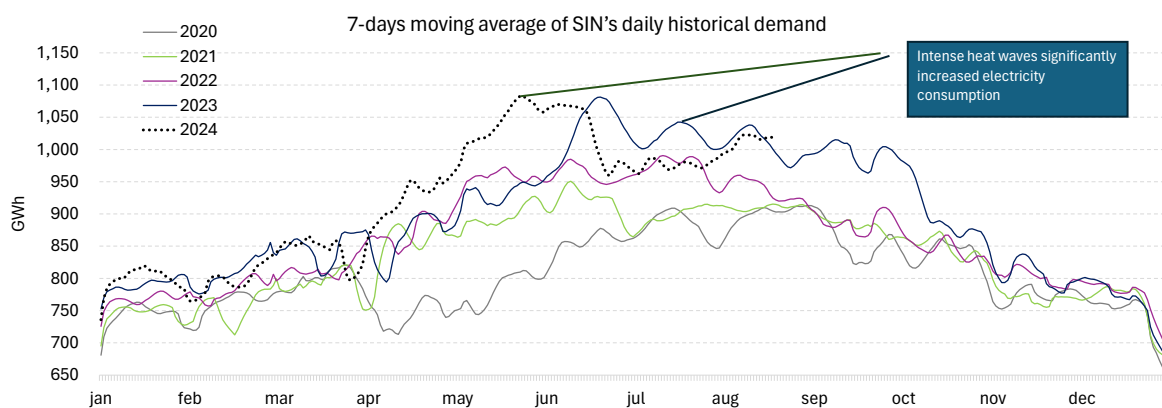
The increase in demand was not uniformly distributed across the country, with regions experiencing the most severe temperature anomalies reporting the highest spikes in electricity usage. This surge in consumption placed additional stress on the SEN, highlighting the system's resilience but also underscoring the need for continued investments in grid modernization and demand-side management strategies. The heatwaves of 2023 serve as a stark reminder of the growing influence of climate change on electricity consumption patterns, emphasizing the importance of adaptive measures to ensure the reliability and sustainability of Mexico's energy supply in the face of increasing climatic variability.

Exhibit 1: SEN' system net electricity consumption (2017 – 2023)



Source: GME elaboration based on CENACE and SENER data.

Exhibit 2: SEN' system net weekly electricity consumption (2020 – 2024)



Source: GME elaboration based on CENACE and SENER data.

3. Electricity Production

3.1. Installed Capacity

In 2023, the National Electricity System (SEN) reached a total installed generation capacity of 89.8 GW. This capacity expansion was driven primarily by the addition of high-efficiency technologies, especially natural gas combined cycle (NG-CCGTs), which continue to play a pivotal role in the country's energy mix due to their reliability and lower emissions compared to traditional fossil fuel sources.

Moreover, there was significant growth in non-conventional renewable energy (NCRE) technologies, with substantial investments in solar and wind power projects. These renewable sources not only contributed to diversifying the energy portfolio but also aligned with Mexico's commitment to reducing greenhouse gas emissions and increasing the share of clean energy in its overall generation capacity. By the end of the year, solar and wind installations accounted for a notable portion of the new capacity, reflecting the country's ongoing

transition towards a more sustainable energy framework.

strategic focus on balancing the need for reliable energy supply with environmental sustainability, as the country works to meet both its growing electricity demand and its climate goals.

