California Independent System Operator Corporation

California ISO

Assessment of potential competitiveness in the energy imbalance market:

Tucson Electric Power Balancing Area

September 23, 2021

Department of Market Monitoring

TABLE OF CONTENTS

1 Introduction

This report provides an analysis of potential market power in the western energy imbalance market (EIM) within the Tucson Electric Power (TEP) balancing authority area (BAA). The analysis uses data provided by TEP for the 18 month period January 2020 to June 2021. The report assesses the potential competitiveness of the TEP area in EIM based on the expected amount of competitive supply that may be transferred into the TEP area from the broader EIM footprint, compared to an approximation of imbalance demand that is expected to be served by the EIM in the TEP BAA.[1]

This analysis indicates that the TEP area will likely be structurally competitive in most intervals in EIM when EIM transfer capacity is available in the range of the estimated levels provided by TEP.[2] The analysis further indicates that during the likely limited number of intervals when the TEP area may be structurally non-competitive, the CAISO's market power mitigation processes provide highly effective mitigation of the potential to exercise market power.

1.1 Energy imbalance market

In the California ISO area, the majority of demand is met by supply procured or scheduled in the day ahead market. The CAISO's real time markets serve primarily to adjust and optimize unit commitments and dispatches in response to changes in system and market conditions and information.

In the EIM, however, almost all system load is served by resources identified in the base schedules of the EIM entities in each BAA. These base schedules are not determined by the automated market systems of the ISO and are not settled by the ISO or paid the EIM prices. The EIM is a real time market which starts from the base schedules for these BAAs and then adjusts and optimizes to best meet the imbalance needs of the aggregate EIM area.

In all EIM areas, only a small portion of total energy produced and consumed is settled by the ISO and paid based on EIM prices. Generating resources that receive or pay the EIM price are scheduled by the EIM entity. The only generation settled on EIM prices is the incremental amount scheduled in the EIM relative to each resource's base schedule. If market power is exercised in EIM, it is exercised on those EIM imbalance quantities. Any measure of competition or market power should be centered on those quantities as the measures of supply and demand.

For a seller to have structural market power in the EIM, some kind of barrier must limit supply from new or outside (third-party) entities. The limited nature of electric transmission can create potential market power in some regions. Any area that can be isolated by limited transmission can be subject to high

[1] The report uses hour-ahead forecast and hourly actual data provided by TEP for total BAA load and losses to estimate hourly imbalance demand for the BAA. These data approximate the 15-minute and 5-minute imbalance demand that will be served by EIM.

[2] Before participation in EIM begins, only an estimate of EIM transfer limits is known. Actual transfer capacity available to TEP in the EIM the will vary by hour and interval, based on available ATC on the applicable transmission paths. However, this analysis uses a conservative estimate of EIM import transfer capacity. Therefore, findings of this analysis are likely robust to some degree of inter-hour variation in EIM transfer capacity, due to the amount by which even a conservative estimate of EIM transfer capacity exceeds estimated imbalance demand.

prices and the effects of uncompetitive behavior if a single seller controls enough generation in the area behind the constraint.

Transfers in the 15-minute and 5-minute EIM processes allow competitively priced sources of power to flow between BAAs, providing access to the BAA for competitive resources from outside areas. The limits of the transfers cap the amount of competitive supply that can be supplied from outside the BAA. In the EIM's 15-minute market and 5-minute market, competitive supply available to meet incremental demand is the transfer capacity that is incremental to the quantity of transfers occurring the prior market. If the imbalance demand in a given market is greater than the incrementally available import transfer capability, some supply from within the BAA is necessary to meet imbalance demand.

A market is not structurally competitive if a single producer can determine market outcomes. In a structurally competitive market, demand can be met without supply from that single producer. If demand cannot be met without that key producer, that producer is said to be *pivotal*. They can effectively dictate the market price. A *pivotal supplier* test compares demand to competitive supply in order to determine if the key supplier is pivotal. Competitive supply used in the pivotal supplier test consists of supply that can reach the market but is not controlled by the key supplier.

