ERCOT 2030

Analysis of Opportunities and Risks in relation with the expansion of the generation fleet

Technical Note | October 2024

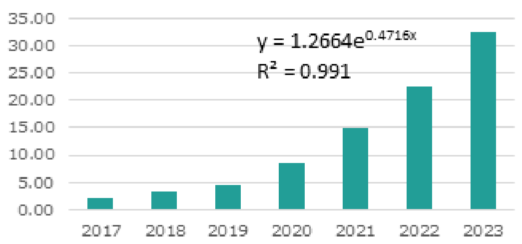
Introduction

The Texas Wholesale Electricity Market, operated by ERCOT (Electric Reliability Council of Texas), has faced, in recent years, a low level of generation reserves, which has increased the risks associated with the normal supply of the system demand. The low levels are due to several simultaneous factors: i) significant increase in the demand, ii) extreme heat waves, iii) unavailability of some power plants (mainly coal-fired), iv) increased generation from intermittent renewable sources such as wind and solar generation.

To mitigate these problems, ERCOT implemented price signals consisting of a significant rise of the market prices when reserves are low (scarcity condition)[1], thus incentivizing short-term generation availability, the hourly shifting of demand resources, and the reduction of price-sensitive electricity consumption.

As a result of these price signals (economic signals), solar PV generation has increased in recent years, showing exponential growth at an annual rate of 47%.

Figure 1: Solar PV Generation [TWh]



Source: GME based on ERCOT data

The growth of solar photovoltaic generation, along with the addition of wind generation, has added volatility to energy production, due to the intermittency of these renewable sources.

To mitigate these operational issues, the installed BESS capacity has increased in recent years, reaching 3,809 MW in 2023, providing Ancillary Services and performing intra-day energy trading (energy arbitrage).

In the medium term, a significant increase in Texas demand is expected, with estimated growth levels that could reach 25% over the next five years. This estimated growth would be explained by multiple factors, including the connection of large users, the population growth, and the increase in economic activity in Texas.

"All of that is putting together a picture of a very significant, different demand growth that is forcing us to really re-think how we're looking at planning to make sure we can meet those needs and continue to deliver on the expectations of all Texans", Pablo Vegas[2] told lawmakers in a Senate Business and Commerce Committee. The Texas Tribune, June 20th, 2024.

According to available market information, a significant increase in solar PV generation and storage resources (BESS) is expected[3]. The higher solar PV generation will probably result in low reserve levels during nighttime hours, increasing the risk of supply shortages like never before in the Texas market. Storage resources will help to mitigate these risks by using energy stored in batteries during high reserve hours to then "generate" energy during low reserve hours, performing what is known as **intra-day energy trading** (energy arbitrage). BESS can also operate by

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[1] Operating Reserve Demand Curve (ORDC)

[2] ERCOT President and Chief Executive Officer

[3] 2023 State of The Market Report for the ERCOT Electricity Markets. Potomac Economics. Independent Market Monitor for ERCOT

providing short-term fast reserves as an **Ancillary Service**.

In this document, we present an analysis of the potential expansion of Texas's generation fleet in the medium term (2030)[4] with a focus on the opportunity to develop storage resources such as BESS projects for intra-day energy trading. The analysis was conducted using GME's economic dispatch simulation models, which allow a detailed representation of ERCOT's generation supply and demand characteristics on an hourly basis.

The simulation models allow us to determine the energy generation by each power plant and storage resources, as well as the associated market prices (LMPs - Locational Marginal Prices). Power plant dispatch and market prices are determined for each hour of the year.

Based on the simulation results, the following outputs were determined:

- Expansion of solar PV generation
- Additional storage capacity for energy arbitrage
- Marginal Rent for new power plants and storage resources

Finally, we present a **SWOT** analysis (Strengths, Weaknesses, Opportunities, and Threats) of the ERCOT market, aiming to assess opportunities and risks for new generation projects for the period under study.

Disclaimer

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In accordance with these accepted standards, this document does not constitute nor in any way make a guarantee or prediction of results, and no guarantee is implied or expressed that the actual outcome will match the results presented in this document.

[4] As of May 21, 2024, ERCOT was tracking 1,780 active generation interconnection requests totaling almost 349 GW. This includes 153 GW of Solar PV, 33 GW of Wind, 145 GW of battery, and 15.5 GW of gas projects. Source: ERCOT

Market Outlook

1. Demand growth

ERCOT demand in 2023 totaled 444.5 TWh, with a peak of 85.5 GW. Currently, demand shows intra-annual variations mainly because of temperature variations, peaking in the summer months during the afternoon hours.