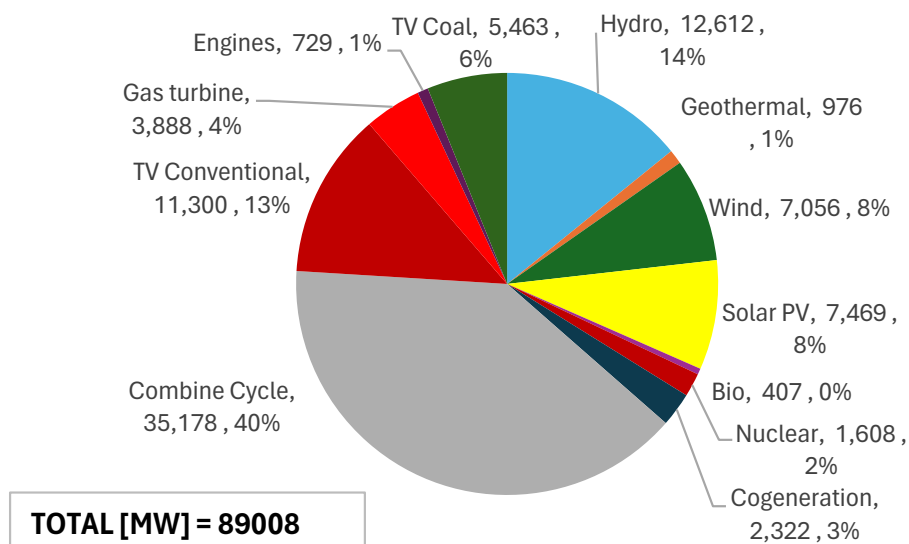
This expansion underscores Mexico's

Exhibit 3: 2023 SEN's system installed capacity (MW), Dec 2023

Technology	Owner				2023	2022
	CFE	CFE-PIE	PRIVATE	PEMEX	TOTAL	TOTAL
Hydro	12,133		479		12,612	12,613
Geothermal	951		25		976	976
Wind	86	613	6,357		7,056	6,921
Solar PV	126		7,311		7,437	6,515
Bio			407		407	408
Nuclear	1,608				1,608	1,608
Cogeneration			1,955	367	2,322	2,308
Solar PV w/BESS	12		20		32	20
Subtotal Clean	14,916	613	16,554	367	32,450	31,369
Combine Cycle	11,108	16,051	8,019		35,178	34,413
TV Conventional	9,998		880	422	11,300	11,343
Gas turbine	2,833		924	131	3,888	3,815
Engines	362		367		729	728
TV Coal	5,463				5,463	5,463
Subtotal Thermal	29,764	16,051	10,190	553	56,558	55,762
TOTAL	44,680	16,664	26,744	920	89,008	87,131

Source: GME elaboration based on CENACE and SENER data.

Exhibit 4: 2023 SEN's system installed capacity (MW, %), Dec 2023



Source: GME elaboration based on CENACE and SENER data.

3.2. Electricity Generation

In 2023, the total electricity generation required to meet national demand reached 346.3 TWh. Most of this energy, approximately 58.8%, was supplied by

natural gas combined cycle (CCGT) plants, emphasizing the dominant role of natural gas in Mexico's energy mix. These plants were crucial in maintaining a stable and reliable energy supply, particularly during peak demand periods exacerbated

by the extreme weather conditions linked to the El Niño phenomenon.

Clean energy sources, which include hydroelectric, solar, wind, geothermal, biomass, and nuclear power, collectively contributed 21.9% of the total electricity generation. This reflects ongoing efforts to transition towards a more sustainable energy system. Hydroelectric power, while traditionally a substantial part of the clean energy mix, faced challenges due to reduced water inflows caused by prolonged droughts, which impacted its overall contribution. Solar energy, in particular, showed significant growth supported by favorable policies to interconnect new projects to the trunk transmission system.

The remaining 19.3% of electricity

generation came from other thermal sources, including conventional steam turbines, coal-fired plants, internal combustion engines, and simple-cycle gas turbines. These sources, while less efficient and more carbon-intensive, continue to be part of the energy landscape, providing critical backup capacity and supporting grid stability, especially during periods of high demand or when renewable generation was lower than expected.

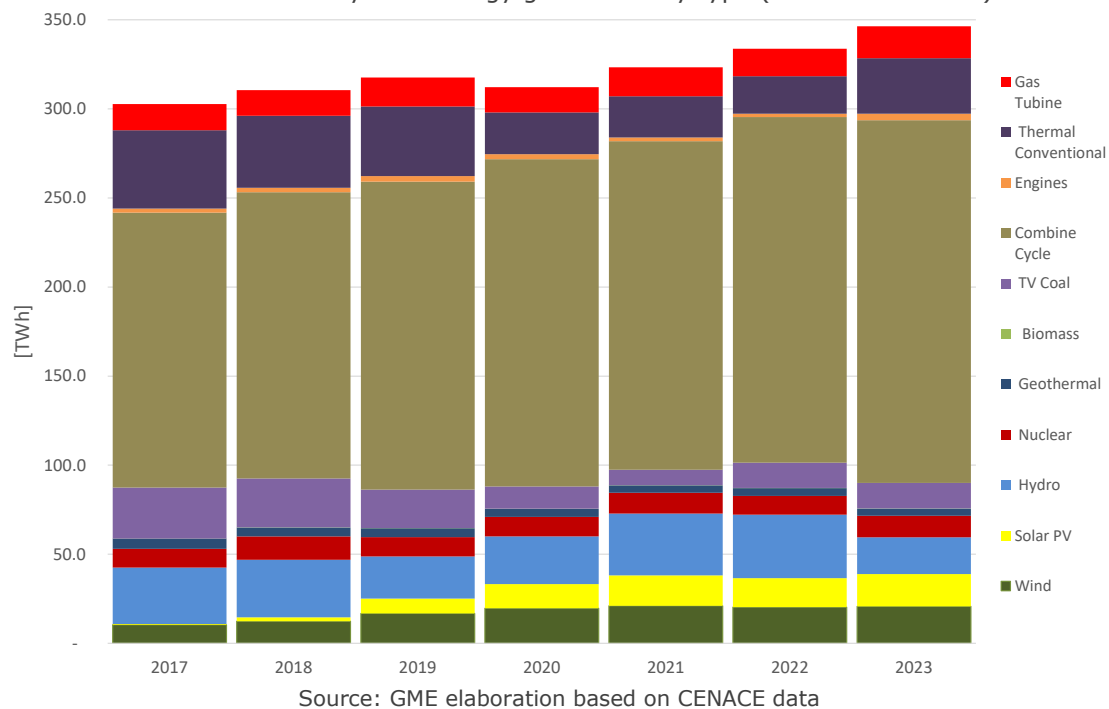
This energy generation profile highlights Mexico's reliance on a diversified energy portfolio, balancing the advantages of clean energy expansion with the necessity of maintaining conventional thermal capacity to ensure reliability and meet the country's electricity needs under varying conditions.