In most EIM areas, the additional imbalance needs that cannot be met by transfers from other areas would have to be met by the EIM entity's generation. In an interval where the imbalance demand is greater than the incremental transfer limits, the EIM entity could theoretically set prices up to the bid cap, knowing that they are pivotal and at least one of their resources would need to be dispatched to meet imbalance energy demand. In such intervals, the EIM entity could determine market outcomes and set market prices at extremely high levels in the absence of any special market power mitigation provisions.

1.2 Demand for imbalance energy

The relevant demand for each portion of the CAISO's multi settlement markets involves the sum of *changes* between two market solutions. In the CAISO, the 15-minute market demand is equal to (1) the sum of all generation in the 15-minute market *minus* (2) the sum of all generation in the day-ahead market. This represents the incremental energy dispatched by the 15-minute market to meet incremental demand in the 15-minute market. Using the changes to generation to quantify imbalance energy demand accurately captures the quantity of imbalance energy dispatched by the market. This approach is preferable to comparing load forecasts across markets, as the load forecast in each market can underestimate or overestimate the actual market demand due to possible changes in self-schedules, renewable output, resource outages, and other factors.

In the EIM, entities do not participate in the day-ahead market, but instead submit hourly base schedules that are treated very much like day-ahead market schedules in the CAISO. For each EIM BAA, the imbalance quantity demanded in the 15-minute EIM market is equal to changes made by the market between base schedules and the final 15-minute schedules. Similarly, the imbalance quantity demanded in the 5-minute EIM market is equal to changes made by the market between the 15-minute and 5-minute schedules.

For an entity that has not yet begun participation in the EIM, there are no historical data of EIM base schedules, 15-minute EIM generation dispatches, or 5-minute EIM generation dispatches from which to estimate imbalance demand. In lieu of actual EIM market data, we can approximate the imbalance

demand expected to be served by EIM through the use of historical hourly imbalance demand data provided by the incoming EIM entity. Where generation schedule data are not available, deriving imbalance demand from data on forecasted and actual load and losses may be used as a reasonable approximation. Supply is scheduled and produced in these quantities to maintain control area balance.

2 Supply and demand in the energy imbalance market

For this report, DMM analyzed historical imbalance demand derived from data provided by TEP, expected EIM transfer limits, and generation ownership in the TEP BAA.[3] These data are compiled for the 18 month period from January 2020 through June 2021.

2.1 Demand for imbalance energy

Figure 1 shows the distribution of the hourly demand for imbalance energy in the TEP BAA for this 18 month period (in MW). Figure 2 highlights the distribution of hourly imbalance energy demand over this period as a percentage of total load in the TEP BAA. Actual EIM imbalance demand will occur at 15-minute and 5-minute granularity, and the amount of intra-hour variation is unknown. However, assessing the best available hourly data is likely to provide a reasonable approximation of what may materialize in EIM. Table 1 and Table 2 provide summary statistics for these data.

As seen in Figure 1, historical hourly demand for imbalance energy in the TEP BAA is roughly normally distributed. Hourly imbalance demand averaged -4 MW with a median value of -3 MW (see Table 1). The close values for the average and median suggest a symmetric distribution.

As shown in Table 1, the demand for imbalance energy was positive during about 47 percent of hours. During hours with positive imbalance demand, the average imbalance demand was about 34 MW. Table 2 shows that the median hourly imbalance demand a percent of total demand was about 1.6 percent.

Table 1. Hourly imbalance demand (MW)

Average	Median	Intervals demand positive	Average positive demand	Percentiles 90th	95th	97th
-4	-3	47%	34	50	72	88

Table 2: Hourly imbalance demand as share of total load (absolute value)

Median	90th	95th	97th
1.6%	4.5%	6.0%	7.2%

[3] For this analysis, hourly demand for imbalance energy in the TEP BAA is calculated as the difference between actual and hour-ahead forecasted control area load and losses. Data were provide directly to DMM by TEP.