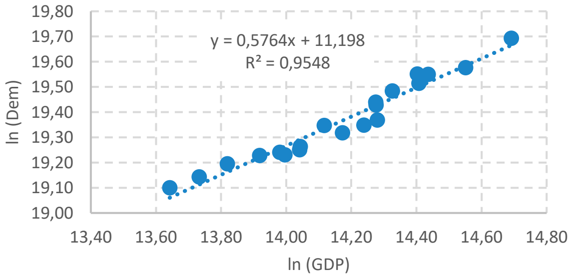
Table 1: ERCOT Demand – 12 x 24 Matrix [MW]

	Month											
Hour	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1	39,390	41,674	38,046	37,110	41,332	50,100	54,877	58,246	50,703	41,365	39,702	41,724
2	38,716	40,914	37,140	36,121	39,930	48,203	52,646	55,982	48,908	40,323	38,900	41,004
3	38,405	40,591	36,706	35,662	39,104	46,954	51,107	54,392	47,721	39,767	38,500	40,697
4	38,513	40,735	36,862	35,814	38,992	46,463	50,335	53,592	47,279	39,854	38,542	40,854
5	39,281	41,529	37,868	36,926	39,914	46,922	50,448	53,718	47,791	40,910	39,252	41,631
6	41,046	43,333	39,876	39,052	41,573	47,662	50,792	54,407	49,082	42,877	40,970	43,412
7	43,841	46,163	41,774	40,200	42,629	48,736	51,432	54,557	49,431	43,887	43,222	45,991
8	45,472	47,606	42,575	41,121	44,254	51,326	54,165	56,992	51,025	44,554	44,270	47,534
9	45,642	47,698	43,323	42,248	46,400	54,681	57,993	61,066	54,313	46,096	44,800	47,784
10	45,438	47,390	43,962	43,251	48,740	58,402	62,155	65,764	58,207	47,780	45,091	47,274
11	45,077	46,888	44,360	44,127	50,990	62,085	66,175	70,443	62,140	49,370	45,164	46,478
12	44,661	46,366	44,648	44,931	53,129	65,426	69,878	74,757	65,861	50,795	45,145	45,612
13	44,255	45,863	44,966	45,767	55,202	68,440	73,110	78,303	69,135	52,274	45,121	44,923
14	43,966	45,537	45,333	46,485	56,885	70,592	75,510	80,650	71,511	53,482	45,215	44,476
15	43,740	45,309	45,791	47,220	58,098	71,844	76,908	81,887	72,969	54,430	45,276	44,180
16	43,734	45,311	46,347	47,933	58,818	72,474	77,725	82,511	73,682	55,018	45,400	44,166
17	44,038	45,645	46,737	48,266	58,752	72,255	77,736	82,277	73,191	54,760	45,553	44,547
18	44,823	46,135	46,531	47,819	57,621	70,951	76,665	80,858	71,118	53,495	46,096	46,001
19	46,215	47,205	46,238	46,979	55,783	68,647	74,433	77,926	68,329	52,975	46,989	47,293
20	46,204	47,581	46,414	46,800	54,506	66,095	71,496	75,180	66,325	51,883	46,593	47,114
21	45,742	47,062	45,427	45,686	52,996	63,948	69,164	72,651	63,597	50,092	45,867	46,794
22	44,771	46,067	43,680	43,356	50,041	60,453	65,553	68,744	59,958	47,596	44,680	46,063
23	43,085	44,317	41,502	40,722	46,646	56,598	61,637	64,637	56,244	44,920	42,859	44,635
24	41,364	42,460	39,467	38,521	43,717	53,120	58,001	60,906	52,974	42,691	41,006	43,075

Source: GME based on ERCOT data

Over the past 10 years, ERCOT demand has grown at an average rate of 2.8% per year. Demand growth is strongly correlated with the economic activity growth in Texas (GDP), with an elasticity=0.57, as shown in the following figure.

Figure 2: Correlation between Electricity Demand and GDP



Source: GME based on ERCOT and IMF data

Note: Demand elasticity to GDP is 0.576

Assuming this 2.8% annual growth rate continues, peak demand in 2030 will be 18 GW higher than in 2023. Additionally, considering forecasts of new demand from the expansion of the Permian Basin power grid and the demand from new data centers, peak demand could increase by 25 GW between 2024 and 2030, resulting in a peak demand of 110 GW. In the following analysis, it is assumed that this new peak demand will be reached by 2030. The conclusions of the study are also valid for the year when the 25 GW demand increase is effectively realized.

1.1. Net demand

The projected growth of solar generation will lead to significant changes in the net demand, which must be met by thermal generation and ultimately determine market prices.

$$\text{Net Demand (h)} = \text{Demand (h)} - G_{REN}\text{ (h)}$$

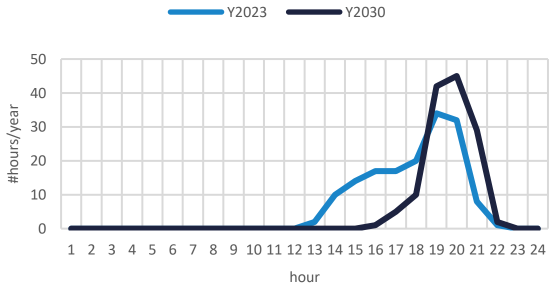
Where:

G_{REN}: Hourly total production from renewable generators (wind, solar, hydro)

These changes in the net demand will have two important effects:

- Peak net demand will be concentrated during nighttime hours, between 19:00 and 21:00, as shown in the following figure. This figure indicates the number of times during the year when the demand at each hour exceeds 90% of the annual peak demand.