Exhibit 5: SEN's system energy generation by type (2017-2023 table)

SEN - Generation by type [TWh]												
Year	Wind	Solar PV	Biomass	TV Coal	Combine Cycle	Engines	Geothermal	Hydro	Nuclear	Thermal Conventional	Gas Turbine	TOTAL
2017	10.5	0.3	0.0	28.7	154.3	2.3	5.7	31.7	10.6	44.0	14.7	302.8
2018	12.4	2.2	0.1	27.3	160.7	2.6	5.0	32.2	13.2	40.4	14.4	310.6
2019	16.7	8.4	0.1	21.6	172.8	3.2	5.0	23.6	10.9	39.0	16.4	317.7
2020	19.7	13.5	0.1	12.5	183.7	2.9	4.5	26.8	10.9	23.4	14.1	312.2
2021	21.1	17.1	0.1	8.7	184.4	2.1	4.2	34.7	11.6	23.2	16.3	323.4
2022	20.3	16.3	0.1	14.2	194.1	1.8	4.4	35.6	10.5	21.0	15.5	333.8
2023	20.7	18.2	0.1	14.2	203.6	3.6	4.1	20.6	12.0	31.2	17.9	346.3

Source: GME elaboration based on CENACE data

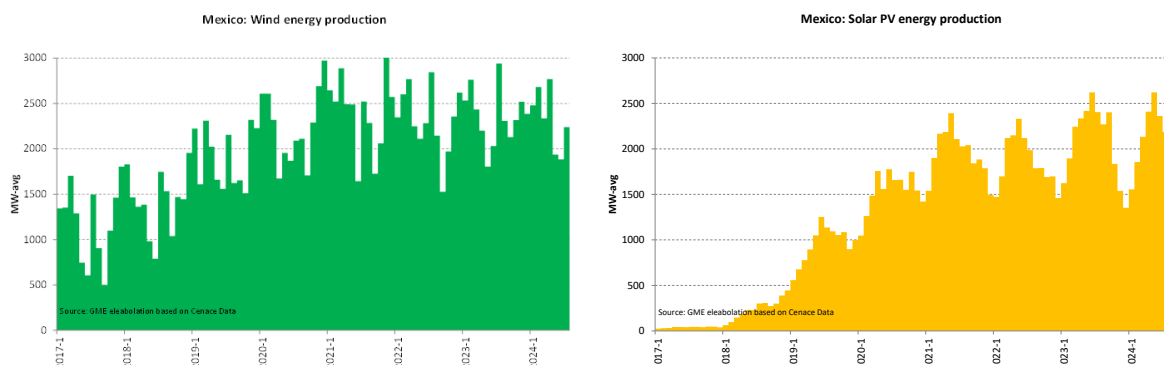
Exhibit 6: SEN's system energy generation by type (2017 -2023 chart)



The following exhibits show the historical evolution of wind and solar generation from 2017 to July 2024. The data shows a steady increase in generation, primarily driven by the continuous expansion of installed capacity in these technologies. However, over the past three years, the growth in annual energy production has been more modest, reflecting a stable energy production despite ongoing

capacity additions. This suggests that while capacity continues to rise, factors such as grid integration challenges, resource variability, or transmission network congestion effects may be influencing the solar and wind production.

Exhibit 7: SEN's historical energy generation – Solar and Wind (in MW avg.)

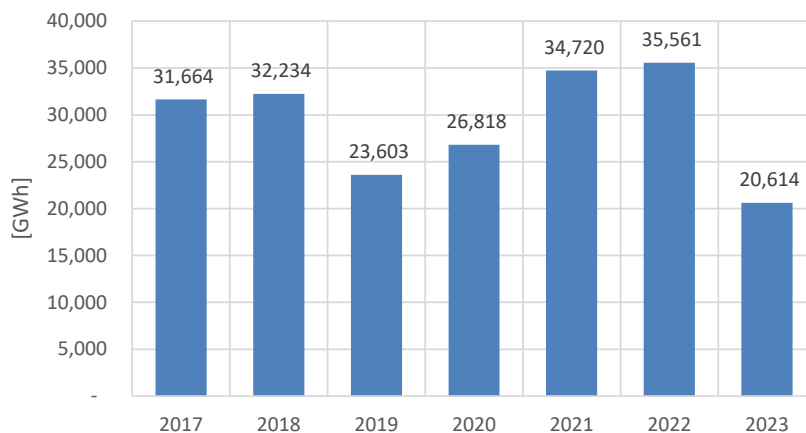


Hydropower production is inherently dependent on climatic conditions, particularly the water inflows to reservoirs, which can fluctuate significantly year to year. In 2023, Mexico experienced one of its driest years on record, severely limiting the availability of water for hydroelectric generation. As a result, hydro production fell to its lowest level in the past seven years, underscoring the vulnerability of this energy source to climatic variability.

additional pressure on overall energy supplies, as the shortfall in hydropower had to be compensated by other, often more expensive and carbon-intensive, generation methods. However, beginning in July 2024, the onset of the rainy season brought much-needed relief. The increased precipitation gradually refilled the reservoirs, allowing for a partial recovery in hydroelectric output. Despite this improvement, the impact of the preceding drought underscored the need for enhanced water management strategies and the diversification of energy sources to mitigate the risks associated with climate-induced fluctuations in hydroelectric generation.