Figure 1. Hourly demand for imbalance energy for the TEP BAA
January 2020 to June 2021

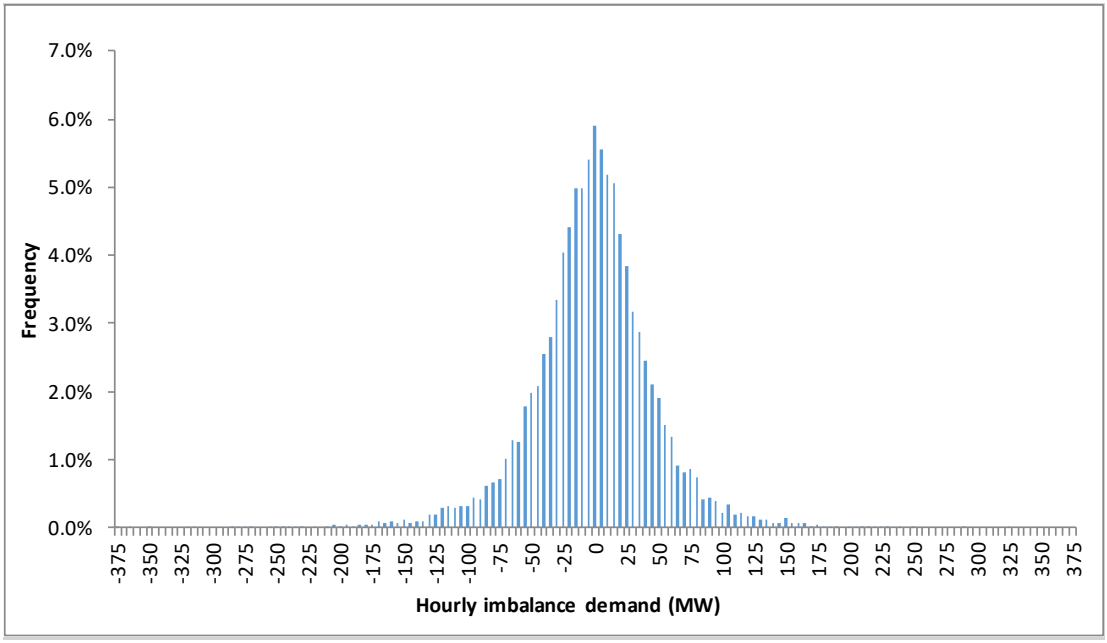
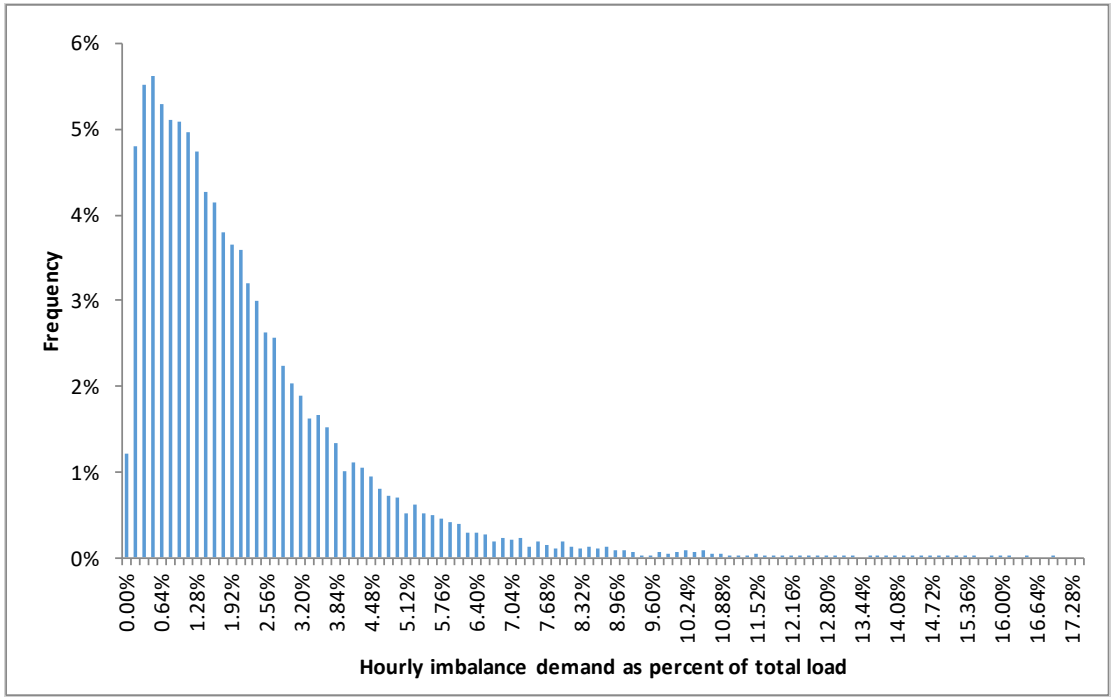