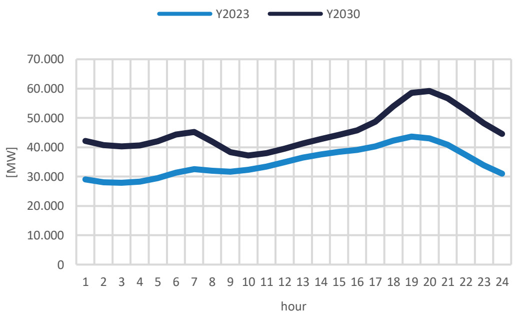
Figure 3: Hourly Net Demand (p90) – Frequency of Occurrence



Source: GME

- Net demand will be lower during daytime hours when solar production is at its peak.

Figure 4: Hourly Net Demand (Annual Average)



Source: GME

These two effects will tend to reduce market prices during daytime hours and increase prices at night, resulting in what is known as the "Duck Curve" of market prices.

The direct consequences will be:

- The reduction in profitability for solar projects due to lower captured energy prices.
- The need for generation units with flexible operation, including storage, to respond to hourly variations in net demand and provide reserves during nighttime hours.

2. Expansion of the generation fleet

2.1. Baseline scenario

The calculation of solar capacity additions, including storage, is carried out considering the following criteria:

- Demand is met with an adequate quality of service.
- New generation projects cover their development costs (fixed plus variable costs) by selling their energy production in the spot market.
- Load Serving Entities (LSE) purchase their energy requirements at minimum total cost.

The generation technologies competing to meet demand are:

- Natural gas combined cycles (NG-CCGT)
- Flexible thermal generation (GT, engines) operating with natural gas
- Photovoltaic solar projects (solar PV)
- Wind projects (wind)
- Battery energy storage systems (BESS)

The following table presents the levelized costs of the above four generation technologies and the storage systems (BESS).

Figure 5: Levelized Costs of Generation Units

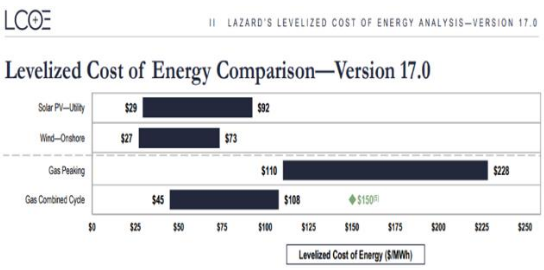
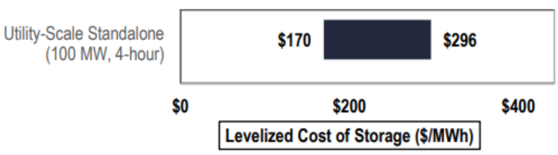


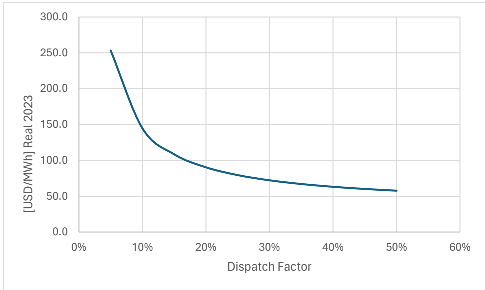
Figure 6: Levelized Costs of BESS



Source: LAZARD'S, LEVELIZED COST OF ENERGY, June 2024

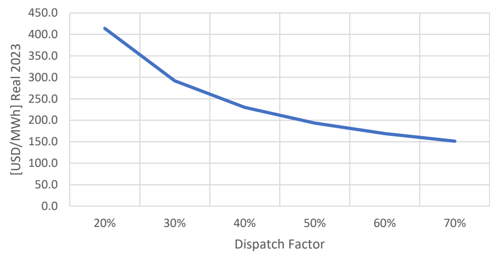
Note: The levelized costs of flexible thermal generation ("gas turbine") and batteries depend on the Dispatch Factor (DF) (time they are generating (hours/year)), as shown in the following figure.

Figure 7: Gas Peaking Levelized cost



Source: GME

Figure 8: BESS Levelized cost



Source: GME

For the economic viability assessments of the different technologies, the following levelized cost values are considered. Captured energy prices higher than these values will lead to a strong economic incentive for the expansion of the generation and storage facilities.

Table 2: ERCOT – Assumed Levelized Costs by Technology

Technology	Levelized cost USD/MWh (real 2023)
CCGT fired w/natural gas (NG-CCGT)	50.0
Solar PV	40.0
Wind	40.0
Gas Turbine (GT) FD:15%	110
BESS 4hs FD:40%	230

Source: GME

Due to their technical characteristics, combined cycle gas turbine (NG-CCGT) power plants can supply demand 24 hours a day. On the other hand, solar PV generators have their energy production restricted to daytime hours and will therefore only compete for supply the system demand during those hours. Flexible thermal generators, due to their lower thermal efficiency, will typically produce energy during low reserve hours, competing directly with BESS.

The "Baseline scenario" is defined as the hourly energy prices curve that ensures that a Combined Cycle Gas Turbine (NG-CCGT) project has an annual remuneration from energy sales in the spot market sufficient to cover its levelized costs. It determines the installed capacity in new NG-CCGT plants required to achieve the aforementioned prices.

In addition will consider that renewable projects (solar PV, wind) will be economically feasible if, by selling energy at the baseline scenario prices, can cover their respective levelized costs. Flexible thermal projects will be economically viable if, by selling energy during low reserve hours, they can cover their levelized costs in direct competition with BESS.