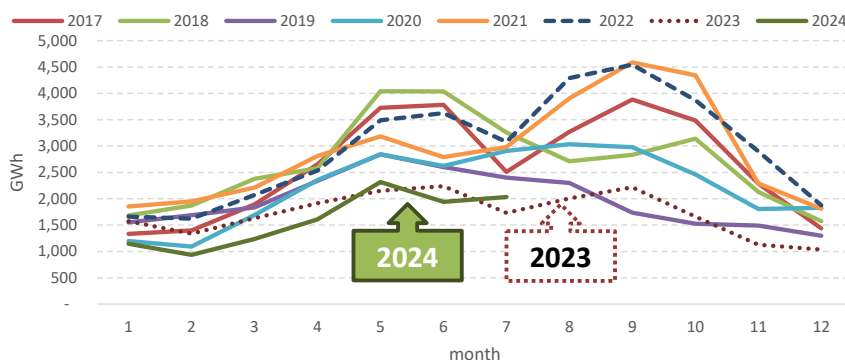
The trend of reduced hydro generation persisted into the early months of 2024, with reservoirs remaining at critically low levels. This prolonged drought period put

Exhibit 8: Historical annual hydro generation (2017-2023)



Source: GME elaboration based on CENACE data.

Exhibit 9: Historical monthly hydro generation (2017-2024)



Source: GME elaboration based on CENACE data.

4. Fuel Prices

Energy prices in Mexico, particularly Locational Marginal Prices (LMPs), are closely tied to natural gas prices, given that natural gas is the dominant fuel for thermal generation in the country. Mexico imports a substantial portion of its natural gas from the United States, primarily from the Permian and Eagle Ford basins. Consequently, the cost of natural gas in Mexico is largely influenced by U.S. benchmark prices, such as those at Henry Hub and Waha, with additional costs incurred for transportation across the border.

In 2023 and the first half of 2024, the average price of natural gas used for power generation in Mexico, derived from Henry Hub and Waha prices, was approximately 2.38 USD/MMBTU. This relatively low-price environment helped to moderate electricity costs, despite the increased demand and operational

challenges posed by the extreme weather conditions of 2023. However, it also reflects the volatility of natural gas markets, which can be influenced by a range of factors including U.S. domestic production levels, export demands, and infrastructure constraints.

The reliance on imported natural gas highlights Mexico's vulnerability to external market fluctuations and underscores the importance of diversifying energy sources. Furthermore, the transportation costs associated with importing natural gas, especially from distant U.S. basins, continue to impact the overall cost structure of electricity generation in Mexico. This situation has encouraged discussions about the potential benefits of expanding domestic natural gas production and storage capacities, as well as exploring alternative energy sources to reduce dependency on imported fuels.

Exhibit 10: 2023-2024 Natural Gas prices (Henry Hub) [USD/MMBTU].

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2023	3.27	2.38	2.31	2.16	2.15	2.18	2.55	2.58	2.64	2.98	2.71	2.52
2024	3.18	1.72	1.49	1.60	2.12	2.53	2.07					

Source: EIA.

5. Short Term Market

The spot market operates on an hourly basis, allowing market participants to buy or sell energy in real-time. Generators use this market to sell any excess energy produced beyond what was committed in their energy sales contracts, as well as to purchase additional energy if they are unable to meet their contractual obligations with their own generation. Similarly, consumers engage in the spot market to sell surplus contracted energy that is not needed to meet their demand,

or to buy additional energy if their consumption exceeds what was initially contracted.

The spot market is divided into two segments: the Day-Ahead Market (DAM) and the Real-Time Market (RTM). In the Day-Ahead Market, participants submit bids and offers for energy that will be delivered the following day, while in the Real-Time Market, transactions are settled on an hourly basis based on the actual supply and demand conditions.

Energy transactions in the spot market are valued at the Locational Marginal Prices (LMPs) at the specific node where the transaction takes place. LMPs represent the marginal cost of supplying the next increment of demand at a particular location, and they vary across different nodes due to factors such as transmission losses and congestion in the grid.

typically reaching their lowest levels during the early morning hours and peaking at night when demand is highest. Seasonal variations are also evident, with LMPs generally being lower during the winter months and higher in the summer, reflecting the increased demand for electricity during periods of extreme heat.