Figure 2. Hourly imbalance energy demand compared to total load for the TEP BAA
January 2020 to June 2021



2.2 Competitive supply of imbalance energy

The competitive supply available to meet EIM internal demand consists of supply that is not controlled by the generation arm of the EIM entity for that BAA or one of its affiliates. In many EIM areas, most or all of the available competitive supply is from outside the EIM BAA in the form of EIM transfers. EIM import transfer capacity represents supply that is incremental to base schedules and available to meet imbalance demand.

To determine the competitive supply that will potentially be available to the TEP BAA in EIM, we consider the EIM import transfer capacity that TEP expects to be available in EIM. These data provided by TEP represent an estimate of expected import transfer capacity for study purposes. Actual EIM transfer capacity will vary by hour and interval, based upon available ATC on the relevant transmission paths. Table 3 shows the estimated lower bound of EIM import transfer capacity expected by TEP from all interconnected BAAs.[4]

Table 3. Potential competitive supply from EIM into TEP (MW)

Source	Limit
Total	721

TEP expects to have EIM transfer capacity with multiple other BAAs in EIM, including AZPS, PNM, PACE, SRP, LDWP, and CISO. As shown in Table 3, total estimated competitive supply through EIM import transfer capability is expected to significantly exceed historical hourly imbalance demand for the TEP BAA, shown in Table 1.

Table 4 summarizes the ownership of incrementally dispatchable generation expected to participate in EIM in the TEP BAA.[5] As shown in Table 4, all expected dispatchable EIM participating capacity in the TEP BAA is owned by the TEP.

Table 4. Ownership of dispatchable generation in TEP BAA expected to participate in EIM

Fuel Type	EIM participating capacity (MW) TEP
Natural gas	2185
Coal	1079
Energy storage	77
Total	3341

[4] TEP provided a historical monthly estimate of total ATC that would be available for EIM transfer capacity for the period May 2020 – April 2021. Estimated total monthly values of EIM import transfer capacity that may be available range from 721 MW to 1896 MW. Our analysis assumes the minimum of 721 MW as a lower bound of EIM import transfer capacity that may be available. This assumption produces conservative estimations of likely competitiveness of the TEP BAA in EIM. Additional EIM import transfer capacity will only increase the competitiveness of the TEP BAA in EIM.

[5] Capacity from EIM participating resources that are not expected to be available for incremental dispatch is not reflected here. This includes solar and other renewable resources.

3 Structural market competitiveness

3.1 Pivotal supplier test

The pivotal supplier test for structural market power in EIM asks this question: could imbalance demand within the EIM BAA have been met by transfers of competitive supply from other unaffiliated BAAs? If so, then the EIM entity was not pivotal in that interval and could not have successfully raised prices at that time. In a structurally competitive market, the exercise of market power would be difficult and opportunities to do so would be rare.

The pivotal supplier test can be performed using historical data for individual intervals in EIM by calculating how often competitive supply was able to meet imbalance demand in the TEP BAA. When the level of competitive supply is below imbalance demand, TEP would be pivotal.

In the absence of EIM market data for the TEP BAA, we estimate the expected outcome of this test for the TEP area using currently available data. This estimation compares the historical hourly imbalance demand data for the TEP BAA to a lower bound of the EIM import transfer limits TEP estimates will be available in the EIM.