Energy prices are proportional to natural gas prices. The analyses are conducted considering average monthly natural gas prices equal to those recorded in 2023.

Table 3: Natural gas Henry Hub Prices

[real 2023 USD/MMbtu]

	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

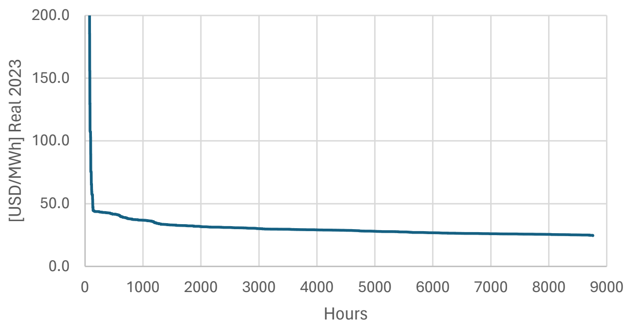
Source: EIA

The average monthly market prices for the year 2030 and the price duration curve are presented in the following table and figure. They show high LMPs during the summer months, with a frequency of occurrence of 1000 hours/year. During the rest of the year, LMPs have values consistent with the variable operating costs of NG-CCGT plants (aprox. 30 USD/MWh). The annual average LMP (50.5 USD/MWh) is consistent with the levelized cost of NG-CCGT, which determines the Baseline.

Table 4: LMPs (2030). monthly average (real 2023 USD)

Month	(2030) USD/MWh
1	33,45
2	27,97
3	26,50
4	25,60
5	26,72
6	39,48
7	42,94
8	208,25
9	81,76
10	32,03
11	29,60
12	28,39
Annual	**50,47**

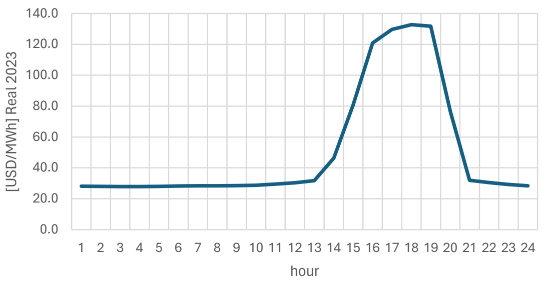
Figure 9: LMPs duration curve (2030)



Source: GME

The following figure shows the hourly annual average market prices for the Baseline scenario. It can be observed that LMPs show an important difference between hours of the day, the highest LMPs being between hours 15 and 20. During the rest of the hours, LMPs are around 30 USD/MWh.

Figure 10: LMPs – Hourly annual average (2030)



Source: GME

The market prices of the Baseline case provide a strong economic signal for the expansion of solar generation, as prices are high during solar production hours. The price captured by a Solar PV project is 74.2 USD/MWh, which is significantly higher than the levelized cost of the same technology, estimated at 40 USD/MWh.

The market prices of the Baseline also encourage the development of BESS for intra-day energy trading (energy arbitrage), as they can buy energy during low-price hours and sell it during high-price hours.

The economic signal for promoting the expansion of solar PV generation and BESS will be highly dependent on the addition of new capacity of these technologies. As new capacity is incorporated into the system, LMPs will progressively decrease, potentially making additional solar capacity economically unfeasible. This risk scenario is analyzed in the following section.

2.2. Expansion of solar PV generation

Solar PV generation cannot meet the expected demand growth during the 24 hours of the day due to its hourly production pattern. Particularly during nighttime hours, when maximum daily demand values are expected to occur.

This situation leads to the fact that solar PV generation only captures LMPs during the hours that the power plant is generating energy. These captured prices tend to be different from the prices determined for the Baseline case.

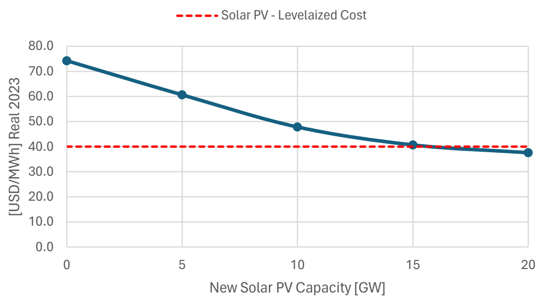
In this regard, captured prices will decrease due to the addition of solar PV generation, as solar production will reduce the output from thermal generation.

The following figure shows the prices captured by a solar PV project as a function of the addition of new solar capacity, for the year 2030. The values shown assume that the Baseline is maintained, and thus, the projects remain competitive compared to NG-CCGT thermal generation.

Table 5: New Solar PV Captured Prices (2030)

Installed Capacity [GW]	Captured Prices [USD/MWh]
0.00	74.2
5.0	60.6
10.0	47.8
15.0	40.7
20.0	37.6

Figure 11: Solar PV Capture Prices (2030)



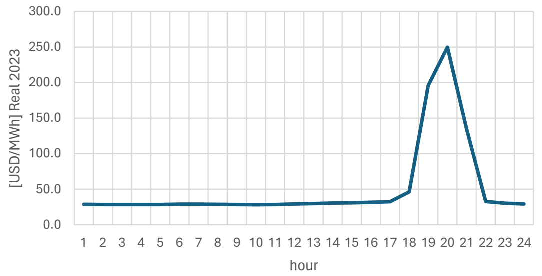
Source: GME

The prices captured by solar PV generation decrease, falling below the levelized cost of the technology (estimated at 40 USD/MWh) for additional installed capacity greater than 15 GW. Therefore, this amount of solar PV capacity is the maximum that is economically feasible to install in ERCOT (by 2030) without considering the addition of BESS facilities.