The table and figure below illustrate the historical evolution of LMPs at various nodes within the transmission system. LMPs fluctuate throughout the day,

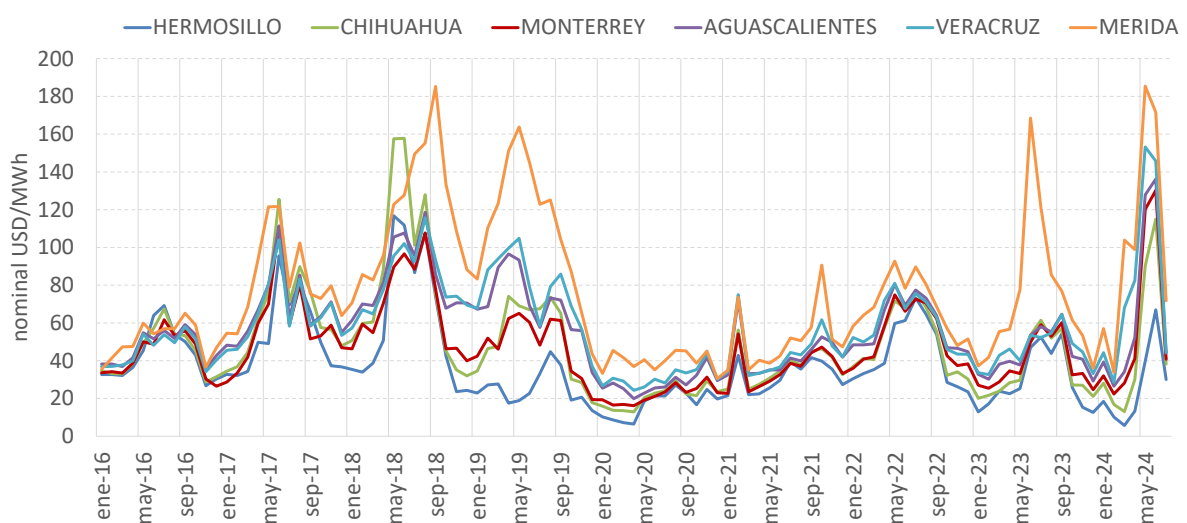
This dynamic pricing mechanism ensures that the cost of energy accurately reflects the real-time conditions of supply and demand, incentivizing efficient generation and consumption patterns while highlighting the critical role of grid infrastructure in determining energy costs.

Exhibit 11: 2019 -2024 monthly LMPs at Queretaro node in the DAM [USD/MWh]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	66.48	69.63	88.56	94.76	91.34	67.55	55.68	70.54	71.18	55.62	54.85	34.06
2020	25.68	28.62	25.23	20.07	23.16	26.20	25.74	30.82	27.19	31.57	41.76	29.57
2021	32.79	72.71	33.07	33.29	34.53	34.45	40.67	39.65	45.30	52.55	49.80	42.29
2022	49.29	48.32	48.69	65.96	78.66	67.06	75.11	71.21	62.56	45.89	45.72	44.56
2023	33.09	30.75	39.11	38.79	37.30	51.67	53.46	53.57	63.21	43.06	42.28	30.25
2024	39.98	26.58	40.61	55.55	126.81	132.00	43.17					

Source: GME elaboration based on CENACE data.

Exhibit 12: 2016 - 2024 Monthly LMPs



Source: GME elaboration based on CENACE data.

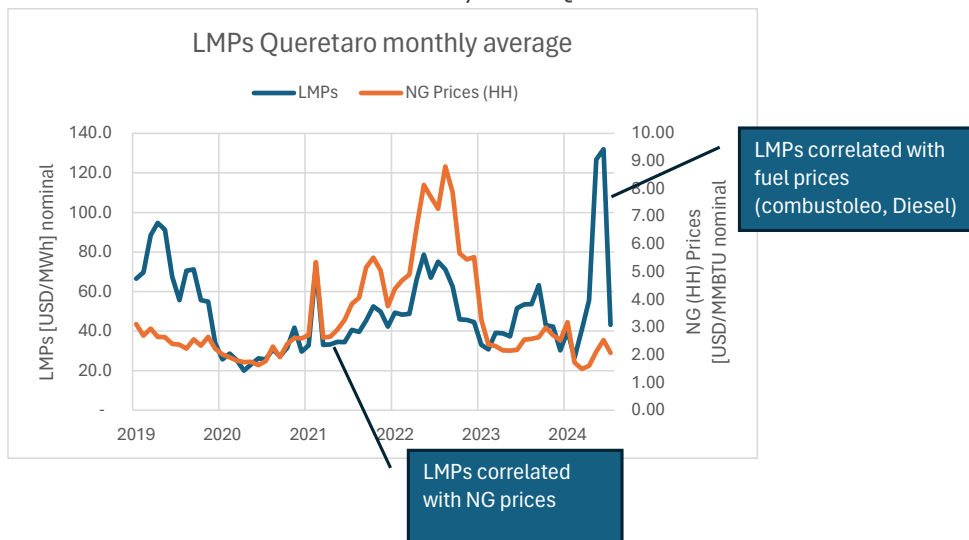
Under normal operating conditions, LMPs exhibit a strong correlation with the prices of natural gas, the primary fuel used by thermal generators. However, when generation reserves are reduced—such as during droughts or when key generation units are unavailable—the need to dispatch thermal power plants that rely on liquid fuels like fuel oil and diesel becomes more frequent. During these periods, LMPs tend to align closely with the higher costs of these liquid fuels, leading to a noticeable increase in energy prices.