This analysis shows that over the 18 month period examined in this report, there were no hours where the estimated hourly imbalance demand was greater than the conservative estimate of expected EIM import transfer supply. This suggests that TEP may be reasonably expected to have access to competitive supply in EIM that significantly exceeds typical imbalance demand.

As noted above, EIM import transfer limits can change hourly and across intervals, based on available ATC on the relevant transmission paths. Further, imbalance demand may vary intrahour by an unknown amount. Despite these caveats, the estimate based on available data should provide a reasonable expectation of overall competitiveness of the TEP area in EIM.

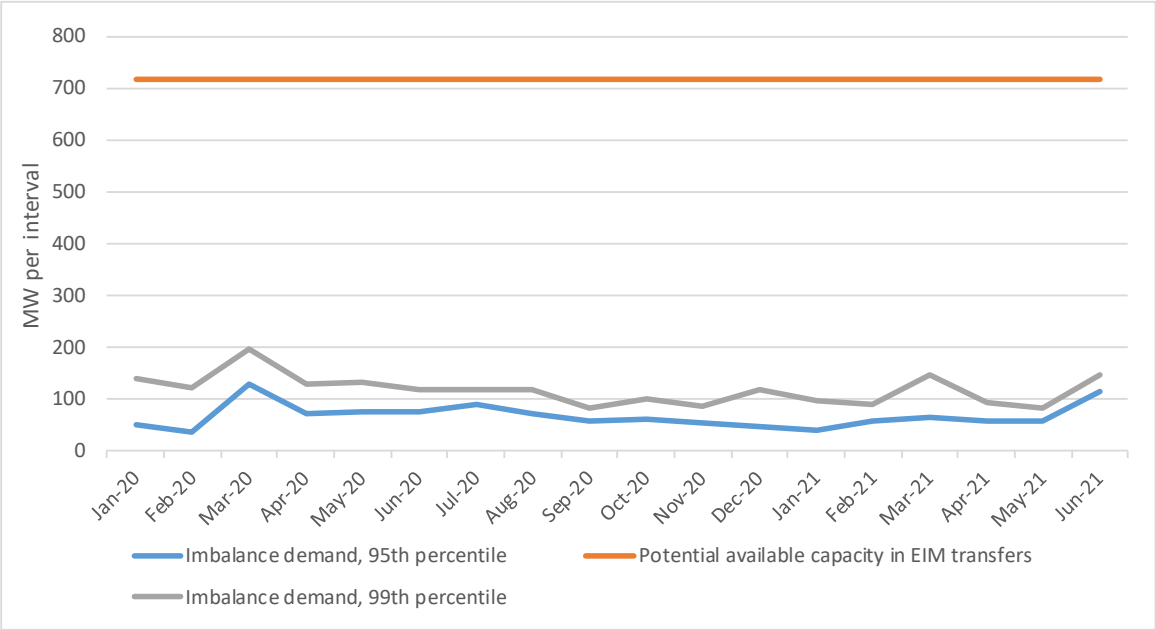
The expected structural competitiveness of the TEP BAA in the EIM can also be estimated based on statistical values of supply and demand. Figure 3 provides a comparison between estimated lower bound of EIM import transfer capacity, representing competitive supply, and the 95th and 99th percentile of historical hourly imbalance demand.[6]

Estimated competitive supply exceeded both the 95th and 99th percentile of imbalance demand during each month of the study period. In the closest months, expected competitive supply is about five times the volume of the 99th percentile of imbalance demand.

These results show that estimated EIM supply and demand conditions were competitive during the study period for the TEP BAA. Import transfer capacity at the estimated level, and values significantly below the estimated level, would have allowed resources from other parts of EIM to compete with resources controlled by TEP in all hours.

[6] If we use the average demand over some period of time to compare to average transfer capacity, we will include the negative intervals and may provide an underestimate of the size of the market. Therefore, instead of comparing average competitive supply to average demand, we compare average competitive supply to imbalance demand during intervals with particularly tight supply conditions.