2.3. Integration of BESS facilities

The expansion of solar PV generation results in very high LMPs during the late afternoon and evening hours when there is no solar production, and thus the electrical system's reserve margin is minimal, as shown in the following figure.

Figure 12: LMPs – Hourly average (2030) included Solar PV expansion



Source: GME

Batteries are charged during low LMP periods and then discharge energy during low reserve hours with high LMPs. The difference in LMPs between charging and discharging periods must cover the cost of charging and discharging losses (approximately 15%).

Storage facilities can operate together with a solar PV generator, known as a "hybrid generator," or as "standalone storage" not associated with a power plant.

The economic feasibility analysis for integrating storage facilities in ERCOT is conducted considering projects with a storage capacity of 4 hours, an efficiency of 85%, and performing intra-day energy trading (energy arbitrage). Revenues from the provision of Ancillary Services are not included in the economic feasibility analysis.

The operation of BESS is based on the LMPs determined for each hour of the day. LMPs are highest during summer months, which results in maximum energy generation by the BESS during this period, as shown in the following figure.

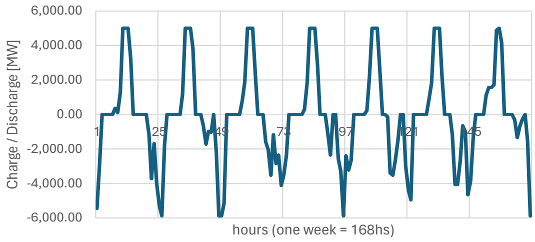
This figure shows the monthly energy injected by a set of BESS with a total installed capacity of 5 GW and a duration of 4 hours. The maximum monthly injection is 620 GWh (in July), indicating that in this month, the BESS produces energy at full capacity every day (EG MAX = 5 GW x 4 h/d x 31 d/m = 620 GWh/m).

Figure 13: BESS dispatch (2030)

Source: GME

The following figure shows the typical operation of the BESS during the 168 hours of a week in July. Positive values correspond to the energy supplied to the transmission grid each hour, while negative values represent the energy consumed from the grid each hour to change the batteries. Battery charging occurs during the late hours of the day and early morning hours when LMPs are at their lowest. Energy injection takes place during hours of peak LMPs.

Figure 14: BESS weekly operation – Total installed capacity: 5 GW



Source: GME

The addition of storage facilities in ERCOT will impact the LMPs, resulting in changes to the prices captured by solar PV generators. The following table shows the captured prices for solar generation and BESS, for different scenarios considering increases in BESS capacity of up to 15 GW.

Table 6: Captured Prices for Increases in BESS Capacity

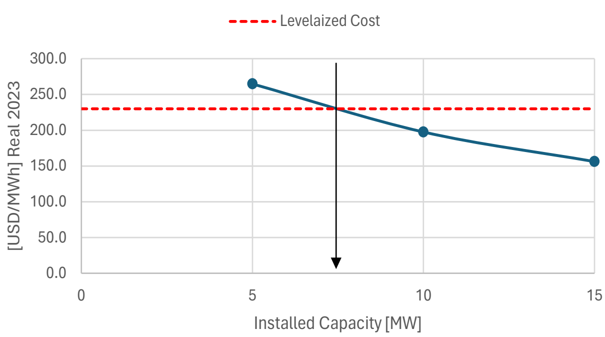
Installed capacity		Captured Prices		BESS
Solar PV	BESS	Solar PV	BESS	Dispatch
[MW]	[MW]	[USD/MWh]	[USD/MWh]	Factor
15	0	40,7		
15	5	50,0	264,8	38%
20	5	40,4	292,1	39%
Installed capacity		**Captured Prices**		**BESS**
Solar PV	**BESS**	**Solar PV**	**BESS**	**Dispatch**
[MW]	[MW]	[USD/MWh]	[USD/MWh]	**Factor**
15	10	57,7	197,6	35%
20	10	49,7	195,9	36%
Installed capacity		**Captured Prices**		**BESS**
Solar PV	**BESS**	**Solar PV**	**BESS**	**Dispatch**
[MW]	[MW]	[USD/MWh]	[USD/MWh]	**Factor**
15	15	56,5	156,2	28%
20	15	47,1	136,3	29%

Source: GME

Adding 5 GW of BESS leads to an increase of the potential additional solar PV capacity to 20 GW (by 2030). The prices captured by the batteries are higher than their levelized cost (230 USD/MWh), indicating that both technologies can be developed simultaneously.

The following figure shows the BESS captured prices as a function of the additional installed BESS capacity. As the installed capacity increases, the captured prices decrease. The equilibrium point, which determines the maximum addition of BESS capacity without captured prices falling below the levelized cost, is around 7.5 GW.

Figure 15: BESS Captured Prices



Source: GME

The captured prices, considering a total BESS capacity of 7.5 GW, are indicated in the following table. The captured prices for both technologies are higher than their respective levelized costs, making the addition of this capacity economically feasible.