In contrast, under certain operating conditions, particularly in nodes with abundant renewable energy generation (NCRE), LMPs can drop to very low levels. This occurs when renewable resources,

such as wind and solar, are able to meet a significant portion of the demand, thereby reducing the reliance on more expensive thermal generation.

The following figure illustrates the historical evolution of LMPs at the Querétaro node compared to natural gas prices at Henry Hub. As shown, there is a generally strong correlation between these prices, reflecting the dominant role of natural gas in setting electricity costs. Notably, during May and June of 2024, LMPs spiked significantly due to the impact of severe heat waves, which necessitated the increased use of fuel oil and diesel for power generation, thus driving the LMPs higher and correlating more closely with the prices of these liquid fuels.

Exhibit 13: Monthly LMPs Queretaro Node



Source: GME elaboration based on CENACE, EIA data.

5.1. LMPs in SIN Region

LMPs vary across different nodes in the power system due to the effects of transmission losses and congestion. In electricity-exporting regions, such as the North, Northeast, and Northwest of

Mexico, LMPs tend to be lower compared to other parts of the country. This is particularly evident in the Northwest region, where transmission constraints prevent the export of low-cost electricity, resulting in some of the lowest LMPs within the National Interconnected

System (SIN).

Conversely, the Peninsular region experiences some of the highest LMPs in the country. This is largely due to its limited transmission capacity, which restricts the importation of cheaper electricity from the rest of the SIN. Additionally, the region lacks sufficient low-cost generation to meet local demand, further driving up prices. A specific example of this is the Cozumel node, where inadequate transmission capacity necessitates the dispatch of expensive local thermal generation, leading to elevated LMPs.

During May and June 2024, LMPs were exceptionally high across all SIN nodes due to severe heat waves and reduced hydroelectric production. However, by July, the electrical system's operation returned to normal, and LMPs decreased to levels more typical for that time of year.

5.2. LMPs in the BC and BCS Regions

In the isolated regions of Baja California (BC) and Baja California Sur (BCS), LMPs are determined by the local supply-demand balance, as these regions are disconnected from the SIN, making it impossible to import cheaper energy or export excess energy.

The Baja California region benefits from the availability of natural gas for thermal generation, including combined cycle gas turbines (CCGTs), which helps to maintain relatively lower LMPs. In contrast, Baja California Sur has the highest LMPs in Mexico due to the absence of natural gas. The region relies heavily on fuel oil and diesel as primary fuels for thermal generation, which significantly drives up LMPs.

Exhibit 14: 2023 average LMPs heatmap for SIN, BCA, BCS [in USD/MWh]

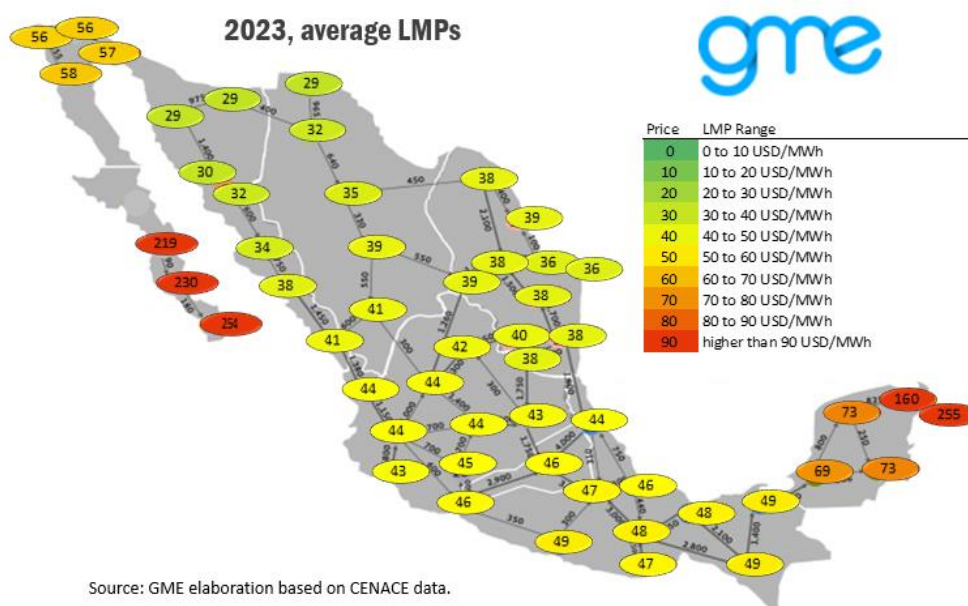
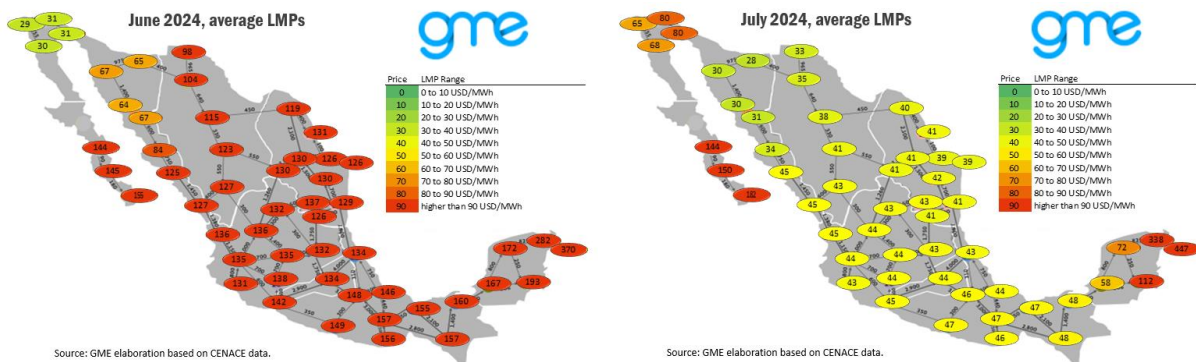