Figure 3: TEP hourly imbalance demand and expected EIM import transfer capacity



3.2 Energy bid mitigation

This analysis based on estimated historical hourly imbalance demand and expected EIM transfer capability suggests that the TEP BAA is likely to be generally competitive in EIM. However, there still exists the possibility in EIM that during some intervals, TEP may become a pivotal supplier and competitive supply from the broader EIM into the TEP BAA may be limited by congestion. When this occurs, this potential structural market power would be mitigated by the CAISO's real-time market power mitigation procedures. These bid mitigation procedures are triggered when congestion is projected in the real-time market.

When bid mitigation is triggered, bids of all supply within a BAA that is separated from the CAISO BAA are automatically subject to bid limits based on each resource's marginal cost and competitive system prices. Thus, even when access to competitive supply is limited by congestion, effective market power mitigation ensures that the resulting price is typically still competitive.

The CAISO implemented enhancements to its real-time bid mitigation procedures in the 15-minute market in Q3 2016 and in the 5-minute market in Q2 2017. DMM analysis shows that with these enhancements, CAISO's market power mitigation processes have a high degree of accuracy of congestion estimation for all existing EIM transfer constraints. This reduces the possibilities of missed mitigation to a very low level for each of the existing EIM BAAs in both the 15-minute and 5-minute market, as shown in Table 6 and Table 7.

Table 6: Accuracy of congestion prediction by region on EIM transfers, 15-minute market January 2020 – June 2021[7]

	Accurately predicted	Predicted but resolved	Under predicted
PACE	93%	4%	3%
PACW	91%	5%	4%
PGE	90%	5%	4%
BCHA	89%	7%	4%
PSEI	90%	5%	4%
IPCO	92%	4%	4%
SCL	91%	5%	4%
PNM	81%	13%	6%
BANC	100%	0%	0%
NWMT	88%	10%	2%
NEVP	96%	2%	2%
TIDC	89%	5%	5%
SRP	95%	2%	3%
AZPS	90%	6%	4%
BANCSMUD	97%	1%	1%
LDWP	91%	4%	4%

[7] Data for SRP and SCL begin April 2020. Data for BANC end March 2021, and are thereafter included with BANCSMUD. Data for BANCSMUD and TIDC begin March 2021. Data for PNM begin April 2021. Data for NWMT begin June 2021.

Table 7: Accuracy of congestion prediction by region on EIM transfers, 5-minute market January 2020 – June 2021[8]

	Accurately predicted	Predicted but resolved	Under predicted
PACE	70%	23%	7%
PACW	73%	18%	9%
PGE	72%	18%	10%
BCHA	70%	20%	10%
PSEI	74%	16%	9%
IPCO	72%	21%	7%
SCL	75%	16%	9%
PNM	44%	49%	7%
BANC	84%	11%	5%
NWMT	78%	16%	5%
NEVP	71%	24%	5%
TIDC	75%	19%	6%
SRP	77%	19%	4%
AZPS	69%	23%	8%
BANCSMUD	69%	22%	10%
LDWP	70%	25%	6%

4 Conclusion

This report provides analysis by DMM evaluating the potential for market power in EIM in the TEP area. Although TEP has not yet begun participation in EIM and no market data are yet available, we analyzed estimated hourly imbalance demand derived from data provided by TEP, generation ownership in the TEP BAA, and an estimated amount of EIM import transfer capacity that TEP anticipates will be available in EIM.

This analysis indicates that the TEP BAA is likely to be structurally competitive during almost all intervals in the EIM due to the amount of estimated competitive supply expected to be available for transfer into TEP from the rest of the EIM.

The report also shows that CAISO's real-time market power mitigation procedures provide assurance that any potential market power in the TEP BAA will be effectively mitigated when the TEP area is separated by congestion from the CAISO and other EIM areas.

[8] Data for SRP and SCL begin April 2020. Data for BANC end March 2021, and are thereafter included with BANCSMUD. Data for BANCSMUD and TIDC begin March 2021. Data for PNM begin April 2021. Data for NWMT begin June 2021.