Table 7: Captured Prices for a 7.5 GW Increase in BESS Capacity

Installed capacity		Captured Prices		BESS
Solar PV	BESS	Solar PV	BESS	Dispatch
[MW]	[MW]	[USD/MWh]	[USD/MWh]	Factor
20	7,5	44,9	252,6	39%

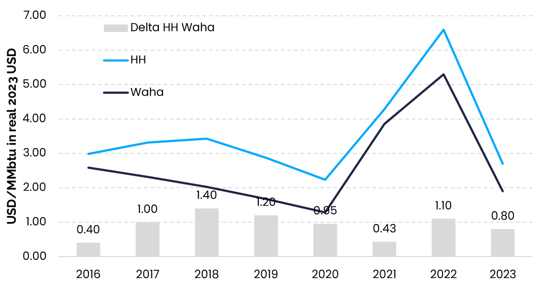
Source: GME

3. Congestion costs

The LMPs corresponding to the Baseline scenario depend significantly on natural gas prices, as the fuel cost is the main component of the levelized cost for a thermal generator.

In Texas, natural gas prices vary significantly between the Permian Basin, located in the west, and east region where most of the natural gas demand is concentrated. The following figure shows the historical evolution of prices in the Permian Basin (Waha) and East Texas (Henry Hub). A variable price differential is observed, averaging around 1.0 USD/MMbtu.

Figure 16: Natural Gas Prices at Henry Hub and Waha – Historical Evolution



Source: GME

In the future, this price differential is expected to decrease as natural gas transport capacity between the Permian Basin and East Texas increases. Long-term equilibrium values for the price differential are estimated at 0.4 USD/MMbtu.

Due to the difference in natural gas prices, the Baseline scenario for thermal generators located in West Texas, in the Permian Basin, which purchase natural gas at the Waha price, will be 3.0 to 7.0 USD/MWh lower than the generators that purchase natural gas at the Henry Hub price in East Texas.

Since natural gas transportation via pipelines competes with electricity transmission through transmission networks, and with both gas and electricity transportation capacities being limited, congestion costs in the transmission system between West and East Texas will also be in the range of 3.0 to 7.0 USD/MWh on an annual average, potentially higher during daytime hours due to increased solar production.

These congestion costs will primarily affect the expansion of solar generation in West Texas, making projects developed in this area less profitable.

4. Risk analysis (SWOT matrix)

Strengths

- ERCOT is a highly competitive electricity market, which results in energy prices that encourage the expansion of the generation fleet.
- The need for LSEs (Load Serving Entities) to secure the supply for their consumers (to hedge against price stricks risks) makes them willing to enter long-term contracts with generators at prices compatible with the levelized costs of competing generation technologies.
- Economic incentives for the development of renewable generation (wind, solar PV) will lead to greater volatility in energy production, which will increase the demand for storage solutions.

Weaknesses

- Generators Revenues come from energy sales and participation in Ancillary Services; there is no capacity remuneration to stabilize generators' income.
- It is necessary to enter into supply contracts with LSEs to stabilize generators' income.
- Renewable generation, much of which is located in western TX, requires intensive use of the transmission system to deliver energy to the major load centers in the east of Texas.

Opportunities

- The electricity market is operating with low generation reserves, leading to high energy prices.
- The expected growth in demand (approximately 25 GW in the next 5 years) will require the addition of new generation capacity.
- Scarcity prices provide a strong economic signal for the construction of new power plants.
- Peak demand is concentrated during nighttime hours, increasing the need for flexible generation and BESS solutions as a way of achieving a secure and minimum-cost supply.
- The reduction in capital costs for renewable generation observed in recent years improves the competitiveness of these technologies, supports the energy transition, and contributes to consumer resilience by having less dependence on external conditions.
- Some forecasts predict increases in natural gas prices in the medium term, with prices at Henry Hub reaching between 3.5 and 4.0 USD/MMbtu. If these increases occur, renewable projects will become more competitive in comparison with thermal projects.

Threats

- Transmission system congestion can lead to curtailment of renewable generation and significant congestion charges.
- Low natural gas prices in western Texas reduce the Baseline scenario for renewable generation in that region.

Conclutions

The analysis of the additional generation capacity required to meet the expected demand growth (25 GW in the next 5-7 years) indicates that solar PV will continue to grow. This is due to market price signals, which result in captured prices for solar PV generation exceeding its levelized costs. The installed capacity of solar PV generation could increase by 15-20 GW in the next 5-7 years, with this expansion being economically viable.

The increase in solar generation will affect the operation of the electricity market, resulting in high LMPs during the late afternoon and evening hours, when the system's generation reserve is minimal.

These changes in the market operation will allow the installation of storage systems (BESS) for intra-day energy trading (energy arbitrage). It is expected for the BESS installed capacity for arbitrage purposes to increase by 5-10 GW in the next 5-7 years, with this expansion being economically viable. This capacity will be in addition to the BESS capacity installed for the provision of Ancillary Services. The equilibrium point, which determines the maximum addition of BESS capacity without captured prices falling below the levelized cost, is around 7.5 GW. This maximum may be increased by specific conditions in some ERCOT areas that maximize energy arbitrage revenue.