Exhibit 15: 2024 June and July LMPs heatmap for SIN, BCA, BCS [in USD/MWh]



6. Capacity Balance Market

6.1. Capacity Price

The capacity prices in the Capacity Balancing Market (CBM) are determined annually by CENACE in February. These prices are set for the SIN as well as for the isolated systems in Baja California (BC) and Baja California Sur (BCS), referred to as Capacity Zones.

For each Capacity Zone, CENACE identifies the Reference Generation Technology (TGR) and calculates the levelized fixed cost of that generating unit, which is the annuity that covers both the investment and fixed operation and maintenance (O&M) costs. This calculation ensures that the TGR can recover its investment.

The capacity price for each Capacity Zone is determined using the following formula:

$$\text{Capacity Price [USD/MW-year]} = \text{FACTOR} \times \text{Levelized fixed Cost} - \text{IMTGR}$$

Where:

- **FACTOR:** A value ranging from 0 to 2,

depending on the reserve margin. A value of 0 is applied when the reserve is more than twice the optimal reserve; 1 when the reserve is optimal; and 2 when the reserve is below the minimum. The FACTOR decreases linearly between these extremes.

- **Levelized fixed cost:** The annuity that covers the fixed costs (investment + O&M) of a TGR-type generation unit.
- **IMTGR:** The marginal income of the TGR, calculated as the difference between the LMPs and the TGR's variable costs, integrated over all the hours of the year when LMPs exceed those variable costs.

The table below shows the capacity prices for the three Capacity Zones for the 2023 production year.

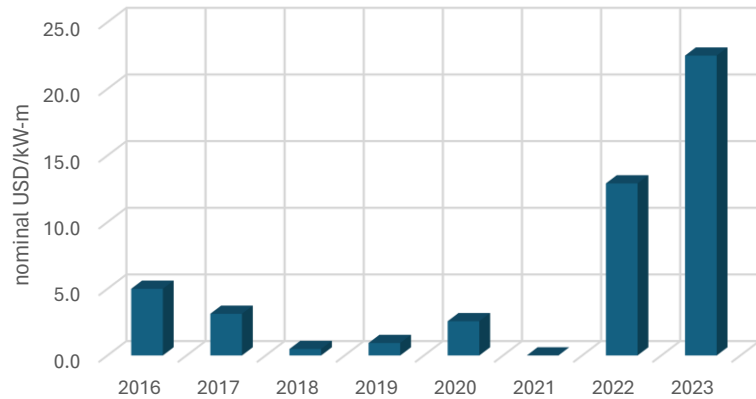
In the SIN, capacity prices have risen significantly over the past two years. These increases are largely due to higher levelized fixed costs for the TGR, and in 2023, they were further influenced by a low reserve margin.

In the BC and BCS regions, capacity prices remain high due to generation reserves being below the minimum threshold, which implies ongoing supply risks.

Exhibit 16: CBM 2016-2023 – Capacity Prices

Year	SIN USD/kW-m
2016	5.0
2017	3.1
2018	0.5
2019	0.9
2020	2.6
2021	0.0
2022	12.9
2023	22.5

Year 2023	
System	USD/kW-m
SIN	22.5
BC	11.5
BCS	26.2



Source: GME elaboration based on CENACE data.