Transmission network congestion will promote the addition of storage systems for intra-day energy trading, as BESS charging typically occurs during daytime hours when transmission congestion results in lower LMPs.

Subsidies for renewable generation development will lead to a greater expansion of these technologies, which will further reduce LMPs during solar hours, favoring the expansion of storage systems.

Our management team

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Education

Industrial Engineer with specializations on Natural Gas.

Gastón Lestard. International Energy Expert

Mr. Gastón Lestard is a director of the Energy Market Intelligence division and Partner at GME, with more than 20 years of experience in power system operation, economic studies, and regulatory frameworks for the electricity industry. Gastón background is in Industrial Engineering and holds a specialization degree in Natural Gas from the Institute of Petroleum and Natural Gas, University of Buenos Aires, Argentina.

He specializes in wholesale energy markets with extensive experience in the use of optimization models and energy project evaluation. Since 2000, he has been running mathematical models and performing tasks simulating the operation of hydro-thermal generation systems, economic dispatch, and calculation of marginal prices.

He has participated in numerous studies of electricity and natural gas supply in Latin American countries and the Caribbean region. He was part of studies on energy efficiency in the design of energy scenarios and emissions generated by electric and natural gas systems in several countries.

He has been a leader advisor in business assessment studies of non-conventional renewable generation, advising developers, lenders, and IFIs. He has participated in regulatory studies related to variable cost declarations, contract market design, renewable promotion, etc. He has led seminars for foreign investors describing cost-based pool markets.

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Education

MBA, Industrial Engineer with both specializations on Natural Gas and Petroleum industry.

Santiago Masiriz. International Energy Expert.

Mr. Santiago Masiriz is a director of the Energy Market Intelligence division and Partner at GME with a background in Industrial Engineering, specializing in Natural Gas and Petroleum (University of Buenos Aires - Argentina). He holds a master's degree in business administration (MBA) from Torcuato di Tella University.

Mr. Masiriz has more than 24 years of experience in the energy sector comprising corporate, consulting, and academic activities. His career track record includes a gas transport company, an international energy group operating in Latin America, and one of the largest gas traders in Argentina. His main capabilities are related to project management, energy policy, strategy and regulation, energy market studies, advice in oil and gas pricing/contracting, corporate planning, business development, and commercial support, among other skills.

Mr. Masiriz has conducted and participated in several energy projects and studies in the LAC region managing more than 100 projects per year.

Daniel LLarens

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Education

Electrical Engineer. International Expert in electricity wholesale market regulation and operations.

Daniel LLarens. International Energy Expert.

Daniel Llarens has been a partner since the beginning and one of the senior consultants at GME group, with more than 30 years of experience in the electricity sector with a special focus on wholesale market operations.

In the last 35 years, he has led more than 500 power plant dispatch, economic, and regulatory assessment projects throughout Latin American countries. In his career as a consultant, he has directly provided advice to more than 50 companies and investors in the development and valuation of generation and transmission businesses in all Latin American countries and regional markets.

He is an expert in the regulation of the Electricity and Natural Gas sectors, planning of electrical systems (generation, transmission), pricing of electrical generation and determination of transmission costs, calculation of rates for regulated companies, and analysis of the operation and dispatch of hydrothermal systems, economic valuation of energy generation, transmission, and distribution projects.

He worked at the Wholesale Electricity Market Administration Company (CAMMESA) in Argentina in the Regulatory area and at the Technological Research Institute for Electrical Networks and Equipment (IITREE) of the Faculty of Engineering, National University of La Plata (UNLP) in the Studies of Power Systems area.

Daniel Llarens is an Electronic Engineer from the National University of La Plata, Argentina.

Our Simulation Tools

GME has multiple tools for simulating the operation of electricity markets, analyzing opportunities and risks of investment projects in the generation segment, and determining strategies for the purchase of energy by large consumers.

Below is a brief summary of the features of the software available in GME.

SDDP

SDDP Dual Dynamic Programming (SDDP) algorithm, developed by PSR-Brazil, is a powerful tool for solving large-scale multi-stage optimization problems under uncertainty. It is widely used in the energy sector for mid- and long-term operational planning.

SDDP models the operation of hydrothermal systems, integrating various energy sources like hydroelectric, thermal, and renewable energy. It helps in optimizing the generation and distribution of electricity by considering uncertainties such as water inflows, fuel prices, and demand variation

shttp://www.psr-inc.com

Key Features:

- Hydro generation and Electrification Modeling: It can model the hydro generation supply chain and its integration into the electrical system.
- Flexible Demand Modeling: It includes features for demand-side management, allowing for the modeling of energy consumption shifts in industrial, commercial, and residential sectors.
- Probabilistic Reserve Calculation: It provides a dynamic evaluation of forecast errors in renewable energy sources, translating these errors into systemic reserve needs

SDDP is a global benchmark, applied in over seventy countries, and is crucial for efficient and sustainable energy planning

OPTGEN

OptGen is an advanced expansion planning model developed by PSR. It is widely used by ministries, regulatory agencies, and planning departments of public and private companies globally. The main objective of OptGen is to support integrated energy planning, focusing on creating a cleaner, affordable, flexible, and resilient energy future

https://www.psr-inc.com/en/news/psr-announces-the-worldwide-release-of-optgen-8-0/

Key Features:

- Resilience in Planning: Incorporates extreme scenarios like droughts, severe temperatures, and interruptions in fuel imports to ensure continuity of supply.
- Co-Optimization: Balances investment costs and operating costs, considering both probabilistic and extreme scenarios.

- New Candidate Projects: Includes options for concentrated solar power plants (CSPs) and hydrogen and electrification processes.
- Expansion Plan Dashboard: Provides detailed investment and operating results.

PLEXOS

PLEXOS is a powerful energy market simulation software developed by Energy Exemplar. It is designed to provide analytics and decision support for modelers, generators, and market analysts across various energy markets, including electric, water, gas, and renewable energy

https://www.energyexemplar.com/plexos

Key Features:

- Unified Data Streams: PLEXOS integrates multiple data streams into a single platform, allowing for comprehensive energy modeling and forecasting.
- Simulation Engine: It offers precise simulations for zonal and nodal energy models, covering long-term investment planning, medium-term operational planning, and short-term market simulations
- Co-optimization: The software can co-optimize electricity, water, and gas systems, providing a holistic view of the energy landscape.
- Flexibility: Users can configure PLEXOS with various scenarios, constraints, and variables, making it adaptable to different modeling needs
- Transparency: All equations, objective functions, and constraints used in simulations are open for review, ensuring transparency in the results.

BESS Optimization

It is a simulation model developed by GME that allows determining the optimal operation of a storage medium within a predetermined time window. The optimal operation is the one that allows maximizing the income from intraday energy trading (Energy arbitrage) considering the technical characteristics of the equipment (stored energy, efficiency, time window for optimization). The model performs the optimization using the CPLEX software (IBM(R) ILOG(R) CPLEX(R) Interactive Optimizer 12.8.0.0).

EMPP (**E**lectricity **M**arkets **P**rice **P**rojection Software)

A simulation model called **EMPP**, developed by GME, allows determining energy prices in electricity markets. It is an innovative approach for risk assessment in power markets with high participation of renewable generation (wind, solar) and thermal generation. The model determines market prices considering the randomness in the typical production of renewable generation and the randomness in the availability of thermal power plants due to forced failures. Market prices are determined through a convolution algorithm applied to the probability functions that characterize energy demand, the randomness in the production of renewable generation, and the availability of thermal generation units. The calculation methodology is considered superior to Monte Carlo-type methodologies used by other simulation programs. The market prices determined by the **EMPP** model provide relevant information for consumers to evaluate energy purchase alternatives correctly and for investors in new generation capacity to determine the profitability of their projects. In particular, the correct determination of energy prices in periods of scarcity allows storage media (BESS) to be correctly sized so that they can provide a quickly managed reserve and thus improve the reliability of the electrical system.

PSS®E

The Power System Simulator for Engineering (PSS®E) is a comprehensive software tool developed by Siemens for simulating and analyzing electrical power transmission networks. It is widely used by power system engineers for both operational and planning purposes

https://www.siemens.com/global/en/products/energy/grid-software/pss-energyip/pss-energyip-contact.html

Key Features:

- Power Flow Analysis: Allows for the calculation of steady-state voltages, currents, and power flows in the network.
- Dynamic Simulation: Models the system's response to disturbances over time, helping to assess stability and performance under various conditions.
- Short Circuit Analysis: Evaluates the system's behavior during fault conditions, essential for protection system design.
- Contingency Analysis: Identifies potential system weaknesses by simulating the loss of critical components and assessing the impact
- Optimal Power Flow: Optimizes the operation of the power system to minimize costs or losses while meeting operational constraints
- Voltage Stability: Analyzes the system's ability to maintain acceptable voltage levels under different loading conditions.
- Transient Stability: Assesses the system's ability to remain stable following large disturbances, such as faults or sudden load changes

PSS®E is known for its high performance and flexibility, making it a preferred choice for power system analysis in over 140 countries.

Our Clients

The consulting group carries out approximately 80 to 100 market studies per year. Some of our clients are:

ACTIS

AES

Akuo Energy

ASHMORE Investment

Atlas Renewable Energy

Bank of America

BCIE – Banco Centroamericano de Integración Económica

Blackrock

Brookfield

CAF – Corporación Andina de Fomento

Canadian Solar

Citi

Contour Global

Copenhagen Infrastructure Partners

Credit Suisse

Credit Agricole

Cubico Investment

DNB Bank

EDF

Enel Green Power

Engie

EMPOWER

FRV

GENNEIA

GIC Infrastructure

Google

Goldman Sacks

IDB – International Development Bank

IFC – International Finance Corporation

IIC - Inter-American Investment Corporation

Invenergy

Isquared Capital

Interenergy

Jinko Solar

JP Morgan

Macquire Capital

Mainstream

Mitsubishi

Mitsui

MBA Lazard

MIP - Mexico Infrastructure Partners (MIP)

MPC Capital

Pattern Energy

Samsung

Scatec Solar

SMBC – Sumitomo Mitsui Bank Corporation

WB - World Bank

X-Elio

About GME

At GME we have been providing strategic advice to companies and institutions in the global energy market for nearly 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 70 consultants specialized in technical, economic and regulatory aspects, we operate from five companies with strategically located offices in Argentina, Brazil, Chile, Mexico, Peru, Texas, 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.

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