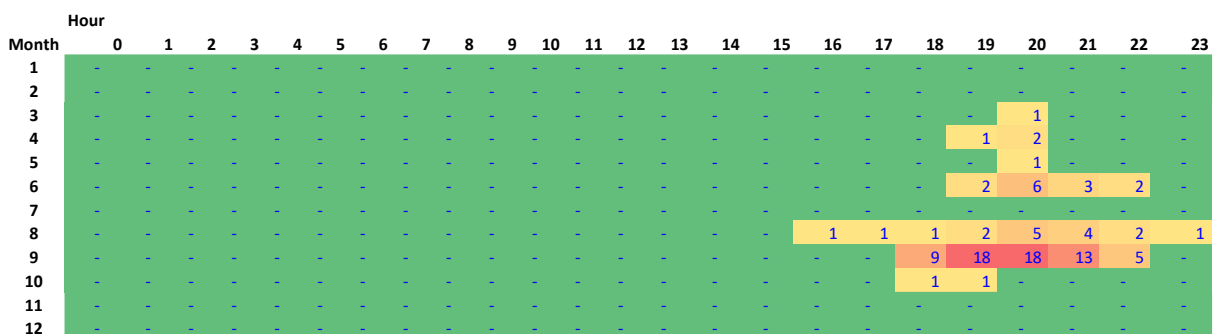
6.2. 100 Critical Hours in the SIN

The electricity market regulation designates the 100 hours of the year with the lowest generation reserve as the "100 critical hours" for each Capacity Market. The generation reserve is defined as the difference between the available capacity and the demand that needs to be met each hour. These 100 critical hours are crucial for determining capacity transactions in the Capacity Balance

Market (CBM).

In 2023, a significant number of the 100 critical hours occurred during nighttime, outside the typical summer season. This shift was primarily due to the exceptionally high demand recorded in August and September 2023, which stressed the system and reduced the available generation reserves during those periods.

Exhibit 17: CBM 2023 – 100 critical hours



Source: GME elaboration based on CENACE data.

7. New Government

In the presidential elections held in early June 2024, Dr. Claudia Sheinbaum Pardo, representing the coalition of Morena, PT, and PVEM, emerged as the winner. This coalition is projected to hold significant majorities in both chambers of Congress: approximately 69% in the House of Representatives and 59% in the Senate. The political direction of the new government is expected to be a continuation of the policies pursued by President Andrés Manuel López Obrador (AMLO)

Throughout his administration, President AMLO attempted multiple times to modify the legal framework governing the electricity and natural gas sectors. However, many of these proposed changes were either deemed unconstitutional by the courts or rejected by Congress.

In February 2024, President AMLO submitted a package of constitutional reform proposals to Congress. Among these were significant changes affecting the electricity sector, the federal judiciary, and the elimination of autonomous regulatory bodies. The main proposed changes include:

- **Article 28:** The amendment stipulates that the Mexican State will be the sole entity responsible for the national electricity system and its control. The amendment emphasizes preserving the country's energy self-sufficiency to ensure low electricity rates without profit motives, and to guarantee national security and

sovereignty through a state-owned entity, specifically the Federal Electricity Commission (CFE).

- **Article 27:** This change proposes that no private company shall have precedence over CFE, reinforcing CFE's dominant position in the energy sector.
- **Article 25:** The reform eliminates the concept of "productive state companies" currently applied to CFE and Pemex, reverting their corporate governance to that of traditional state-owned companies.
- **Second Transitional Provision:** Congress is given 180 calendar days from the enactment of the constitutional reform to make the necessary adjustments to secondary laws.

Additionally, the government has proposed the dissolution of seven autonomous agencies and the merging or elimination of 17 decentralized organizations. Among the autonomous bodies slated for elimination are the National Institute of Transparency (INAI), the Federal Economic Competition Commission (Cofece), the Energy Regulatory Commission (CRE), and the National Hydrocarbons Commission (CNH). The functions of these agencies would be absorbed by federal public administration bodies to prevent duplication of roles.

The reform aims to significantly strengthen CFE, shifting it from being just another participant in the electricity market to reclaiming its status as the dominant state-owned company, as it was before the 2014 Energy Reform.

Technical Note by



Santiago Masiriz

**Partner - Director
Energy Markets Intelligence Div.**

+54 11 4383 7378
+54 911 6493 7688 (Mobile)
Buenos Aires, Argentina
smasiriz@gme-global.com



Joaquín Stornelli

**Senior Consultant
Energy Markets Intelligence Div.**

+54 11 4383 7378
Buenos Aires, Argentina
jstornelli@gme-global.com



About GME

At GME we have been providing strategic advice to companies and institutions in the global energy market for three decades. Our interdisciplinary platform implements comprehensive solutions tailored to each type of client, at each link in the value chain.

With a team of more than 85 consultants specialized in technical, economic and regulatory aspects, we operate from five companies with strategically located offices in Argentina, Brazil, Chile, Mexico, Peru, Uruguay and South Africa. This allows us to manage more than 300 projects per year for the electricity, oil and gas, and water and sanitation sectors.

We were pioneers in global energy consulting, with the first market reforms in the 90s, and it is thanks to our expertise, our vocation for excellence, and our vision for the future that today we continue to be a strategic partner for all our clients.

Energy Market Intelligence Division



Santiago Masiriz

Partner & Managing Director

smasiriz@gme-global.com

+54 (911) 6493-7688



Gastón Lestard

Partner & Managing Director

glestard@gme-global.com



Daniel LLarens

Partner and Senior Director

dllarens@grupome.com